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ii) Crop Planning based on Rainfall Analysis and Moisture Availability Index (MAI) in the Central Brahmaputra Valley Zone (CBVZ) of Assam	Jyotishman Goswami
iii) Simulation modelling of Winter Rice ( <i>Oryza sativa</i> L) using DSSAT model in Agroclimatic condition of Jorhat	Nikhil Shrishail Paschapur
iv) Crop suitability mapping using GIS for the upper Brahmaputra valley zone of Assam	Saranga Bordoloi
v) Quantification of thermal and radiation regimes on growth and yield of aromatic rice in Jorhat district of Assam	Silpa Rajkhowa
<b>5.6. Agronomy</b>	<b>427 – 462</b>
i) Effect of varying drip irrigation level and N K fertigation on direct seeded autumn rice ( <i>Oryza sativa</i> L.)	Abhinandan Chetia
ii) Zinc fortification in maize <i>Zea mays</i> through soil and foliar application	Anupriya Yadav
iii) Nutrient and weed management in buckwheat ( <i>Fagopyrum esculentum</i> ) after <i>sali</i> rice	Bamon Timung
iv) Performance of quality protein maize ( <i>Zea mays</i> L.) under different crop management practices	Gargi Kashyap

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|-------|--|------------------------|
| v)    | Agronomic bio-fortification of fodder maize ( <i>Zea mays</i> L.) with boron and zinc                                | Himangshu Deka         |
| vi)   | Effect of Phosphate Solubilising Bacteria (PSB) on fodder productivity of cowpea in acid soil                        | Jishnu Pratim Mudoi    |
| vii)  | Effect of varieties and integrated nutrient management practices in rapeseed and mustard under rice fallow situation | Keisham Dony Devi      |
| viii) | Irrigation scheduling in rapeseed using Can evaporimeter   | Krishna Bharadwaj      |
| ix)   | Crop diversification in organic rice ecosystem   | Merajul Hussain        |
| x)    | Integrated nutrient management in summer maize ( <i>Zea mays</i> )   | Minakshi Bezboruah     |
| xi)   | Intercropping of buckwheat and lathyrus in rice fallow under organic ecosystem                                       | Nayan Jyoti Bordoloi   |
| xii)  | Nutrient and weed management in rainfed toria by organic methods   | Prostuti Bora          |
| xiii) | Studies on potato crop as affected by planting date and nutrient management  | Rajibul Hoque Mullah   |
| xiv)  | Response of rainfed late sown toria in rice fallows as influenced by application of sulphur and boron and sulphur    | Rekhankona Pegu        |
| xv)   | Nutrient management in rapeseed through organic sources  | Sonam Lhamu            |
| xvi)  | Performance of direct seeded sali rice under two different crop establishment methods and weed management practices  | Vigneshwaran M         |
| xvii) | Organic weed management in aromatic rice under two different systems of establishment                                | Yerradoddi Sindhu Sree |

### **5.7. Crop Physiology**

**463 – 476**

- |    |   |              |
|----|---|--------------|
| i) | Effects of Manganese on some rice genotypes in acid soil of Assam | Aisina Yomso |
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- ii) Regulation of vase life and quality of gerbera (*Gerbera jamesonii*) by postharvest chemical application Anirban Saikia
- iii) Effect of jatropha leaf extract and seed oil on okra (*Abelmoschus esculentus* L.) Jeffrey Malsawmzuala
- iv) Phenotyping of some cultivated and wild banana germplasm of NE India under rainfed and irrigated conditions of Assam Nishita Pathak
- v) Physiological performance of lentil genotypes under late sown condition in rice fallow as influenced by rhizobacteria (*Pseudomonas fluorescens*) Reshme Moirengjam
- vi) Impact of high temperature and carbon dioxide on plant growth and beneficial rhizospheric microbes of rice Supriya Sarma Rajkhowa
- vii) Study on growth and yield of green gram (*Vigna radiata* L. Wilczek) under high level of CO<sub>2</sub> Tarique Aziz

### 5.8. Entomology

477 – 503

- i) Studies on predator-prey and host-parasitoid relationship involving sucking pests and its entomophages in mulberry ecosystem Arindam Khanikar
- ii) Efficacy of certain newer insecticides against major insect pests of okra, *Abelmoschus esculentus* (L.) Moench Arpita Das
- iii) Bioassay of some plant extracts against banana leaf and fruit scarring beetle (*Nodostoma subcostatum* Jacoby, Coleoptera: Chrysomelidae) Baishali Boruah
- iv) Avifaunal diversity in Rice Agro ecosystem Chiranjeeb Sonowal Borah
- v) Evaluation of Two Native Entomopathogenic Nematodes against Termite (*Odontotermes obesus*) and Cutworm (*Agrotis ipsilon*) K. Sindhura Bhairavi
- vi) Comparative biology of *Callosobruchus chinensis* (L.) under different colour cues Komedit Chamua

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|---|-----------------------|
| vii) Application of Vastu Shastra for house design in Jorhat City   | Khumukcham Jenita     |
| viii) Morphology of sensilla of lac insect, <i>Kerria chinensis</i> (Kerriidae: Hemiptera)  | Nang Himadri Chowsong |
| ix) Pests scenario of tea, <i>Camellia sinensis</i> (L.) O. Kuntze, and management of red spider mite, <i>Oligonychus coffeae</i> Nietner by newer acaricidal molecules   | Parthiban. M          |
| x) Botanicals for Tea Insect Pest Management  | Ritushree Mahanta     |
| xi) Brood rearing and foraging activity of stingless bee ( <i>Tetragonula iridipennis</i> Smith) in cucumber ( <i>Cucumis sativus</i> Linnaeus) under protected condition | Sourav Sen            |
| xii) Haemocyte Morphology and Cellular Immune Response in Cabbage butterfly, <i>Pieris brassicae</i> (L.) against <i>Beauveria bassiana</i> (Bals.)Vuill.                 | Sravanthi Erla        |
| xiii) Evaluation of release methods of Trichogrammatids (Hymenoptera: Trichogrammatidae) against lepidopteran pests of cabbage  | Tanbir Hazarika       |
| xiv) Effect of gamma irradiated rice seeds against certain insect pests of rice   | Uddipana Shandilya    |

#### **5.9. Extension Education**

**504 – 532**

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|--|--------------------|
| i) Resource Integration in <i>bari</i> system farming: A study in Jorhat district of Assam   | Ashish Hazarika    |
| ii) An exploratory study on the utilization of Information and Communication Technologies (ICTs) by extension field functionaries and farmers for farm communication | Biplab Gogoi       |
| iii) A study on the effectiveness of Agricultural Technology Information Centre (ATIC), AAU, Jorhat  | Chiranjeeta Dutta  |
| iv) A Study on the Extent of Adoption of Recommended Muga ( <i>Antheraea assamensis</i> ) Rearing Practices in Lakhimpur District of Assam                           | Jagat Jyoti Baruah |

- v) Training need assessment of agricultural input dealers in Upper Brahmaputra Valley Zone (UBVZ) of Assam Lisha Bordoloi
- vi) A Study on the factors influencing entrepreneurial behaviour of the members of Farmer Producer Company with reference to commercial potato production Manisha Barman
- A Study on Technological Gap in Adoption of Recommended Practices of Khasi Mandarin (*Citrus reticulata*) Cultivation by the Growers in Tinsukia District of Assam Pankaj Dahal
- vii) Preference of farm women towards sericulture as income generating activity- a study in Sivasagar district of Assam Rekamoni Gogoi
- viii) Information needs and information seeking behaviour of farmers in relation to organic vegetable production in two agro climatic zones of Assam Sanjana Bora
- ix) Perceived assessment of utilization pattern of remittance – A study on interstate migration from Assam to Kerala Shinu Thomas
- x) An appraisal of Farmer Producer Organisation operating in Assam And Karnataka Somesh Hiremath

#### 5.10. Horticulture

533 – 572

- i) Effect of seed priming and germination media on growth, flowering, and seed production of annual bedding dahlia (*Dahlia variabilis*) Biprajit Datta Choudhury
- ii) Nutrient management in Thailand ber (*Zizyphus mauritiana*) Bipul Das
- iii) Studies on effect of different mulches on growth and yield of chilli (*Capsicum annum* L.) Chayanika Das
- iv) Standardization of propagation of jackfruit (*Artocarpus heterophyllus* Lam.) by grafting Debashree Baruah
- v) Response of chinese cabbage (*Brassica campestris* ssp. *Pekinensis*) to organic amendments Dilsha Chandran

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|--------|---|------------------------------|
| vi)    | Integrated Nutrient Management in Lemon var. Assam lemon ( <i>Citrus limon</i> L. Burm.)  | Eleza Baro                   |
| vii)   | Ready-to-reconstitute soup mix from <i>Moringa</i> leaf and <i>Mentha</i> leaf powders  | Jadhav Priyanka<br>Yashwant  |
| viii)  | Response of garden pea ( <i>Pisum sativum</i> L.) to foliar application of zinc   | Lupita Borah                 |
| ix)    | Standardization of growing media and assessment of plant species suitable for Vertical Gardening  | Madhushree Ghosh             |
| x)     | Studies on different exotic varieties of Lettuce ( <i>Lactuca sativa</i> ) in agro-climatic condition of North Bank Plain zone of Assam | Mrutyunjaya Behera           |
| xi)    | Performance of radish ( <i>Raphanus sativus</i> L) cv Japanese white as influenced by organic inputs and microbial consortium           | Nandeesh J                   |
| xii)   | Organic amendments on growth, yield and quality of strawberry ( <i>Fragaria x ananassa</i> Duch.)                                       | Pooja Rayanna<br>Bastawadkar |
| xiii)  | Response of Bitter Gourd ( <i>Momordica charantia</i> L.) to organic amendments   | Raktim Kiran Das             |
| xvii)  | Growth performance of some gladiolus cultivars in paired row system   | Rocktim Baruah               |
| xviii) | Effect of dehydration methods on quality parameters of drumstick ( <i>Moringa oleifera</i> Lam.) leaves                                 | Sahinur Ahmed                |
| xix)   | Impact of seed priming and priming durations on early season okra [ <i>Abelmoschus esculentus</i> (L.) Moench]                          | Sarath Krishna R             |
| xx)    | Rice Distribution System Through Co-operative Societies and Fair Price Shops in Jorhat district of Assam                                | Tabarak Hussain              |
| xxi)   | Development of a beverage powder using Elephant apple ( <i>Dillenia indica</i> ) and whey   | Udangshree Borah             |
| xxii)  | Effect of growth regulators on Assam Lemon ( <i>Citrus limon</i> L)   | Wahedullah Bakhtari          |

<b>5.10.1 Food Science &amp; Technology (Horticulture)</b>	<b>533 – 572</b>
i) Preparation and analysis of whey based fruit beverage	Ananya Borah
ii) Quality of elephant apple ( <i>Dillenia indica</i> L.) powder as affected by drying methods	Aradhana Boruah
iii) Ready-to-reconstitute soup mix from <i>Moringa</i> leaf and <i>Mentha</i> leaf powders	Jadhav Priyanka Yashwant
iv) Studies on quality of dried Oyster mushroom ( <i>Pleurotus ostreatus</i> ) and Milky mushroom ( <i>Calocybe indica</i> ) as influenced by various pre-treatment and selected drying temperatures	Nastalina Borah
v) Development of Vinegar from Rice Varieties of Assam with Herbal Incorporation	Pratikshya Dutta
vi) Formulation of ready-to-use curry powder for ethnic cuisines of North East India	Priyankhi Kalita
vii) Development of a beverage powder using Elephant apple ( <i>Dillenia indica</i> ) and whey	Udangshree Borah
<b>5.11. Nematology</b>	<b>573 – 582</b>
i) Survey and management of root-knot nematode, <i>Meloidogyne incognita</i> on tuberose, <i>Polianthes tuberose</i>	Abhijit Chetia
ii) Bio-management of rice root knot nematode, <i>Meloidogyne graminicola</i> through native fungal bioagent	Indumoni Phukan
iii) Mechanism of <i>Lantana camara</i> leaf extracts in the management of <i>Meloidogyne incognita</i> on tomato	Kankana Bordoloi
iv) Management of root knot nematode ( <i>Meloidogyne incognita</i> ) in Tomato by Bacterial Bioagent	Karter Nyodu
v) Characterization and evaluation of Heterorhabditis bacteriophora	Madhumita Goswami
vi) Antagonistic crop biomass as a tool for improving carrot yield in root knot nematode ( <i>Meloidogyne incognita</i> ) infested field	Mirlona Rongpipi



- vii) Histopathological and biochemical changes in traditional rice cultivars due to rice root-knot nematode *Meloidogyne graminicola* Priyanka Gogoi
- viii) Effect of Silver Nanoparticles on the development of root knot nematode (*Meloidogyne incognita*) in Green gram Rishikesh Phukan

#### 5.12. Plant Breeding and Genetics

583 – 612

- i) Characterization of rice (*Oryza sativa* L.) cultivars for traits associated with adaptation under moisture stress Abu Saleh Nizamuddin Ahmed
- ii) Morphometric Characterization of Selected Mutants of Mungbean (*Vigna radiata* L. Wilczek) Deepshikha Saikia
- iii) Assessment of genetic variability for glucosinolate in a set of Indian mustard [*Brassica juncea* (L.) Czern. & Coss.] genotypes and their relationship with economically important agronomic traits Devidutta Lenka
- iv) Evaluation of inbred progenies of maize (*Zea mays* L.) for yield and important morphometric traits Dikshita Gogoi
- v) Interspecific hybridization in the genus *Capsicum* and Molecular characterization of F1 hybrids Gayatree Hazarika
- vi) Genetic variability and diversity analysis for morpho-physiological traits associated with grain yield in cultivated rice (*Oryza sativa* L.) Pratibha Das
- vii) Genetic variability of root traits of different classes of rice (*Oryza sativa* L.) in Assam Priyanka Bairagi
- viii) Assessment of genetic variability and screening of soybean cultivars against major diseases in Assam Priyankee Dutta
- ix) Evaluation of maize (*Zea mays* L.) hybrids at high plant density for important yield attributes Ramesh Kanna M
- x) Evaluation and background selection of Bacterial Blight introgressed lines in Ranjit Sub-1 Sruthi R
- xi) Assessment of genetic variability and association analysis for morpho-physiological attributes in Sesame (*Sesamum indicum* L.) Subrat Das

xii) Genetic variability in Rice bean ( <i>Vigna umbellata</i> Thunb.) for important quantitative characteristics and their relationship with grain and forage yield	Suchitra Balmiki
xiii) Performance evaluation and character relationship in a set of genotypes of Yellow Sarson ( <i>Brassica rapa</i> L.)	Supriya Kaushik
xiv) Evaluation of selected F3-4 lines of Tomato crosses ( <i>Solanum lycopersicum</i> x <i>Solanum pimpinellifolium</i> ) for morpho-metric traits	Upasana Bordoloi
<b>5.12.1. Plant Breeding and Genetics (SST)</b>	<b>583 – 612</b>
i) Effect of different storage structures on the seed quality of green gram ( <i>Vigna radiata</i> )	Madhurima Bezboruah
ii) Varietal characteristics and divergence of rice varieties for genetic identity	Mannem Niveditha
iii) Influence of seed priming on aged seeds	Pratha Pratim Bora
iv) Evaluation of some indigenous rice varieties for seed morphology and cooking quality characteristics	Rajasree Rajkhowa
v) Performance evaluation of pre-sowing seed treatments using bio agents in transplanted aromatic rice for organic condition	Shamima Nashrin
<b>5.13. Plant Pathology</b>	<b>613 – 629</b>
i) Molecular screening of Citrus germplasm for simultaneous detection of <i>Candidatus</i> Liberibacter species associated with citrus greening disease	Amitha Paul
ii) Bioassay of toxicity of green synthesized silver nanoparticles on biocontrol agents and mammalian cells	Arti Kumari
iii) Study on fungal diseases of Gerbera ( <i>Gerbera jamesonii</i> Bolus ex. Hook F) in Assam	Bishal Saikia
iv) Study on incidence, detection and characterization of Brinjal Little Leaf (BLL) disease in Assam	Dibya Sree Dutta

- v) Enhancement of microbial load in *Bhut chilli* (*Capsicum chinense* Jacq.) rhizosphere by bioformulation application and management of bacterial wilt disease (*Ralstonia solanacearum*) Dipankar Das
- vi) Increasing the yield attributing character of different species of pleurotus through hybridization Karishmi Riba
- vii) Detection, incidence and molecular characterization of Papaya ringspot virus (PRSV) Lonmow Gohain
- viii) Residue analysis of carbendazim used for controlling contaminants of oyster mushroom (*Pleurotus* spp.) Lunisha Pegu
- ix) Bioformulation of Organophosphate Degrading Bacteria and Plant Growth Promoting Microbes for pesticide degradation *vis-à-vis* management of bacterial wilt pathogen *R. solanacearum* Shenaz Sultana Ahmed
- x) Evaluation of antifungal activity of essential oil against grey mould of tomato caused by *Botrytis cinerea* Sudharshan K. R.
- xi) Management of fruit rot of *Capsicum chinense* Jacq. with fungal bio-formulations Sunita Dutta
- xii) Management of seed-borne mycoflora of greengram through botanicals Suveta T. S.

**5.14. Sericulture**

**630 – 644**

- i) Economics of Sericulture with Special Reference Barsha Das
- ii) Study on constraints in adoption of improved sericultural technologies by the farmers in Jorhat district of Assam Dipankar Hatibaruah
- iii) Effect of zinc chloride (ZnCl<sub>2</sub>) supplementation on larval growth and economic cocoon characters of eri silkworm, *Samia ricini* Boisd. (Lepidoptera: Saturniidae) Nanita Bora
- iv) Sucking pests and their natural enemies in mulberry ecosystem in Jorhat district of Assam Nilutpal Saikia

- v) Effect of botanical and chemical bed disinfectants on larval growth and economic cocoon characters of mulberry silkworm, *Bombyx mori* L. (Lepidoptera: Bombycidae) rearing Pompi Kowar
- vi) A study on the extent of livelihood security of the sericulture farmers in Kamrup district of Assam Pulak Rabha
- vii) Seasonal variation on larval, cocoon and yarn parameters of eri silkworm (*Samia ricini* Boisd.) reared on *Ailanthus* species Raktim Ranjan Borah
- viii) Study on regional variations on cocoon and yarn characteristics of muga silkworm during commercial seasons Shilpa Saikia

#### 5.15. Soil Science

645 – 670

- i) Nutrient availability in soil and yield of tomato as influenced by manure sources and rice stubble management Anupama Das
- ii) Effect of Tillage and Herbicide (Pretilachlor) Application on Soil Biological Properties in Winter Rice Dipankar Sonowal
- iii) Soil-Site Suitability Evaluation for Major Crops in Sarupathar Block of Golaghat District, Assam Duhanti Gogoi
- iv) Distribution of micronutrients under different land uses in soils of Golaghat district of Assam Jatiprasad Barala
- v) Soil acidity components and its influence on available phosphorus in soils of East Karbi Anglong district of Assam Jemima Ahmed
- vi) Symbiotic Effectiveness of Common Bean (*Phaseolus vulgaris* L.) *Rhizobium* grown in Soils of Assam Jyotirupa Kalita
- vii) Morphometric evaluation and soil loss estimation of a transect of Subansiri watershed in Lakhimpur district of Assam Kamal Kishor
- viii) Profile distribution of potassium in some soils of Sarupathar block of Golaghat district, Assam Karabi Das

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|--|--------------------------|
| ix) Effect of liming on soil acidity components and available nutrients in Upper Brahmaputra Valley Zone of Assam              | Manoharmayum Monica Devi |
| x) Nutrient availability, soil acidity and tomato yield as influenced by FYM-lime-wood ash mixture and rice stubble management | Prantika Kakati          |
| xi) Distribution of micronutrients in soils under Horticultural crops of Assam   | Srinivasulu Kumbha       |
| xii) Soil properties in termite mounds under different land uses   | Sushmita Konwar          |
| xiii) Morphometry and Soil Erodibility of a transect of Ranganadi Watershed in Lakhimpur district of Assam                     | Tilak Prasad Panika      |

#### **5.16. Tea Husbandry & Technology**

**671 – 689**

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|--|--------------------|
| i) Scope of Augmenting Farmers' Income In Small Tea Plantations – A Case Study In Golaghat Sub Division of Golaghat District                                       | Anganjyoti Swarup  |
| ii) Impact of Gas Flaring on Soil Health and Growth of Tea Plants Adjacent to Oil Field in Merbil Majuli OCS 6 (West) In Dibrugarh District of Assam               | Anubrat Borah      |
| iii) Impact of oil field effluent on soil health and growth in small tea farms of Shalmari OCS-1, Dibrugarh district of Assam                                      | Eimon Bharadwaj    |
| iv) Impact of oil field effluent on soil health and growth in small tea farms of Shalmari OCS-1 (North), Dibrugarh district of Assam                               | Jayshree Konwar    |
| v) Impact of gas flaring on soil health and growth of tea plants adjacent to Merbil Majuli, OCS-6 (South) in Dibrugarh district of Assam                           | Kalparanjan Bhuyan |
| vi) Impact of oil field effluent on soil health and growth of tea in small tea farms in proximity of OCS-2 in the Digholia area of Dibrugarh district of Assam     | Preetisha Dutta    |
| vii) Impact of oil field effluent on some physico- chemical properties of soil and growth of tea in the plantation of small growers of Dibrugarh district of Assam | Pubali Neog        |

- viii) Impact of Gas flaring on soil health and growth of tea plants adjacent to Kothaloni OCS North in Dibrugarh district of Assam Rashmi Kalita
- ix) Impact of Gas Flaring on Soil Health and Growth of Tea Plants Adjacent to Kothaloni OCS South in Dibrugarh District of Assam Ripsita Phukan
- x) Scope of Augmenting Farmers' Income in Small Tea Plantations - A case study in Titabor sub-division of Jorhat district Shyamal Kishore Bordoloi

## 6. Master of Science (Fishery)

### 6.1. Aquaculture

691 – 704

- i) Effect of vermiwash on plankton production and growth performance of *Labeo catla* (Hamilton, 1822) Dibakar Gogoi
- ii) Effect of Stocking Densities on the Growth Performance of Indian Major Carps and Water Quality Parameters in Short Duration Fish Culture Hasina Momtaz
- iii) Effect of stocking densities on growth performance and survivability of Amur Carp (*Cyprinus carpiohaematopterus*) in floating cage environment of a floodplain wetland of Morigaon District Homen Saikia
- iv) Growth Performance and Digestive Physiology of Amur Carp (*Cyprinus carpio* var. *haematopterus*) Fingerlings Reared in Biofloc Zero Water Exchange System Imlichuba Imchen
- v) Effect of Diet on Growth, Haematology and Disease Resistance of Amur Carp (*Cyprinus carpio haematopterus*) Through Replacement of Rice Polish with Rice Beer Waste Miss Astrica Phukan
- vi) Effect of *Streblus asper* Lour. as Periphyton Substrate on Growth Performance of Jayanti Rohu (*Labeo rohita* Hamilton) and Amur Carp (*Cyprinus carpio* Haematopterus Temminck & Schlegel) Mr. Kongkon Jyoti Bhuyan
- vii) Experimental Breeding Ofchanna Striatus (Bloch, 1793) Using Different Hormones Under The Agro-Climatic Condition of Assam Rikki Bagra

- viii) Effect of probiotic bacteria identified and characterized from gut of freshwater fish on growth performance of *Labeo rohita* Rubina Yasmin
- ix) Effect of Natural and Artificial Carotenoid for Colour Enhancement in Tiger Barb, *Puntigrus tetrazona* (Bleeker, 1855) Shilparani Hazarika
- 6.2. Aquatic Environment Management 705 – 711**
- i) Acute Toxicity Study of Silica Nanoparticles (SiO<sub>2</sub> - NPs) on *Cyprinus carpio* (Linnaeus, 1758) Habiba Jahan Ahmed
- ii) Assessment of Productivity and Fish Diversity of Dzii River of Kohima, Nagaland Mr. Kedolhouse Kuotsu
- iii) Effect of pH on Acute Toxicity of Synthetic Antioxidant Butylated Hydroxytoluene in Embryo of Zebrafish *Danio rerio* (Hamilton, 1822) Nikimoni Borah
- iv) Assessment of Environmental Integrity of Northern Plain Region of the River Umtrew (Digaru) in Meghalaya and Assam with special reference to its pollution status Nishi Sarmah
- v) Assessment of Acute Toxicity in Fresh Water Cypriniform *Cyprinus carpio* (Linnaeus, 1758) Exposed to a Commercial Neem based Biopesticide Rituparna Borah
- vi) Acute Toxicity of Synthetic Pyrethroid Pesticide Cypermethrin in Developing Zebrafish (*Danio rerio*) (Hamilton-Buchanan, 1822) Embryo Ruhul Amin
- vii) An Assessment of Carbon Sequestration of a Floodplain Wetland (48 No. Thekera beel, Morigaon District) of Central Brahmaputra Valley Zone, Assam Rupam Jyoti Nath
- 6.3. Fisheries Resource Management 712 – 715**
- i) Study on Ichthyofaunal Diversity and Physicochemical Parameters Downstream of Hydroelectric Power Project Dam of Subansiri River, Assam Imran Hussain
- ii) Study on Ichthyofaunal Diversity and Physico-Chemical Parameters of a Floodplain Wetland (Jaluguti Beel, Morigaon District, Assam) of Central Brahmaputra Valley Zone Sheetala Chintey

**7. Master of Science (Home Science)**

**7.1. Extension and Communication Management** **717 – 722**

- i) Knowledge, attitude and practice of students towards spiritual life skills Birina Das
- ii) Effect of Bandhan Microfinance on Empowerment of Rural Women in Tinsukia district of Assam Inameeka Baruah
- iii) Problems faced by undergraduate students of Assam Agricultural University in obtaining scholarships Santosh

**7.2. Family Resource Management** **723 – 724**

- i) Prevalence of work related musculoskeletal disorder of women involved in Papad Making industry of Ganjam, District, Odisha Smruti Rekha Panigrahi

**7.3. Food Science and Nutrition** **725 – 734**

- i) Development and quality evaluation of hydrothermally treated rice from Kaoli Jamfri – a red kernel rice of Assam Mandeep Digra
- ii) Effect of processing on antioxidant potential and antidiabetic activity of Cajanus Cajan (L.) tender leaves Meghna Borgohain
- iii) Development of gluten- free functional rice bread Pallabi Sarkar
- iv) Assessment of nutritional status of Karbi adolescent girls from Diphu, Assam Puspa Khakhlary
- v) Development and quality evaluation of nutri-dense pancake mix Taposhi Thakuria

**7.4. Human Development and Family Studies** **735 – 743**

- i) Prevalence of bullying among adolescents Irin Das
- ii) Enhancing Number Concepts of Preschool Children Through Musical Intervention Jyotika Boruah
- iii) Parent-adolescent disagreement in the use of social media Kshiptimayee Patra



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| iv) Selfie taking behaviour of college students   | Pallavi             |
| v) Academic procrastination among students of Assam Agricultural University of Jorhat- An Explorative Study | Rashmi Rekha Gohain |

#### **7.5. Textiles and Apparel Designing**

**745 - 750**

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|---|--------------------|
| i) Extraction of sugarcane bagasse fibre for different end uses   | Dilowar Hussain    |
| ii) A study on extraction of underutilized plant fibre from pendulous sleeping hibiscus and evaluation of its physico-chemical properties | Mintu Hazarika     |
| iii) Extraction of fiber from <i>Gossypium arborium</i> and evaluation of fiber for various end uses                                      | Rikamchi Ch. Marak |
| iv) Development of Lac Dye from Lac Insect <i>Kerria chinensis</i> , (Hemiptera:Kerriidae)  | Saswati Rajkhowa   |

#### **8. Master of Science (Veterinary Science)**

##### **8.1. Animal Biotechnology**

**752 – 760**

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|--|--------------------|
| i) Expression of Cap Protein of Porcine Circovirus Type 2 (PCV2) and Evaluation of Its Immunogenicity in Mice                                      | Debarun Borah      |
| ii) Evaluation of PAgN-Based Peptide(S) IN Combination With Vi-Capsular Antigen as Vaccine Candidate for <i>Salmonella</i> Typhi                   | Puranpurna Goswami |
| iii) Molecular Characterization of <i>Lactobacilli</i> Isolated From Indigenous Ducks of Assam and In Vitro Assessment of Their Probiotic Activity | Samiso Kramsapi    |
| iv) Dna Polymorphism In Mitochondrial Genes Encoding Nd1, Co1 and Cytb In Canine Malignant Tumours   | Shakeel-UI-Rehman  |

##### **8.2. Animal Genetics and Breeding**

**791 – 784**

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|--|-----------------|
| i) Production Performance of Daothigir Chicken Under Field Condition | Banani Talukdar |
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- ii) Performance Evaluation and Polymorphism Profiling of Fecundity Genes In Indigenous Sheep of Meghalaya Dimpri Khanikar
- iii) Performance of Hd-K75 In The Original Nucleus Herd *Vis a Vis* Public And Private Sectors of Organised Pig Farm Eyangshuman Das
- iv) Characterization of Indigenous Geese of Assam Hanidul Hoque
- v) Performance of Indigenous Chicken In Certain Districts of Assam Under Backyard Farming System Jehirul Islam
- vi) Performance of Indigenous Sheep of Assam Pinky Saikia
- vii) Genetic Studies nn Growth Performance of Crossbred Pigs Racy Rongpi
- viii) Performance of Binjharpuri Cattle In Its Breeding Tract Shrabanee Nayak
- ix) Performance of Siri Cattle of Sikkim Under Field Condition Tenzing Lobsang Bhutia
- x) Growth and Reproductive Performance of Hampshire X Desi Half- Bred Pigs Toshimongla Aier
- xi) Certain Productive and Reproductive Performance of Sahiwal Cattle Under Organized Farm Condition of Assam Upasana Baruah
- xii) Characterization of Indigenous Ducks of Manipur Y. Sovarani devi

**8.3. Animal Nutrition**

**785 – 822**

- i) Effects of Feeding of Prebiotics, Probiotics and Synbiotics in Broiler Chicken on Corn-Soya Based Diet Aibaniairi Fancon
- ii) Effect of Dietary Supplementation of Zinc Nano-Particles on Growth Performance of Crossbred Calves Ajay Barman
- iii) Effect of Black Pepper (*Piper nigrum*) Supplementation to Diets Containing Different Levels of Energy on The Growth Performance, Nutrient Utilization and Blood Biochemical Profile of Growing Pigs Akash Mahanta

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|---|-------------------|
| iv) Effect of Feeding Dry <i>Moringa oleifera</i> Leaves on Growth Performance and Nutrient Utilization in Crossbred Calves   | Anisul Hamza      |
| v) A Comparative Study on the Performance of Broiler Chickens on Feeding Diets Containing Essential Oil, Antibiotic and Probiotic   | Baishali Shil     |
| vi) Performance of Broiler Chicken Fed on Diet Supplemented With Oregano Essential Oil  | Biswajit Borah    |
| vii) Effect of Supplementation of Certain Anti-Oxidants (Vitamin E, Vitamin C and Selenium) On The Growth Performance of Broiler Chicken During Heat Stress                       | Chanra Deep Singh |
| viii) Effect of Feeding Nano-Iron on Growth Performance and Nutrient Utilization In Grower Pigs   | Dangshawa Morung  |
| ix) Certain Productive and Reproductive Performance of Sahiwal Cattle Under Organized Farm Condition of Assam   | Gagan Bhuyan      |
| x) Evaluation of Banana Stem and Urea Treated Paddy Straw Based Complete Rations For Growing Crossbred Calves   | Keruulenuo Yhome  |
| xi) Effect of Dietary Supplementation of Cysteine-Protease and 1,4-B-Xylanase and Their Combination In Low Plane of Nutrition on Growth Performance of Commercial Broiler Chicken | Mokadesh Ali      |
| xii) Effect of Feeding <i>Azolla (Azolla Pinnata)</i> Based Complete Feed Block on Growth, Nutrients Utilization and Blood Biochemical Parameters of Beetal X Assam Hill Goats    | Mostafizur Ahmed  |
| xiii) Growth Performance of Beetal Kids Feeding on High Plan of Nutrition Under Stall Fed Condition   | Pallab Borah      |
| xiv) Effect of Supplementation of Garlic And Multi-Strain Probiotics on The Performance of Broiler Chicken  | Reema Shrestha    |
| xv) Effect of Supplementation of Acidifier on The Performance of Broiler Chicken  | Rupjyoti Dutta    |

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|--------|--|-----------------|
| xvvi)  | Effect of Feeding Total Mixed Ration and Complete Feed Block on Productive Performance of Crossbred Cows                                     | Sikhamoni Haloi |
| xviii) | Effect of Mannan-Oligosaccharide and Pomegranate ( <i>Punica granatum</i> ) Peel Powder on The Performance of Broiler Chicken                | Sudhanya Nath   |
| xix)   | Effect of Partial Replacement of Concentrate by Feeding Dried Azolla ( <i>Azolla caroliniana</i> ) on Growth Performance of Crossbred Calves | Sunita Kalita   |
| x)     | Effect of Feeding Varying Levels of Subabul ( <i>Leucaena leucocephala</i> ) Leaf Meal on the Performance of Broiler Chicken                 | Tanmoy Medhi    |

#### **8.4. Animal Reproduction, Gynaecology and Obstetrics**

**823 – 862**

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|-------|---|---------------------------|
| i)    | Effect of Bypass Fat and Bypass Protein Supplementation During Transition Period on Reproductive Performance of Assam Hill Goat                   | Akshay Krishnamurti Hegde |
| ii)   | Seroprevalence of Leptospirosis In Dairy Cows With Reproductive Disorders and Therapeutic Management of Endometritis                              | Alapa Baba Ikpe           |
| iii)  | Reproductive Performance In Prepubertal Assam Hill Goat Supplemented With Bypass Fat  | Arjyarittik Kalita        |
| iv)   | Fertility Status In Relation to The Physico-Biochemical Properties of Cervico-Vaginal Mucus, Serum Minerals Andhormonal Profile In Lakhimi Cattle | Bhaskarjyoti Kalita       |
| v)    | Effect of Commercial Extender and Curcumin As Additive on Quality of Frozen Beetal Buck Semen   | Bhubaneswar Sahoo         |
| vi)   | Induction of Postpartum Oestrus In <i>Lakhimi</i> Cow Through Hormonal and Nutritional Interventions  | Chahidur Rahman           |
| vii)  | Addressing Postpartum Anoestrus In Crossbred Cows   | Chandra Prakash Dixit     |
| viii) | Extrapolation of Gestational Curve and Whelping Time In Bitch   | Chayanika Das             |

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|--|---|------------------------|
| ix)  | Effect of Nano Zinc Supplementation on Reproductive Performance of Assam Hill Goat  | Dipika Deori           |
| x)   | A Study on Centrifugation Regime and Commercial Extender on Quality of Frozen Beetal Buck Semen   | Himsikha Chakravarty   |
| xi)  | Diagnostic and Therapeutic Management of Canine Transmissible Venereal Tumour (CTVT)  | H. Phunchu Bappo       |
| xii)   | Pregnancy Diagnosis In Pig With Special Reference to Biomarker Analysis   | Jyotimalita Roy        |
| xiii)  | Preservation of Dog Semen In CLC Loaded Soyabean Extender   | Kanchan Joshi          |
| xiv)   | Correlation of Insulin Like Growth Factor-1 Concentration With Semen Characteristics of Beetal Buck   | Keshav                 |
| xvi)   | Effect of Additives on Quality of Boar Semen During Preservation at 15°C  | Mebanshan N. Lyngdoh   |
| xvi)   | Metagenomics of Uterine Bacteria of Repeat Breeder Cows and Therapeutic Management of Endometritis  | Sabera Islam Chowdhury |
| xvii)  | Nanoemulsions For Reducing Oxidative Stress In Cryopreserved Buck Semen   | Soihem Diana Rongmei   |
| xviii)                                       | Effect of Different Cryoprotectants on Post Thaw Quality of Porcine Spermatogonial Stem Cell  | Sunita Thakuria        |
| xix)   | Effect of Preservation on Quality of HD-K75 Boar Semen and Its Molecular Evaluation   | Surabhi Basumatary     |
| xx)  | Performance of Hampshire Piglets Reared on Hot Water Treated Floor  | Sweta Pachani          |
| <b>8.5. Veterinary Anatomy and Histology</b> |   | <b>863 – 871</b>       |
| i)   | Influence of Zinc Oxide Nanoparticle on The Growth of Intestinal Epithelium and Microflora In Broiler Chicken ( <i>Gallus gallus domesticus</i> ) | Alline Josph Pathil    |
| ii)  | Anatomical Studies on Liver and Pancreas of <i>Pati</i> Ducks ( <i>Anas platyrhynchos domesticus</i> ) of Assam During Post-Natal Development     | Kulajit Kalita         |

- iii) Comparative Anatomical, Haemato-Biochemical and Hormonal Studies on The Female Reproductive System of Kamrupa Variety and Indigenous Chicken (*Gallus domesticus*) of Assam During Different Stages of Laying Mansil M. Sangma
- iv) Post-Natal Development of Tongue, Oesophagus and Proventriculus of Pati Duck (*Anas platyrhynchos domesticus*) of Assam at Different Age Groups Tanu Dogra

**8.6. Veterinary Biochemistry**

**872 – 874**

- i) Effect of tolR Deletion Mutation on Release of OMV of *Salmonella typhimurium* and Evaluation Of Nano – and Microparticles Conjugated Vaccines Anisha Sultana
- ii) Development of Nanoparticle based Oral Vaccine against Necrotic Enteritis and Evaluation of its Immuno-potential Dr. Samiron Borah

**8.7. Veterinary Clinical Medicine, Ethics & Jurisprudence**

**875 – 895**

- i) Otitis In Dog and Its Therapeutic Management Arpana Barua
- ii) Sub Clinical Mastitis In Buffalo and Its Therapeutic Management Chainmoy Sarma
- iii) Anthelmintic Activity of *Acorus aalamus* Rhizome Extract Against *Haemonchus* Species In Goats Champa Sharma
- iv) Prevalence of Eye Diseases In Dog With Special Reference To Bacterial Infection Dibyajyoti Das
- v) Sub-Clinical Mastitis In Dairy Cow and Its Therapeutic Management Gaurab Kafle
- vi) Osteomalacia : Its Diagnosis and Management In Dairy Cows Gunajit Barman
- vii) Studies on Anthelmintic Efficacy of *Zanthoxylum armatum* against Gastrointestinal Parasites of Goat Jakir Hussain
- viii) Management of Hypovitaminosis-D For The Prevention of Periparturient Hypocalcaemia In Dairy Cows Patel Nisha Manish

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| ix) Haemoprotozoal Diseases of Cat and Its Therapeutic Management  | Pooja Kapil Marwaha      |
| x) Urinary Tract Infection In Dog and Its Therapeutic Management   | Pooja Sonar              |
| xi) L Inico-Haematobiochemical and Therapeutic Management of Anaemia Associated With Chronic Kidney Disease (CKD) In Dog | Pradyout Pallav Hazarika |
| xii) Congestive Heart Failure in Dogs and Its Therapeutic Management   | Prerona Patowary         |
| xiii) Canine Pyoderma : Diagnosis and Therapeutic Management   | Sabetini S. Marak        |
| xiv) Evaluation of Salivary Biomarkers For Chronic Kidney Disease In Dogs  | Tanu Sharma              |

**8.8. Veterinary Epidemiology and Preventive Medicine**

**896 – 916**

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| i) Transmission of Newcastle Disease Virus at Domestic-Wild Bird Interface   | Abhilasha Sharma        |
| ii) Management of Clostridial Infection with Special Reference to <i>Clostridium perfringens</i> in Asiatic Elephant ( <i>Elephas maximus</i> ) In Assam | Ashit Chakraborty       |
| iii) Epidemiology and Economic Impact of Rabies In Animals of Kamrup Metro District of Assam and West District of Tripura                                | Bishal Debbarma         |
| iv) Detection and Genotypic Characterization of Rotavirus In Dog and Its Management  | Chayanika Mazumder      |
| v) Tick Infestation In Dogs: Its Epidemiology and Therapeutic Management   | Dhritismita Boruah      |
| vi) <i>Escherichia coli</i> Associated Diarrhoea In Calves and Its Management  | Gautam Ramjibhai Parikh |
| vii) Epidemiological Study and Economic Impact of African Swine Fever in Few Affected Districts of Assam   | Jahnabi Doley           |

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| viii) | Hormonal and Mineral Status of Captive Asian Elephants ( <i>Elephas maximus</i> ) under Stress Condition and Its Management       | Nikita Thingom Chanu       |
| ix)   | Prevalence of Newcastle Disease Virus in Backyard and Commercial Poultry in Assam   | Pubaleem Deka              |
| x)    | Evaluation of Immune Response in Broiler Chicks Immunized With A Minimum Cold Chain Dependent Newcastle Disease Virus Formulation | Rofique Ahmed              |
| xi)   | Parvoviral Enteritis in Puppies and Its Therapeutic Management  | Sayed Nazrin Rumana Rahman |
| xii)  | Prevalence of Bat Lyssavirus In Assam   | Tinku Das                  |
| xiii) | Ehrlichiosis In Dogs: Its Epidemiology and Therapeutic Management   | Queen Devi                 |

**8.9. Veterinary Extension Education**

**917 – 936**

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|-------|---|------------------------|
| i)    | Empowerment of Women Through Milk Cooperative Societies in Selected Districts of Assam  | Banani Das             |
| ii)   | Adoption Level in Scientific Poultry Rearing Practices in Ri-Bhoi District of Meghalaya   | David Teileng Sun      |
| iii)  | Impact of Female Participation in Livestock and Poultry Enterprises in Ensuring Women Empowerment and Household Food Security Among Selected Tribes/ Ethnic Group in Goalpara District of Assam | Deepjyoti Roy          |
| iv)   | Empowerment of Women of Selected Tribes in Tripura Through Livestock Enterprises  | Keshab Jamatia         |
| v)    | Participation of Tribal Farmwomen in Livestock Management Activities in Dima Hasao District of Assam  | Komolika Bodo          |
| vii)  | Assessment of Ethno-Veterinary Practices and Its Relevance for Livestock and Poultry in Majuli District of Assam  | Migom Mili             |
| viii) | Dynamics of Urbanization in the Livelihood of Livestock Farmers in The Peri-Urban Areas of Guwahati City  | Parag Sankar Choudhury |



- ix) Women Empowerment Through Self-Help Group With Special Reference To Animal Husbandry: ASRLM Perspective Rahul Kanti Deka

**8.10. Veterinary Livestock Production and Management 937 – 980**

- i) Effects of Split-Weaning on the Performance and Behavioural Traits of Hampshire Piglets Arunima Kalita
- ii) Effect of Feeding Practices on the Performance of Crossbred Kids Biswajyoti Das
- iii) Performance of Hampshire Piglets Fed on Indigenously Fermented Feed Biswa Shankar Dutta
- iv) Effect of Dietary Supplementation of Yeast (*Saccharomyces cerevisiae*) on Growth Performance of Crossbred Heifers Chandrika Hazarika
- v) Performance of Pre-Weaning Hampshire Piglets Reared on Rubber Mat Floor Ibasani Sawian
- vi) Physicochemical and Microbiological Quality of Drinking Water for Livestock Under Organized and Unorganized Sectors in the Brahmaputra Valley of Assam Jiaur Rahman
- vii) Effect of Feeding Liver Tonic on Growth Performance of Crossbred Dairy Calves Kayitha Madhukar
- viii) Productive Performance of Sahiwal Cows Subjected to Different Levels of Herbal Supplements Manmi Kalita
- ix) Effect of Weaning Age on the Growth Performance of Crossbred Calves Minder Teron
- x) Effect of Dietary Supplementation of Satomul (*Asparagus racemosus*) on Certain Production Performances of Crossbred Dairy Cows Parteek Kumar Khera
- xi) Performance of Hampshire Piglets Reared on Hot Water Treated Floor Phanidhar Mili
- xii) Effect of Challenge Feeding on the Production Performance of Crossbred Cows Poonam Das

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| xiii) Performance of Assam Hill Goat Reared on Periodically Disinfected Floor                               | Santana Das      |
| xiv) Growth and Carcass Characteristics of Indigenous Sheep of Assam Reared Under Different Feeding Systems | Sakil Ahmed      |
| xv) Growth Performance of Crossbred Calves Fed Molasses and Probiotics Supplemented Diet                    | Sanidur Ahmed    |
| xvi) Study on the Indigenous Knowledge System on Pig Rearing Adopted by the Rabha Community of Assam        | Sayashree Rabha  |
| xvii) Effects of Dietary Protein Level during Transition Period of Crossbred Heifers                        | Shams Uz Zaman   |
| xviii) Shelf Life of Raw Cow Milk in Different Temperatures   | Subarna Sarkar   |
| xix) Performance of Crossbred Cows under Farm Conditions  | Venus Das        |
| xx) Effect of Supplementing Garlic Powder on the Performance of the Sahiwal Calves                          | Zara Kaku Sorang |

**8.11. Veterinary Livestock Reproduction and Management** **981 – 1027**

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|---|-------------------------|
| i) Effects of Split-Weaning on The Performance and Behavioural Traits of Hampshire Piglets                              | Arunima Kalita          |
| ii) Empowerment of Women Through Milk Cooperative Societies In Selected Districts of Assam                              | Banani Das              |
| iii) Trematode Parasites of Asian Elephant ( <i>Elephas maximus</i> ) With Special Reference of Liver Fluke             | Bandanpreet Kour Raisim |
| iv) Sero-Prevalence and Risk Factor Analysis of Leptospirosis Among Cattle Population In West District of Tripura State | Baninya Mohan Tripura   |
| v) Intraoperative Assessment of Intestinal Viability In Rabbits   | Evakordor Hynniewta     |
| vi) Clinico Pathological Studies of Canine Parvoviral Infection   | Ginah Maria Binny       |

- vii) Performance of Pre-Weaning Hampshire Piglets Reared on Rubber Mat Floor Ibasani Sawian
- viii) Carcass and Meat Quality Characteristics of *Kamrupa* Chicken Jameel Ahmad
- ix) Physicochemical and Microbiological Quality of Drinking Water For Livestock Under Organized and Unorganized Sectors In The Brahmaputra Valley of Assam Jiaur Rahman
- x) Empowerment of Women of Selected Tribes In Tripura Through Livestock Enterprises Keshab Jamatia
- xi) Characterization of Methicillin Resistant *Staphylococcus Aureus* Isolated From Raw Meat Leons Mathew Abraham
- xii) Prevalence of Cysticercosis In Jorhat District of Assam Mrinmoyee Sarma
- xiii) Tiletamine-Zolazepam Anaesthesia In Cat Monalisa Ahmed
- xiv) *In Vitro* Evaluation and Molecular Mechanism of Parthenin as Anti-Cancer Agent Monoshree Sarma
- xv) Evaluation of *In-Vitro* Antiviral Effect of Nanocurcumin and Nano Eugenol Against Goat Pox Namitha. A
- xvi) Immune Response of Pigs Vaccinated With Classical Swine Fever (CSF) Diva Based Vaccine and Cell Culture Adapted Lapinized Vaccine Nouluongunuo Suokhrie
- xvii) Effect of Dietary Supplementation of Satomul (*Asparagus Racemosus*) on Certain Production Performances of Crossbred Dairy Cows Parteek Kumar Khera
- xviii) Prevalence of Newcastle Disease Virus In Backyard And Commercial Poultry In Assam Pubaleem Deka
- xix) Isolation of Foot-And-Mouth Disease Virus Type 'O' of Bovine And Porcine Origin In Different Cell Lines and Molecular Characterization of The Adapted Virus. Ray Kayaga
- xx) Sevoflurane Anaesthesia In Butorphanol-Midazolam Premedicated Dogs Induced With Propofol and Ketamine Sarahna Taufiq

xxi)	Attenuation and Molecular Characterization of Vero Cell Line Adapted Goatpox Virus Isolate From Assam	Shyama Prasad Panda
xxii)	Effects of Starter Culture and Types of Bamboo on Quality Attributes of <i>Banhor Chunga Doi</i>	Sumi Roy
xxiii)	Physio-Biochemical Studies of Adult Pati Ducks Reared Under Semi-Intensive System	Tenzing Lopsang Lachenpa
xxiv)	Performance of Crossbred Cows Under Farm Conditions	Venus Das
<b>8.12. Veterinary Livestock Products Technology</b>		<b>1028 – 1041</b>
i)	Quality Characteristics of Soy Milk Blended Yoghurt	Arifa Khatun
ii)	Carcass and Meat Quality Characteristics of <i>Kamrupa</i> Chicken	Jameel Ahmad
iii)	Development of Duck Meat Sausages Incorporated with Foxtail Millet ( <i>Setaria italica</i> )	Kiran Moye Handique
iv)	Effect of Spices and Methods of Smoking on Certain Quality Attributes of Chhana Sausage	Manash Jyoti Chutia
v)	Development of Enzyme Based Chromogenic Strips for Detection of Selected Adulterants in Milk	Priya Muktan
vi)	Effects of Soy Protein Isolate and Inulin on Certain Quality Characteristics of Low-Fat Duck Meat Sausages	Sushmita Moirangthem
<b>8.13. Veterinary Microbiology</b>		<b>1042 – 1061</b>
i)	Isolation and Characterization of Bacteriophages and Their Lytic Effects on Multidrug Resistant <i>Escherichia coli</i> Strains from Pig	Adwitiya Das
ii)	Seroprevalence and Molecular Detection of Bovine Brucellosis and Leptospirosis in Assam	Bandana Devi
iii)	Neutralization Efficacy of Classical Swine Fever C-Strain Specific Antibody to Different Genotypes Circulating in North Eastern States, India	Jayashree Sarma

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|---|-----------------------|
| iv) Physicochemical Properties of Live Attenuated Duck Plague Vaccine and Evaluation of Stabilizer Efficacy for Lyophilization                                    | Jonmoni Barua         |
| v) Characterization of Methicillin Resistant <i>Staphylococcus aureus</i> Isolated from Raw Meat  | Leons Mathew Abraham  |
| vi) Adaptation of Mesogenic Newcastle Disease Virus (Genotype XIII) In Vero Cell and Its Immunogenic Potential  | Lewamangphika Rapphap |
| vii) Immune Response of Pigs Vaccinated with Classical Swine Fever (CSF) Diva Based Vaccine and Cell Culture Adapted Lapinized Vaccine                            | Nouluongunuo Suokhrie |
| viii) Isolation of Foot-And-Mouth Disease Virus Type 'O' of Bovine and Porcine Origin in Different Cell Lines and Molecular Characterization of the Adapted Virus | Ray Kayaga            |
| ix) Thermoadaptation of a Newcastle Disease Virus Isolate from Duck and Its Immunogenic Potential   | Sangeeta Das          |
| x) Attenuation and Molecular Characterization of Vero Cell Line Adapted Goatpox Virus Isolate from Assam  | Shyama Prasad Panda   |
| xi) Molecular Characterization of Avipoxvirus from Domestic Ducks   | Sumi Chungkrang       |

#### **8.14. Veterinary Parasitology**

**1062 – 1068**

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|---|-------------------------|
| i) Trematode Parasites of Asian Elephant ( <i>Elephas maximus</i> ) with Special Reference of Liver Fluke | Bandanpreet Kour Raisim |
| ii) Ectoparasites of Goat with Special Reference to Mange Mite  | Debjani Borah           |
| iii) Tick and Mite Infestation in Dog in and Around Guwahati, Assam                                       | Pratik Bhowmik          |
| iv) Forensic Entomology-Based Post-Mortem Interval Estimation in Animals and Birds                        | Souvik Sarma            |

**8.15. Veterinary Pathology**

**1069 – 1101**

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|---|---------------------------|
| i) Pathomorphological and Molecular Studies of Respiratory Mannheimiosis in Goats   | Ameddul Islam<br>Mazumder |
| ii) Prevalence and Pathology of Duck Pasteurellosis and Its Concurrent Infection With Duck Virus Enteritis  | Anjali Das                |
| iii) Etiopathological Studies on Bacterial Pneumonia In Goats   | Deepjyoti Saharia         |
| iv) Etiopathology of Bacterial Diarrhoea in Dogs With Special Reference to <i>Escherichia coli</i>  | Farhin Aktar Choudhury    |
| v) Clinico Pathological Studies of Canine Parvoviral Infection  | Ginah Maria Binn          |
| vii) Pathology and Molecular Detection of Classical Swine Fever (CSF) and Its Association with Porcine Circovirus Associated Disease (PCVAD) in Pig | Karthikan. S              |
| viii) Pathomorphology and Molecular Detection of Duck Virus Enteritis Virus (DVEV) Infection in Assam   | Krishna Kalita            |
| ix) Etiopathology of Mortality in Captive Wild Animals in and Around Guwahati   | Mousumi Namasudra         |
| xi) Pathomorphological and Molecular Detection of Avian Leukosis Virus Infection in Chicken   | Nibedita Tamuly           |
| xii) Clinico-Pathological Studies of Ethanol Toxicity in Rat and Its Ameliorative Effect with Commercially Available Herbal Preparations            | Prakash A.N.              |
| xiii) Pathomorphology and Molecular Detection of Mycoplasma infection in Broiler Chicken  | Risabh Sarmah             |
| xiv) Clinicopathological Study of Anemia with Special Reference to Canine Babesiosis  | Ruby Devi Nath            |
| xv) Pathomorphological and Molecular Detection of Bacterial Pathogens Associated With Porcine Pneumonia   | Sabina Yasmin             |

- xvi) Etiopathology OPF Pre-Weaning Mortality in Piglets with Particular Emphasis on Anemia and Hypoglycemia Samiran Borah
- xv) Pathomorphology and Molecular Diagnosis of Newcastle Disease Virus Infection in Poultry in and Around Guwahati Taufique Ansari
- xvi) Pathomorphological and Molecular Detection of *Riemerella anatipestifer* Infection in Duck Udaya Sai Sitaram Tella

**8.16. Veterinary Pharmacology and Toxicology**

**1102 - 1114**

- i) Evaluation of Wound Healing Properties of *Zanthoxylum oxyphyllum*: An Indigenous Medicinal Plant Kushal Rabha
- ii) Role of Nanocurcumin on Experimentally Induced Alpha-Amanitin Toxicity in Rats Khumtya Debbarma
- iii) Toxic Potential of Acephate on Rainbow Rooster Chicken Lakhyajyoti Saikia
- iv) *In Vitro* Evaluation and Molecular Mechanism of Parthenin as Anti-Cancer Agent Monoshree Sarma
- v) Evaluation of In-Vitro Antiviral Effect of Nanocurcumin and Nano Eugenol Against Goat Pox Namitha. A
- vi) Elucidating Intracellular Signalling Mechanism in Nitric Oxide Mediated Effects on Goat Detrusor Muscle Navya L.N
- vii) Evaluation of Anti-Inflammatory, Analgesic and Antipyretic Activity of *Nyctanthes arbor-tristis* Leaf Extract Sumitra Debnath

**8.17. Veterinary Physiology**

**1115 – 1124**

- i) Monitoring Certain Physiobiochemical Parameters of Post Weaned Crossbred Kids Raised under Three Different Climate Resilient Housing System Dhiman Patgiri
- ii) Physiological Effect of Cryoprotectants in Freezing of Embryonic Fibroblast Cells Faijun Toufiki

- iii) Zinc Mediated Performance in Assam Hill Goat Iqbal Salik Minhaz
- iv) Strategy for Development of Stem Cell Like Embryonic Fibroblast Cells Prerana Das
- v) Monitoring Physio-Biochemical Characteristics in Goat During Transition Period Following Selenium and Vitamin E Supplementation Salima Siddika
- vi) Physio-Biochemical Studies of Adult Pati Ducks Reared Under Semi-Intensive System Tenzing Lopsang Lachenpa

**8.18. Veterinary Poultry Science**

**1125 – 1146**

- i) Analysis of Duck Farming Systems in Morigaon District of Assam Anuj Dutta
- ii) Sustainable Management of Dead Birds, Poultry Slaughterhouse and Hatchery Wastesthrough Composting Ferdinee Dhar
- iii) Utilization of Chicken Whole Blood for Preparation of Chicken Nuggets Konmoni Goyari
- iv) Effect of Dietary Supplementation of Aloe Vera (*Aloe barbadensis* M.) Leaves Powder on the Performance and Carcass Quality of Commercial Broiler Chickens Manasjyoti Thakuria
- v) Effect of Fenugreek (*Trigonella goenum-gracum* L.) Seed powder Natural Feed Additive on Growth performance of Commercial Broiler Chicken Metung Kamchi
- vi) Effect of Dietary Supplementation of Marigold Flower Powder on the Productive Performance of Broiler Chickens Rajsekhar Sapkota
- vii) Quality Evaluation and Shelf Life Study of Chicken Meat Patty Incorporated with Chicken Blood Plasma and Mint Powder Shakura Siddika Barbhuiya
- viii) Effect of Dietary Supplementation of Curry Leaves (*Murraya koenigii*) Powder on the Performance and Histology of Certain Lymphoid Organs of Commercial Broiler Chicken Sukanya Deori



**8.19. Veterinary Public Health**

**1147 – 1160**

- i) Sero-Prevalence and Risk Factor Analysis of Leptospirosis among Cattle Population in West District of Tripura State Banitya Mohan Tripura
- ii) West Nile Virus: Sero-Prevalence in Duck and Molecular Detection of the Virus in Mosquitoes in and Around Guwahati Jakir Hussain
- iii) Detection of Bacterial Biofilms in Drinking Water Systems in Peri-Urban Dairy Farms of Guwahati City Johnson Th.
- iv) Sero-Prevalence and Molecular Detection of Canine Brucellosis in Urban and Peri-Urban Areas of Guwahati Malela Saikrishna Goud
- v) Prevalence of Cysticercosis in Jorhat District of Assam Mrinmoyee Sarma
- vi) Mosquito-Borne Flaviviruses in Livestock and Poultry Farms in Urban Settings of Guwahati: Mosquito Identification and Molecular Detection of Virus Phunu Talkdar
- vii) Sero-Prevalence and Molecular Detection of Leptospire in Dogs of Peri-Urban Livestock Farms and Urban Households of Guwahati Ritriisha Saikia

**8.20. Veterinary Surgery and Radiology**

**1161 – 1195**

- i) Comparative Evaluation of Interlocking Nailing and Locking Compression Plating Vis-a-Vis Management of Long Bone Fractures in Canine Anjali C J
- ii) Evaluation of Xenogenic Acellular Pericardium Matrix of Caprine and Porcine Origin for Abdominal Wall Reconstruction in Rabbit Anjali Padhan
- iii) Anaesthetic Effects of the Different Doses of Dexmedetomidine and Ketamine in Bovines Arja Avinash
- iv) Efficacy of Intra-Articular Autologous Platelet-Rich Plasma (PRP) and Ascorbic Acid in Degenerative Joint Disease of Dogs Supplemented with Chondroitin Sulphate and Glucosamine Assad Al Imran

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| v)     | Effect of Jackfruit ( <i>Artocarpus heterophyllus</i> ) Sap and Chitosan Derived Biosealant on Wound Management                                | Banashree Gogoi     |
| vi)    | Ultrasound Guided Epidural Analgesia for Perioperative Pain Management in Dogs Undergoing Ovariohysterectomy Operation                         | Bindiya Mahanta     |
| vii)   | Surgical Affections in Free Ranging and Captive Wildlife of Assam with Special Reference to Elephants  | Donnelly Gayle Hugh |
| viii)  | Intraoperative Assessment of Intestinal Viability in Rabbits   | Evakordor Hynniewta |
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- xx) Platelet Rich Plasma (PRP) with B-Tri Calcium Phosphate (B-TCP) and Demineralised Bone Matrix (DBM) in Healing of Bone Tissue in Rabbit Suman Kalita

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## **Ph.D (Agriculture)**

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- **Agricultural Biochemistry**
- **Agricultural Biotechnology**
- **Agricultural Economics and Farm Management**
  - **Agronomy**
  - **Crop Physiology**
  - **Entomology**
  - **Extension Education**
  - **Horticulture**
  - **Nematology**
- **Plant Breeding and Genetics**
  - **Plant Pathology**
  - **Sericulture**
  - **Soil Science**
- **Tea Husbandry and Technology**

# **Nutritional and Anti-nutritional Profile of Lentil (*Lens culinaris*) Cultivars of Assam and West Bengal**

*Partha Mondal*

Nutritional and anti-nutritional profiling of lentil (*Lens culinaris*) cultivars of Assam and West Bengal were studied from dehusked seed flour. Cultivars were collected from Regional Agricultural Research Station, Assam Agricultural University, Shillongoni (cultivars of Assam); Bidhan Chandra Krishi Viswavidyalaya; Regional Research Station, Uttar Banga Krishi Viswavidyalaya, Majhian and local farmers (cultivars of West Bengal). During this study moisture, starch, crude protein, total soluble protein, crude fat, crude fibre, ash content, minerals (P, Ca, K, Fe, Na), water-soluble vitamins, total phenolics, tannin, saponin, phytic acid content was estimated. As lentil is a pulse crop, protein is the major nutritional ingredient, fractionation of total soluble protein also done. From this study, biochemical constituents like moisture content (12.55-13.43 g %) on fresh weight basis, starch (44.80-52.70 g %), crude protein (21.59-36.00 g %), soluble protein (19.05-35.82 g %), crude fat (0.50-1.42 g %), crude fibre (0.71-1.12 g %), ash content (2.17-2.84 g %), minerals viz. Ca (24.11-29.60 mg %), Na (25.50-26.62 mg %), Fe (6.00-7.26 mg %), P (274.57-305.72 mg %), K (749.49-768.50 mg %) and ascorbic acid (4.08-4.40 mg %) were estimated on dry weight basis. Further, fractionation of protein on the basis of solubility, albumin (9.05-17.86 g %), globulin (54.12-63.84 g %), glutelin (13.77-26.62 g %), prolamin (1.91-3.99g %) were found on dry wt. basis. From UHPLC analysis some B vitamins were estimated. Anti-nutritional factors like phenol (0.12-0.20 mg/g gallic acid equivalent), tannins (5.29-7.52 mg/g), phytic acid (8.41-9.37 mg/g), saponin (2.78-4.87 mg/g) content were calculated on dry weight basis. The nutrient contents of the cultivars under study found to contain appreciable amount and comparable with other cultivars of lentil grown in India. On the other hand, the anti-nutritional constituents of the cultivars were found within the limits of lentil. Therefore, all those selected cultivars could be recommended for cultivation from nutritional point of view.

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**Abstract of Ph.D. thesis**

**Department: Agriculture Biochemistry**

**Major Adviser: Dr. A. M. Baruah**

# **Optimization of *in vitro* transformation protocol and RNAi based gene silencing for viral (Cucumber Mosaic Virus) resistance in Bhut jolokia (*Capsicum chinense* Jacq.)**

*Bharati Deuri*

Bhut jolokia (*Capsicum chinense* Jacq.), one of the most popular and hottest chillies in the world, is widely cultivated in Assam and other North Eastern regions in India. A member of the Solanaceae family, Bhut jolokia is characterized by very high pungency due to the presence of high amount of phenolic alkaloid 'Capsaicinoids'. It is an ideal chilli variety for extraction of oleoresin and capsaicin, which have high market demand due to their industrial uses and medicinal properties. Bhut jolokia production is challenged by several biotic constraints, particularly viral diseases, which affect its quality and yield. Among the viruses, Cucumber Mosaic Virus (CMV) causes severe crop damage, leading to low productivity. Current control measures for CMV are mainly preventive through vector management strategies, which are not adequate in controlling the disease. An effective way to control the disease is the use of biotechnological tools such as RNA interference (RNAi) technology to engineer resistance against the virus. Plants expressing a copy of a viral gene in sense and/or antisense orientation have shown resistance upon infection with the virus via post-transcriptional gene silencing. In the present investigation, an *in vitro* regeneration/transformation strategy has been optimized for Bhut jolokia and, a hairpin RNA (hpRNA) based gene silencing construct has been developed using the Replicase gene from CMV. The study was initiated by callus induction from Bhut jolokia leaf segments in MS basal medium. Very good quality callus were induced in MS medium supplemented with 0.5 mg/l or 1 mg/l 2,4-D. Multiple shoot induction and regeneration from callus were obtained in MS medium supplemented with 8.5 mg/l KIN and 0.5 mg/l TDZ along with 5 mg/l AgNO<sub>3</sub> with maximum shoot initiation frequency of 95% and regeneration frequency of 90%. Root regeneration was found to be optimum in half strength MS medium supplemented with 1.5 mg/l NAA within 4 weeks of culture with

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**Abstract of Ph.D. thesis**

**Department: Agriculture Biotechnology**

**Major Adviser: Dr. Priyadarshini Bhorali**

maximum rooting frequency of 70%. For standardization of an *Agrobacterium*-mediated genetic transformation system, the strain LBA4404 carrying pCAMBIA1301 binary vector construct with *gusA* as the reporter gene and *hptII* and *nptII* as selection marker genes was used. Transformation was carried out using 45 days old callus and also with intact Bhut jolokia seeds as explants. Hygromycin concentration of 9 mg/l was found to be optimum for efficient selection of putative transformants. From a total of 30 nos. of callus infected by *Agrobacterium*, 9 numbers of putative transformed shoots were regenerated in presence of selection agent. Finally, only 2 (6.66%) fully rooted plants survived out of which, only 1 plant finally survived during hardening in the green house. Moreover, out of 30 nos. of infected seeds, a total of 7 numbers of putative transformed seedlings were developed. Finally, only 1 (3.33%) seedling survived, which was transferred to the green house for hardening. Thus, both callus and seeds could be used as explants for transformation in Bhut jolokia, although the frequency of putative transformants obtained using callus explants was higher than that in seed transformation. The putative transformants were confirmed by GUS histochemical assay and PCR analysis. For developing the RNAi construct, a 323 bp Replicase gene sequence was cloned into pHANNIBAL vector both in sense and anti-sense orientations. The construct was then transferred to pBI121 binary vector, which was electroporated into *Agrobacterium* strain LBA4404 for plant transformation. Functional validation of the CMV Replicase hp-RNA construct was done through bioassay in model plant *Nicotiana benthamiana* by Agro-infiltration. Transgene expression in *N. benthamiana* was confirmed by RT-PCR analysis. The bioassay results indicated suppression of CMV infection in Agro-infiltrated *N. benthamiana* plants when mechanically inoculated with CMV sap. Further, DAS-ELISA established the functional efficiency of the hpRNA construct in providing considerable level of resistance against CMV infection. The in vitro regeneration-transformation strategy and the hpRNA based gene silencing construct, developed through this study would serve as a foundation towards future studies on engineering resistance against CMV in Bhut jolokia.

# **SSR marker based genetic diversity analysis and differential transcriptome in deepwater rice of Assam**

*D Shephrou Helena*

Deepwater rice (*Oryza sativa*), locally known as baodhan, is an important crop in the flood plains of Brahmaputra valley and Barak valley of Assam. A deepwater flood is a large-scale flood lasting for a prolonged period with water levels that range from a few to several meters. Deepwater rice adapts to submergence by rapidly elongating its internodes and thereby maintaining its leaves above the water surface. It hides this unique ability in its genome and uses it during a water emergency. The remarkable, rapid growth in response to water depth is a unique biological and environmental adaptation in deepwater rice which is known as an escape strategy. At present, there is inadequate evaluation data, no concerted effort to evaluate the genetic diversity and less exploration of this traditional landraces at molecular level. A set of 92 deepwater rice germplasm of Assam were genotyped using 74 SSR markers to assess the genetic diversity and genetic relationship. A total of 139 alleles was amplified with an average of 2.48 alleles per locus and the PIC value ranged from a low of 0.18 (RM413) to 0.69 (RM206) with a mean value of 0.39. Cluster analysis grouped these varieties into seven clusters. Analysis of molecular variance (AMOVA) revealed that 96% of the total variation observed in this germplasm came from within the populations, while 4% of the variation emanated among the populations. The biochemical analyses revealed the significant increased activity of anaerobically induced enzymes. Furthermore, to understand the insight of molecular mechanisms underlying the internode elongation of deep water rice, whole genome transcriptomics study was initiated. KEGG annotation revealed the enrichment of differentially expressed genes in several metabolic pathways including plant hormonal signal, secondary metabolite, cysteine-methionine and tryptophan. Among DEGs identified, most interestingly, we found the upregulation of genes like ERFO65, ERF051, ACO2, SAUR31, CYP93G2 and downregulation of ERF3(ERF076), ACO1, WRKY21, ABA8OX3, JA1 in internodal and nodal tissues signifies the possibility of its involvement role in imparting adaptability to Negheri Bao

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**Abstract of Ph.D. thesis**

**Department: Agriculture Biotechnology**

**Major Adviser: Dr. Priyabrata Sen**



rice in response to deepwater stress. Among the transcription factor genes, the ERF family genes were expressed especially at high levels during submergence. Our results highlight the genes that contribute to the essential mechanisms of deep-water tolerance in rice, including carbohydrate metabolism, pyrophosphate-dependent energy conservation, and ethylene signaling pathways.

# Mapping of drought tolerant QTLs in upland rice variety Banglami

*Nabarun Roy*

The study entitled 'Mapping of drought tolerant QTLs in upland rice variety Banglami' was taken up to identify the drought tolerant QTLs in Banglami, a local medium duration upland low yielding landrace of Assam which is drought tolerant. For this a mapping population was developed by crossing Banglami with Ranjit, an elite long duration high yielding photosensitive and drought susceptible variety of Assam. QTL mapping was done in this population with the use of SSR markers by Verma et al. (2017a) and Sharma et al. (2017) and several QTLs were mapped. But with the demand of latest technology which needs QTLs within narrow confidence intervals so that they can be used precisely in any breeding programme without much problem of linkage drag, the present work done became demanding as Genotyping by sequencing (GBS) technology was used to find out SNP markers which will now flank the mapped QTLs. For this, the mapping population was evaluated for 2 consecutive seasons for several yield and agronomic traits under both reproductive stage drought stress and control condition. The phenotypic data collected was associated with genotypic data to form a high density/saturated linkage map. 4646 polymorphic informative SNPs were assigned to 12 linkage groups (LGs) covering a total of 1306.424 cM of the rice genome at an average marker distance of 0.32 cM. A total of 65 QTLs were mapped which explained a PVE of 1.95- 13.80% with LOD scores ranging from 2.5- 31.6, out of which 30 QTLs were mapped from stress data, whereas 35 QTLs were mapped from non stress data. Out of these only 5 QTLs were major QTLs and 2 QTLs were found to be stable across environments. 3 QTLs were mapped for the trait grain yield per plant (GYP). 10 QTL clusters were identified among which cluster no. 10 on chromosome no. 12 had a congregation of 8 QTLs together within a region of 29 cM and can be considered as a QTL hotspot. Six gene within the QTL regions were found to be differentially expressed under stress condition. The genes were Calcium-transporting ATPase 9, Phosphoinositide binding protein, Histone demethylase JARID1C, Nuclear-pore anchor and OsWAK3 – OsWAK receptor - like cytoplasmic kinase and Cytochrome P450.

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**Major Adviser: Dr. Mahendra Kumar Modi**

Overall results from the present study sets a good achievement within the science of molecular breeding and can give a strong scientific background for the future researchers, the outcomes of which can help them to develop drought tolerant rice varieties.

# **Characterization of the *Sinapis alba*-*Alternaria brassicicola* interaction and, identification of associated defense response genes**

**Reshma Ahmed**

*Alternaria* blight caused by *Alternaria brassicicola* is one of the most devastating and widespread fungal diseases of the oilseed mustards. It causes yield losses up to 47% and has been reported from various parts of the country including the state of Assam. The non-host *Sinapis alba*, wild relatives of Brassicaceae, has been reported to have resistance against *Alternaria* blight disease. In order to understand this non-host mechanism, isolation and identification of pathogen, morphopathological, screening for resistance both in vitro and in vivo, histopathological study by using Scanning Electron Microscopy (SEM) and global gene expression using next generation sequencing method(NGS), RNA-seq, has been done to develop resistance variety of rapeseed mustard against *Alternaria* blight. For this, infected leaves, siliques and stems of the Toria variety TS-38, showing the initial conspicuous characteristic symptoms of *Alternaria* blight, were collected for isolation of the pathogen. The infected plant parts were surface sterilized and inoculated in petriplates containing Potato Dextrose Agar (PDA) medium under optimal conditions for fungal growth and sporulation. The mycelial growth of the fungus was observed after 3days of inoculation and the hyphal growth covered the petriplates within 15days of inoculation. On the basis of the conidial morphology as observed through microscopic studies, the pathogen was identified as *Alternaria brassicicola*. Purification of the fungal pathogen was done by single spore isolation method. Further, molecular detection of the fungus was successfully carried out by amplification of the fungal genomic DNA using reported ITS primers (ITS1/ITS2 & ITS2/ITS4). Sequencing of the fungal ITS region also confirmed the pathogen at the genus level. Further confirmation upto species level has been done with *A. brassicicola* specific primers (ABS28). The primary screening test both in vitro detached leaf assay showed the development of infection by showing chlorotic region after 72hpi with no chlorosis in *S. alba*. The light microscopy study of the infected portion showed the appearance of increase number fungal filaments in *B. rapa* with a few filaments in *S.*

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alba. The trypan blue staining showed the increase level of necrosis in *B. rapa* in comparison with *S. alba*. The SEM analysis also showed a similar type of result with light microscopy with a less hyphal penetration with a few spores in comparison with *B. rapa* by the presence of mass of hyphal filament with increased number of spores. Further Pathogenicity test was performed in vivo that showed successful development of disease in *B. rapa* after 72hpi whereas the infection 7 developed after 7dpi in *S. alba*. The disease progression study by morphological study showed a slow and restricted with little infection in *S. alba* after 10dpi whereas in *B. rapa* with severe infection with complete death of the inoculated leaves within that period. The disease scoring has been studied from 0hrs to 10 days. Leaf disease incidence percentage (LDI%) was calculated that analyzed the number of incidence of spot after infection. LDI% for *B. rapa* was found to be 82.50% while in *S. alba* it only showed 15% after 10dpi which is very less and showed its resistance against *A. brassicicola*. Global transcriptome profile has been done at early infection period viz. 48 and 72 hours post inoculation to identify the genes responsible for its resistance by differential expression study of genes in both the cultivars. A mapping percentage of 79.41% and 78.46% was found in *S. alba* after 48 and 72hpi and of 96.63% and 92.87% was found in *B. rapa* after 48 and 72hpi. DEG analysis showed a large number of genes were up-regulated at 48hpi than 72hpi. Validation of transcriptome data was performed by selecting 12 defense related genes that showed a high fold change in *S. alba* in comparison with *B. rapa* which showed a similar trend that confirms the validation of the targeted data set.

# **Use of Agro-Chemicals and their Effect on Commercial Vegetable Production in Assam**

*Ghana Kanta Sarma*

During the production of vegetables farmers generally use different agrochemicals. It has numerous benefits, but over utilization may cause health hazardous to human beings, animals, soil and to the environment. Scientific cultivation of vegetables is a profitable venture from the economic point of view. There are number of vegetables that farmers grow. This study was confined to five rabi vegetable namely; cabbage, cauliflower, potato, brinjal and tomato considering the time constraint.

The present study was carried out with the objectives to examine the economics of commercial vegetable production in different categories of farms, to study the extent of use of agro-chemicals in commercial vegetables production, to explore the factors affecting the use of agro-chemicals in commercial vegetable production and to examine the nature and extent of agro-chemicals residue in consumption ready vegetables.

Out of six agro-climatic zones of Assam, three agro-climatic zones namely; Lower Brahmaputra Valley Zone (LBVZ), North Bank Plain Zone (NBPZ), and Central Brahmaputra Valley Zone (CBVZ) were selected based on the area under vegetable cultivation. From each zone, one district such as Barpeta district from Lower Brahmaputra Valley Zone, Darrang district from North Bank Plain Zone and Nagaon district from Central Brahmaputra Valley Zone was selected purposively. Two ADO circles from each district were selected based on the area coverage under vegetable cultivation and its production. From each ADO circle, 5 (five) numbers of village were selected for the study. From each village, 15 (fifteen) number of vegetable growing farm families were selected randomly. Thus, the total number of respondent farm families in each district was 150 and the total number of farm families covered for the study was 450. For construction of strata, the Cumulative Square Root frequency method was followed (Singh and Mangat, 1996). The cost of production of the selected vegetables was calculated as per the standard cost concepts. The determinants of use of plant protection chemicals and chemical fertilizers in vegetable production are evaluated using multiple regression analysis. The purity of the samples was confirmed by HPLC analysis.

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**Abstract of Ph.D. thesis**

**Department: Agricultural Economics & Farm Management**

**Major Adviser: Dr. R. K. Sarma**

The results of the study revealed that out of 2856 populations of the 450 farm families under study, 51.37 per cent (1467 numbers) populations were male and 48.63 per cent (1389 numbers) were female. The average size of household was calculated as 6.65 in all the three zones under study. Out of the total populations, 37.57 per cent populations were considered as children who had not yet attained the age of 18 years. 36.41 per populations attained the age range 18 – below 40 years and 18.77 per cent populations were under the age group of 40 – below 60 years. Only the 7.25 per cent of the populations attained the age more than 60 years. Amongst the respondents, 28.22 per cent respondents were higher secondary passed followed by high school passed (23.78 per cent), ME passed (18.00 per cent), degree passed and above (11.78 per cent) and LP passed (10.44 per cent). Only 7.78 per cent respondents are found illiterate.

Out of the total respondents of 450, the percentage of farmers growing potato was found the highest (62.00 per cent) followed by cabbage (60.00 per cent) and cauliflower (52.67 per cent) and the lowest percentage was calculated for tomato (31.33 per cent). 32.44 per cent respondents had 10 - 15 years vegetable farming experience.

In case of cabbage, the highest all farm net return was received by the farmers of Lower Brahmaputra Valley zone amounting to Rs. 1,38,103 followed by the farmers of North Bank Plain zone (Rs. 1,33,295) and Central Brahmaputra Valley zone (Rs. 1,15,127). In case of cauliflower, the highest was received by the farmers of Lower Brahmaputra Valley zone amounting to Rs. 1,00,879 followed by the farmers of North Bank Plain zone (Rs. 97,021) and Central Brahmaputra Valley zone (Rs. 77,478). For potato, the highest was received by the farmers of North Bank Plain zone amounting to Rs. 79,823 followed by the farmers of Lower Brahmaputra Valley zone (Rs. 77,032) and Central Brahmaputra Valley zone (Rs. 63,126). In case of brinjal, the highest net return was received by the farmers of North Bank Plain zone amounting to Rs. 2,12,650 followed by the farmers of Lower Brahmaputra Valley zone (Rs. 1,79,520) and Central Brahmaputra Valley zone (Rs. 1,75,136). In case of tomato, the highest all farm net return was received by the farmers of North Bank Plain zone amounting to Rs. 1,40,455 followed by the farmers of Lower Brahmaputra Valley zone (Rs. 1,33,641) and Central Brahmaputra Valley zone (Rs. 1,15,142).

The highest return over cost for cabbage was calculated in Lower Brahmaputra Valley zone (2.03) followed by North Bank Plain zone (1.98) and Central Brahmaputra Valley zone (1.86). For cauliflower, the highest return over cost was recorded for Lower Brahmaputra Valley zone (2.06), the second and the third rank was occupied by North Bank Plain zone (1.93) and Central Brahmaputra Valley zone (1.68) respectively. In case of potato cultivation, in terms of return over cost, the first rank was occupied by North Bank Plain zone (1.51) followed by Lower Brahmaputra Valley zone (1.48) and Central Brahmaputra Valley zone (1.40). The return over cost for brinjal was calculated the highest for North Bank Plain zone (2.92) followed by Central Brahmaputra Valley zone (2.73) and Lower Brahmaputra Valley zone (2.59). In case of tomato, the return over cost was found the highest for North Bank Plain zone (2.23) followed by Lower Brahmaputra Valley zone (2.04) and Central Brahmaputra Valley zone (1.82).

The major chemical fertilizers used by the respondent farmers were urea, single super phosphate (SSP), murate of potash (MOP), diammonium phosphate (DAP), borax, some chemical micronutrients. The insecticides used by the farmers in vegetables cultivation were Dimethoate 30 EC, Malathion 50 EC, Chloropyriphos 20 EC, Endosulphan 35 EC, Monocrotophos 36 WSC, Cypermethrin 25 EC, Carbofuran 3G. The fungicides used by the farmers were Carbendazim, Carboxin, Mancozeb, Zineb, Captan, Copper Oxychloride, Metalaxyl 8% + Mancozeb 64% and Carbendazim 12% + Mancozeb 63%. All the farmers used insecticides and fungicides at a higher concentration as compared to the recommended dose. Farmers sprayed the plant protection chemicals at different time and as per their convenience. All zones average revealed that the highest percentage of farmers (49.33 per cent) sprayed the chemicals at 4 - 7 days before harvesting of the crops followed by 1 - 3 days before harvesting (35.11 per cent) of crops. In case of insecticides, the farmers made lesser number of sprays in potato and tomato crops than cabbage, cauliflower and brinjal but they made more number of fungicide sprays in potato and tomato crops than the other three crops. On an average 10.00 per cent farmers took full protective measures during the application of pesticides, 45.56 per cent farmers took partial protective measures and 44.44 per cent of the total respondent farmers did not take any protective measures.

Out of different factors responsible for use of plant protection chemicals vegetable farming experience (years) showed a significant relationship at 0.1 level in group II and group III. The use of chemical fertilizers showed a significant relationship with the use of plant protection chemicals at 0.01 level in all farmers' groups of LBVZ. In NBPZ, educational qualification and vegetable farming experience showed a significant relationship with the use of plant protection chemicals at 0.1 level in group I and group III respectively. Distance from home to inputs dealer showed a significant relationship at 0.1 level in group I. Area under rabi vegetables showed a significant relationship at 0.1 level in group I and group III. Use of chemical fertilizers showed a significant relationship with the use of plant protection chemicals at 0.01 level. In CBVZ only the use of chemical fertilizers showed a significant relationship with the use of plant protection chemicals at 0.01 level. In case of use of chemical fertilizers, age (yr) of the head of the households showed a significant relationship at 0.01 level in group I and at 0.5 level in group III in LBVZ and use of plant protection chemicals showed a significant relationship with the use of chemical fertilizers at 0.01 level in all groups. In NBPZ, use of plant protection chemicals showed a significant relationship with the use of chemical fertilizers at 0.01 level in all groups. In CBVZ, use of plant protection chemicals showed a significant relationship with the use of chemical fertilizers at 0.01 level in all groups and type of seeds used a significant relationship with the use of chemical fertilizers at 0.1 level.



The residue test analysis of the insecticides Endosulfan 35 EC, Chlorpyrifos 20 EC, Cypermethrin 25 EC and Carbofuran 3G available in vegetables ready for consumption revealed that except a few all the vegetables contained the residues of the above chemicals above the Maximum Residue Level (MRL) as compared to the report made by Agnihotri (1999) and the Food Safety and Standard Authority of India (FSSAI).

# **Economic analysis of production and marketing of milk and milk products in Assam**

*Pinky Pathok*

Livestock happens to be an integral component of Indian economy since time immemorial. Though, Assam possesses comparatively large number of Bovine population, it continues to remain a deficit state in terms of total milk production and per capita milk availability. The availability of milk in the state was around 35.00 per cent of the total requirement during 2016-17. However, there is enough potential of making dairy a lucrative proposition in Assam in mitigating the problem of unemployment in one hand, and income generation, on the other. Therefore, the present study was undertaken to have an insight into the dairy sector in Assam and to examine the livelihood pattern of dairy farmers in the context of Dairy Cooperative Societies and also to suggest ameliorative measures through field investigation. The study was conducted in Jorhat and Morigaon district of Assam. Two Dairy Co-operative Society (DCS) from each district were selected and from each DCS, 30 registered members with DCS and 15 non-members were selected, thereby making the total sample size for the entire study at 180 households. Also, the trade-related information was collected from 25 milk traders and the sampled DCSs. Dairy continued to be a major occupation for a large chunk of population in both the districts, contributing significantly to the total income, and for that matter, to the livelihood pattern. For Morigaon district, the DCS were more organized as compared to that of Jorhat district and hence, dairy, as a livelihood option, yielded more income. Dairy contributed more than 50.00 per cent of the total annual income earned by the DCS-members. Also, parameters like age, experience, area under fodder crops, herd size and milk productivity were found to be positively related to the income generated from dairy enterprise. The B: C ratio shows that, dairy, as a means of livelihood, was successful in the study area. Commercialization of dairy farming in Morigaon district had resulted in increase in income through increased milk production. Majority of the non-members in Jorhat district had dairy as their main occupation while the DCS-members of the district had dairy as their subsidiary occupation. However, in case of Morigaon district, majority of the members had dairy as their main occupation while it was a secondary occupation for

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**Abstract of Ph.D. thesis**

**Department: Agricultural Economics & Farm Management**

**Major Adviser: Dr. A. K. Das**

majority of the non-members of the district. The overall net return per litre of milk was higher in Morigaon district (Rs.7.01) as against Rs. 5.05 6 in Jorhat district. Among the various cost components, feed cost accounted for highest share (60-70 per cent) to the total cost. Growth and development of dairying has not only increased the income of the dairy farmers, but also stimulated the growth of agriculture through increased demand for feed and fodder.

Apart from paying higher price to the DCS members in Morigaon district, the cooperative provided easy, stable and lucrative price for milk which helped the farmers to plan for better dairy farming. Traditional marketing system dominated the study area but more so in Jorhat district (55.64 per cent). Non-members involved in milk marketing had to face the problems of high marketing cost, unstable milk price, time consuming nature of home delivery, high production cost and were deprived of other benefits as availed by the Cooperative society members. Cooperative provided all modern marketing facilities which lacking in Jorhat district. Further, the conversion of milk to milk products was found to be more profitable. Milk marketing through the DCS can reduce the transportation cost due to collective marketing, can get benefits from the Government and can avail available infrastructure and marketing facilities. Therefore, synergy among the Governments and other agencies is the need of the hour to strengthen the dairy sector in Assam through promotion of cross-bred cows, making adequate provision of animal health support, motivation of dairy farmers to go for fodder cultivation, aiding and assisting in obtaining banking and technical support. At the same time, there is need to promote the DCS among the dairy farmers to stimulate them to go for it on a mission mode which can ultimately raise their living standard besides creating additional opportunities for others.

# **Crop Insurance in Odisha: An Empirical Assessment**

*Saddam Hossen Majumder*

The present study identified and quantified the various risks, performance of crop insurance schemes in Odisha and assessed the impact of its adoption along with the prioritization of risk mitigation strategies adopted by the rice growers. The study used primary as well as secondary data and primary data was collected from 240 farmers comprising both insured and non-insured farmers selected from two districts, namely Jagatsinghpur and Kendrapara from East and South eastern coastal plains zones of Odisha, where rice cultivation and climatic related hazards, both are widespread. Few officials and field functionaries of implementing agencies were also selected and interviewed. The study revealed that farmers in Odisha state and the study area as well are much vulnerable to adverse climatic environments, especially floods, drought, severe cyclones and infestation of pest and diseases. Farmers do have their own risk coping strategies like sale of farm produce/ livestock and non-farm activities (daily wage labour) apart from adoption of crop insurance. Crop diversification as a tool of risk reduction also examined through various indices and it was found that insured farmers were in better position to diversify their crops than the non-insured farmers. Growth analysis of earlier introduced insurance schemes showed that farmers and area coverage, farmers covered and benefitted, premium paid and claims settled, etc. decreased except National Agricultural Insurance Scheme (NAIS) in which growth of above indicators were positive during kharif seasons for loanee farmers. The present scheme Pradhan Mantri Fasal Bima Yojana (PMFBY) introduced during 2016, replacing earlier schemes were also examined and found loanee and non-loanee farmers' coverage got increased during kharif season, but percentage coverage of loanee farmers was much higher than non-loanee farmers. Post revamp of PMFBY scheme witnessed increase in the number of non-loanee farmers during rabi 2020-21. However, compensations against crop damages were much lower than the average value of threshold yield. The results also depicted that the farmers were reluctant to invest more due to frequently occurrence of adverse climatic risks but they spend more in material costs in rice production anticipating high yield and compensation in case of any

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catastrophes, and the fact was reinforced by significant regression coefficient of insurance adoption on materials costs. To estimate the true impact of crop insurance, the difference in difference (DiD) method was employed and found a negligible difference between increment in costs, returns and investment on agriculture between insured and non-insured farmers. Estimates of logit regression models showed that farm size, farmer's contact with extension agencies, access to credit, information access from media and influence of fellow farmers' were the key drivers of awareness creation and adoption of crop insurance. Estimates of tobit regression model indicated that gross cropped area, credit availed, affordability of farmers to premium rate and diversification status of farm, etc. were the key factors influencing the premium paid by the insured farmers. Delay in conducting crop cutting experiments (CCE), damage assessment and settlement of claims were the main hindrances for adoption of crop insurance as identified and ranked using Garrett ranking technique. Creation of awareness about benefits of crop insurance and considering the individual farm as a unit of assessment instead of gram panchayat were the key suggestion for better coverage of the scheme. It is concluded that a demand driven approach comprising of location specific crops and coverage, targeting young and educated farmer and easy access to information flow through better extension services will facilitate more adoption and improve the farmer's stands in protecting their crops from various adversities.

## **Organic nutrient management in aromatic rice-linseed cropping sequence under rainfed situation**

*Anjan Krishna Sarmah*

A field experiment entitled “Organic nutrient management in aromatic rice linseed cropping sequence under rainfed situation” was conducted at Instructional-cum-Research Farm, Assam Agricultural University, Jorhat during *kharif* and *rabi* seasons, 2018-19 and 2019-20 to evaluate the direct effects of organic nutrient management on growth, yield attributes, yield and quality of aromatic rice varieties and residual effects on succeeding relay sown linseed under rainfed situation taking into account the system’s cumulative effects on soil health. The experiment consisted of three aromatic rice varieties *viz.*, *Kola joha* (V1), *Keteki joha* (V2) and *Chakhao poireiton* (V3) and five organic nutrient management practices *viz.*, control (N0), vermicompost @ 40 kg N ha<sup>-1</sup> (N1), vermicompost @ 30 kg N ha<sup>-1</sup> + *in situ* green manuring with *Sesbania aculeata* (N2), vermicompost @ 30 kg N ha<sup>-1</sup> + *in situ* green manuring with *Sesbania aculeata* + seedling root dip treatment with *Azospirillum* and PSB @ 3.5 kg ha<sup>-1</sup> each (N3) and vermicompost @ 20 kg N ha<sup>-1</sup> + *in situ* green manuring with *Sesbania aculeata* + seedling root dip treatment with *Azospirillum* and PSB @ 3.5 kg ha<sup>-1</sup> each (N4). The experiment was laid out in factorial RBD with three replications. The soil of the experimental site was sandy loam in texture with pH 5.3, low in available N (242.50 kg ha<sup>-1</sup>), low in available P<sub>2</sub>O<sub>5</sub> (18.60 kg ha<sup>-1</sup>), medium in available K<sub>2</sub>O (140.60 kg ha<sup>-1</sup>) and medium in organic carbon (0.58 %). The total rainfall received was 1544.3 mm with 86 rainy days in 2018-19 and 1691.30 mm with 80 rainy days in 2019-20 during the total cropping period. The growth, yield attributes and yield of aromatic rice was significantly influenced by the varieties and different organic nutrient management treatments. Among the varieties tested, most of the growth parameters *viz.*, plant height, LAI, root dry weight, root length and root volume, dry matter production at different stages were observed to be significantly higher in *Chakhao poireiton*. However, the highest leaf number and panicle number m<sup>-2</sup> was recorded in *Keteki joha*. The length of panicle, weight of panicle and test weight was found highest in *Chakhao poireiton*. The filled grain panicle-1 was highest in *Kola joha* and unfilled grain panicle-1 was lowest in *Keteki joha*. The highest grain yield was recorded in *Keteki joha* which was found to

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be statistically at par with *Chakhao poireiton* during both the years of experimentation. The highest pooled grain (27.46 q ha<sup>-1</sup>) and the straw (78.80 q ha<sup>-1</sup>) yield were recorded with *Keteki joha* and *Chakhao poireiton*, respectively. Different organic nutrient management practices significantly influenced most of the growth, yield attributing parameters and yield of aromatic rice as compared to the control. The highest panicle numbers viz., 264.93 m<sup>-2</sup> in 2018 and 271.40 m<sup>-2</sup> in 2019 were recorded in *Keteki joha* with the N3 treatment. The N3 treatment was found superior in respect of almost all the studied parameters which was found statistically at par with the N2 treatment for most of the parameters. The N3 treatment registered the highest pooled grain (31.42 q ha<sup>-1</sup>) and straw (67.48 q ha<sup>-1</sup>) yield. The interaction effects between the varieties and organic nutrient management practices were found not significant except for the panicle numbers. N, P and K contents and their uptake by grain and straw were significantly influenced by the varieties and the highest uptake of N (92.7 kg ha<sup>-1</sup>), P (20.78 kg ha<sup>-1</sup>) and K (91.98 kg ha<sup>-1</sup>) were recorded in *Chakhao poireiton*. All the organic nutrient management practices recorded significantly higher nutrient content and uptake as compared to the control and the highest values were recorded with N3 treatment. All the three rice varieties showed significant variations in their quality traits and *Kola joha* was found superior in respect of Fe, Zn and Mn content and aroma, *Keteki joha* was found superior in respect of crude protein, Ca and Mg content and milling quality whereas the *Chakhao poireiton* registered the lowest amylose content (6.23%). Most of the studied quality traits did not differ significantly due to organic nutrient management practices.

All the studied parameters on growth, yield attributes and yield of succeeding relay sown linseed (var.T-397) were not significantly influenced by the aromatic rice varieties but significantly influenced by the organic nutrient management practices applied to the preceding rice crop. The highest values of growth, yield attributes and yield were recorded with the treatment N3 and the highest pooled seed yield (405.74 kg ha<sup>-1</sup>) and stover yield (893.36 kg ha<sup>-1</sup>) were recorded with this treatment. The effect of organic nutrient management practices on available N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O in soil after the sequence was found significant. The highest available N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O in soil after harvest of linseed were recorded with the N3 treatment. The difference in organic C due to organic nutrient management practices was found significant and the N3 treatment recorded the highest build up of organic C. The comparative economic study of the aromatic rice-linseed (relay) sequence revealed that the highest net return and B:C ratio was achieved with the N3 treatment in *Keteki joha*-linseed, *Chakhao poireiton*-linseed and *Kola joha*-linseed sequence as a whole during both the years. However, the highest B:C ratio (1.63) was achieved with the N4 treatment in *Kola joha*-linseed sequence during the second year of experimentation. The *Keteki joha*-linseed was found to be the most profitable sequence which was closely followed by the *Chakhao poireiton*-linseed sequence. Based on the findings of two years study on organic nutrient management in aromatic rice-linseed cropping sequence, it may be concluded that among the varieties tested *Keteki joha* and *Chakhao poireiton* were found to be at par in respect of their

yield potential under organic nutrient management in rainfed situation. Among the organic nutrient management practices, application of 30 kg N ha<sup>-1</sup> through vermicompost along with green manuring with *Sesbania aculeata* and seedling root dip treatment with *Azospirillum* and PSB @ 3.5 kg ha<sup>-1</sup> each (N3) was found to be most effective in regard to their direct effect on rice, carryover effect on the succeeding relayed linseed and sustenance of soil health.



## **Integrated Nutrient Management in rice (*Oryza sativa*) - toria (*Brassica campestris* var. toria)-greengram (*Vigna radiata*) cropping sequence under different rice establishment techniques**

*Barshi Baro*

A field experiment on “Integrated Nutrient Management in rice (*Oryza sativa*) - toria (*Brassica campestris* var. toria) - greengram (*Vigna radiata*) cropping sequence under different rice establishment techniques” was carried out at Instructional-cum-Research Farm of Assam Agricultural University, Jorhat during 2016-17 and 2017-18. The experiment was laid out in split-plot design with three replications. The treatments consisted of two different establishment techniques of rice viz., Transplanted rice (M1) and Direct seeded rice (M2) in main plot and five different nutrient management practices viz., Control(N1), 100% RDF (N2), 50% RDN as inorganic + 50% RDN as vermi-compost + bio-fertilizer (N3), 75% RDN as inorganic + 25% RDN as vermi-compost + bio-fertilizer (N4) and 100% N as vermi-compost + bio-fertilizer (N5) in sub-plots. The soil of the experimental plot was sandy loam, acidic in reaction (pH 5.8), medium in organic carbon content (0.61%), available N (299.67kg ha<sup>-1</sup>), available K<sub>2</sub>O (139.71 kg ha<sup>-1</sup>) and low in available P<sub>2</sub>O<sub>5</sub> (21.59kg ha<sup>-1</sup>).The total rainfall received during the experimental period was 138.4 mm and 220.6 mm during 2016 and 2017 respectively.

The results of the experiment revealed that the establishment techniques of rice brought significant effect on growth characters in terms of plant height, dry matter accumulation, post flowering photosynthetic contribution (PFPC), yield attributing characters, grain and straw yield and NPK-uptake of rice during both the years. Transplanted technique of rice establishment recorded the higher value for all those growth characters except for CGR, RGR and LAI in first crop rice. Yield attributing characters, grain and straw yield, NPK-uptake was also higher under transplanted technique of rice as compared to direct seeded rice. In second crop toria, growth attributing characters viz., plant height, dry matter accumulation, post flowering

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photosynthetic contribution (PFPC) and yield attributing characters, seed and stover yield, sink capacity, oil content and oil yield were found higher when grown following transplanted technique of rice establishment. The NPK- uptake in seed and stover registered the higher value grown following transplanted techniques of rice establishment over direct seeded rice establishment technique. The growth attributing characters, in terms of plant height, number of leaves per branch, dry matter accumulation, CGR, LAI and post flowering photosynthetic contribution (PFPC) recorded the higher values under transplanted technique of rice establishment in third crop greengram. Yield attributing characters and yield were also higher under transplanted technique of rice establishment. NPK- uptake in seed and stover, available soil NPK- status after harvest of crop, nutrient harvest index were also higher in transplanted rice establishment technique as compared to direct seeded rice establishment technique.

Different nutrient management brought about significant differences in growth attributes, yield attributing characters, grain and straw yield, NPK-uptake, physiological nitrogen use efficiency, NPK - status in soil during both the years. Among all the nutrient management, 50% RDN as inorganic + 50% RDN as vermi-compost + bio-fertilizer recorded the highest value of growth and yield attributing characters, grain and straw yield, NPK-uptake, physiological nitrogen use efficiency in rice. The treatment was followed by 75% RDN as inorganic + 25% RDN as vermi-compost + bio-fertilizer. The increase in grain yield under the treatment was 9.19% and 9.34% higher than 75% RDN as inorganic + 25% RDN as vermi-compost + bio-fertilizer in first year and second year respectively. Nutrient management with 75% RDN as inorganic + 25% RDN as vermi-compost + bio-fertilizer registered the highest value of growth and yield attributing characters in second crop toria. The percent increase in seed yield was 18.43% and 53.42% higher than 100% RDF and 50% RDN as inorganic + 50% RDN as vermi-compost + bio-fertilizer respectively. The lowest seed yield (2.99q/ha and 3.31 q/ha) was observed under the control in both the years. The highest oil content and oil yield, NPK- uptake in seed and stover were found in 75% RDN as inorganic + 25% RDN as vermi-compost + bio-fertilizer. Similarly, in third crop greengram, nutrient management with 50% RDN as inorganic + 50% RDN as vermi-compost + bio-fertilizer registered the highest value in growth and yield attributing characters. The treatment was closely followed by 100% RDF, 75% RDN as inorganic + 25% RDN as vermi-compost + bio-fertilizer and 100% N as vermi-compost + bio-fertilizer. The increase in seed yield under the treatment was 15.73% and 18.77% and 19.97% and 23.58% higher than 100% RDF and 75% RDN as inorganic + 25% RDN as vermi-compost + bio-fertilizer in first year and second year respectively. Nutrient management with 50% RDN as inorganic + 50% RDN as vermi-compost + bio-fertilizer also reported the highest NPK-status in soil after harvest and nutrient harvest index in greengram.

Transplanted technique of rice establishment with nutrient management package of 50% RDN as inorganic + 50% RDN as vermi-compost + bio-fertilizer recorded the highest values of total equivalent yield and production efficiency of the system as a

whole. Similarly, in terms of soil health also, transplanted technique of rice with nutrient management package of 50% RDN as inorganic + 50% RDN as vermi-compost + bio-fertilizer registered the highest value. In terms of economics, transplanted techniques of rice with 100% RDF gave the highest net return of Rs.1, 19,365.12 and Rs.1,24,099.40, benefit - cost ratio of 2.20 and 2.28 during both years, respectively.

## **Integrated nutrient management in yellow sarson - greengram cropping system under rainfed condition**

*Bebi Gogoi*

A field experiment entitled “Integrated nutrient management in yellow sarson - greengram cropping system under rainfed condition” was carried out at the Instructional-cum-Research farm of Assam Agricultural University, Jorhat during two consecutive *rabi* (Oct-Feb) followed by summer (Feb-May) seasons of the year 2017-2018 and 2018-2019. The experiment was laid out in randomized block design for first crop and split plot design for second crop with three replications. The eight INM practices *viz.*, 100% RDF (60-30-30 kg/ha N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O) (Y1), 100% RDF + biofertilizer consortium (Y2), 75% RDF + 25% N through vermicompost (Y3), 75% RDF + 25% N through vermicompost + biofertilizer consortium (Y4), 50% RDF + 50% N through vermicompost (Y5), 50% RDF + 50% N through vermicompost + biofertilizer consortium (Y6), 25% RDF + 75% N through vermicompost (Y7) and 25% RDF + 75% N through vermicompost + biofertilizer consortium (Y8) were applied to yellow sarson crop. In greengram crop the residual effect of the treatments applied to yellow sarson were allotted in main plots and two different integrated nutrient management practices *viz.*, 100% RDF + biofertilizer consortium (G1) and 50% RDF + biofertilizer consortium (G2) in the sub plots. The soil of the experimental site was sandy loam in texture, acidic in reaction (pH 5.40 and 5.56), medium in organic carbon (0.69 and 0.72%), available N (274.86 and 290.75 kg/ha), available K<sub>2</sub>O (138.16 and 140.89 kg/ha) and low in available P<sub>2</sub>O<sub>5</sub> (17.90 and 20.30 kg/ha) in the year 2017-18 and 2018-19, respectively. Experimental findings revealed that application of 75% RDF + 25% N through vermicompost + biofertilizer consortium (Y4) resulted in significantly higher growth as well as yield attributing characters like plant height, number of branches per plant, dry matter accumulation, crop growth rate, relative growth rate, number of siliquae per plant, length of siliqua, number of seeds per siliqua in both the years. The highest seed yield of 998.34, 1026.22 and 1012.28 kg/ha, stover yield of 2393.97, 2420.65 and 2407.31 kg/ha during 2017-18, 2018-19 and in pooled analysis,

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respectively, were recorded with treatment having 75% RDF + 25% N through vermicompost + biofertilizer consortium (Y4). The seed oil content of 36.40 and 36.97% and seed protein content of 13.27 and 13.44% were also recorded in Y4 in 1<sup>st</sup> and 2<sup>nd</sup> year, respectively. Similar effects of this treatment were also observed in respect of N, P and K content and uptake by both seed and stover. However, soil microbial population, microbial biomass carbon, phosphomonoesterase activity and fluorescein diacetate hydrolase activity after harvest of yellow sarson were significantly higher in treatment having 25% RDF + 75% N through vermicompost + biofertilizer consortium (Y8). The crop recorded the highest gross return (₹ 56105 in 2017-18 and ₹ 57652 in 2018-19), net return (₹ 35407 during 2017-18 and ₹ 36954 during 2018-19) and benefit-cost ratio (2.71 during 2017-18 and 2.79 during 2018-19) with the treatment containing 75% RDF + 25% N through vermicompost + biofertilizer consortium (Y4).

In case of greengram, residual effect of 25% RDF + 75% N through vermicompost + biofertilizer consortium (Y8) resulted in significantly higher growth as well as yield attributing characters like plant height, number of branches per plant, dry matter accumulation, crop growth rate, number of pods per plant and number of seeds per pod in both the years. The effect of these was reflected in higher seed yield (849.56, 806.56 and 828.06 kg/ha in the year 2018, 2019 and in pooled analysis, respectively) and stover yield (2012.68, 1935.58 and 1974.13 kg/ha in 2018, 2019 and in pooled analysis, respectively) under the same integrated nutrient management practices. The maximum values of N, P and K uptake by seed and stover, soil microbial population, microbial biomass carbon, phosphomonoesterase activity and fluorescein diacetate hydrolase activity after harvest of greengram were also observed under this treatment (Y8). However, direct application of 100% RDF + biofertilizer consortium (G1) brought about higher values in growth parameters, yield attributes, yield of seed (804.21, 724.68 and 764.45 kg/ha during 2018, 2019 and in pooled analysis, respectively) and stover yield (1830.89, 1763.80 and 1797.35 kg/ha during 2018, 2019 and in pooled analysis, respectively), protein content in seed (22.39 and 22.26% in 2018 and 2019 respectively), content and uptake of N, P and K by both seed and stover, soil microbial population, microbial biomass carbon, phosphomonoesterase activity and fluorescein diacetate hydrolase activity after harvest of greengram over 50% RDF + biofertilizer consortium (G2). The highest gross return (₹ 50726 in 2018 and ₹ 48922 in 2019), net return (₹ 33611 during 2018 and ₹ 31807 during 2019) and benefit-cost ratio (2.96 during 2018 and 2.86 during 2019) were observed under treatment Y8G1 containing 100% RDF + biofertilizer consortium (G1) + residue of treatment Y8 (25% RDF + 75% N through vermicompost + biofertilizer consortium). In regards to yellow sarson-greengram cropping system the highest yellow sarson equivalent yield (1678.57 and 1614.02 kg/ha in 2018 and 2019, respectively) were obtained by treatment Y4G1 containing 100% RDF + biofertilizer consortium (G1) + residue of treatment Y4 (75% RDF + 25% N through vermicompost + biofertilizer consortium). The highest gross return (₹ 93518 in 2017-18 and ₹ 89981 in 2018-19), net return (₹ 55705 during 2017-18 and ₹ 52168 during 2018-19) and benefit-cost ratio (2.47 during 2017-18 and 2.37 during 2018-19)

of yellow sarsongreengram cropping system were observed under treatment Y4G1, containing 100% RDF + biofertilizer consortium (G1) + residue of treatment Y4 (75% RDF + 25% N through vermicompost + biofertilizer consortium). The performance of yellow sarsongreengram cropping system was assessed on the basis of yellow sarson equivalent yield, net monetary returns and B-C ratio. The application of 75% RDF + 25% N through vermicompost + biofertilizer consortium to yellow sarson and 100% RDF + biofertilizer consortium to greengram was the most beneficial combination compared to rest of the treatments.

# **Organic Nutrient Management in winter rice (*Oryza sativa* L.) Under different methods of crop establishment and its effect on summer rice**

*Gayatree Goswami*

An experiment entitled “**Organic nutrient management in winter rice (*Oryza sativa* L.) under different methods of crop establishment and its effect on summer rice**” was carried out at the instructional cum research farm of AAU, Jorhat during 2016-17 and 2017-18 to study the effect of organic nutrients on winter rice, to assess the performance of winter rice under different methods of crop establishment, to study the effect of nutrient management in winter rice on summer rice and to assess the soil physico-chemical properties as influenced by the organic nutrient management. The experiment was laid out in factorial Randomized Block Design (RBD) with three replications. The treatments consisted of three crop establishment (E) methods *viz.*, transplanting (E1), wet seeding (E2) and SRI (E3) and five nutrient management (N) practices *viz.*, control (N0), application of vermicompost either @ 2.5 t/ha (N1) or @ 5.0 t/ha (N2) and application of enriched compost either @ 2.5 t/ha (N3) or @ 5.0 t/ha (N4). *Satyaranjan* (winter rice) and *Kanaklata* (summer rice) were the crop varieties. The soil of the experimental field initially was sandy loam in texture, acidic in reaction (5.21), medium in organic carbon (0.63%), medium in available nitrogen (302.85 kg/ha), high in available phosphorous (32.04 kg/ha) and medium in available potassium (167.78 kg/ha). The main weeds in the experimental field were; *Echinochloa crusgalli*, *Digitaria violescens*, *Cyperus iria*, *Cyperus rotundas*, *Scirpus juncooides*, *Monochoria vaginalis*, *Marsilea minuta*, *Alternanthera philoxeroides*, *Cynodon dactylon*, *Eleusine indica* and *Ageratum conyzoides*.

The crop establishment method significantly increased plant height, dry matter accumulation/plant, leaf area index (LAI), crop growth rate (CGR), relative growth rate (RGR), number of tillers/m<sup>2</sup> and root dry weight/plant in winter rice. Transplanting increased days to 50% flowering and maturity in winter rice followed by SRI and wet seeding. The yield attributing characteristics, *viz.*, number of effective tillers/m<sup>2</sup>, number of grains/panicle, number of filled grains/panicle, percent unfilled grains/panicle, 1000-grain weight, grain yield and straw yield of winter rice were found

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to be significantly increased due to crop establishment method. SRI was the best treatment in respect of growth and yield attributing characteristics of winter rice followed by transplanting and wet seeding. SRI also significantly increased the yield of winter rice (30.83 q/ha in 2016 and 31.49 q/ha in 2017) by 32.77% and 30.23% over wet seeding in 2016 and 2017, respectively. During both the years, density and dry weight of weeds in winter rice were found to be significantly higher in case of wet seeding (E2). Application of 5.0 t/ha enriched compost (N4) resulted in significant improvement of the aforesaid growth and yield attributing characteristics in winter rice. Application of 2.5 t/ha of enriched compost (N3) was the second best treatment. The interaction effect was significant in respect of LAI at 90 DAS, dry matter accumulation/plant at 90, 120 DAS and harvest and CGR at 90-120 DAS during both the years of experiment. SRI (E3) alongwith application of 5.0 t/ha of enriched compost (N4) was the best combination in this regard followed by the treatment combination E3N3 *i.e.* SRI (E3) alongwith application of 2.5 t/ha of enriched compost (N3). SRI resulted in significantly higher nitrogen, phosphorous and potassium uptake at 60 DAS of winter rice plants and also of rice grain and straw and thus the total uptake followed by transplanting (E1) and wet seeding (E2). Application of 5.0 t/ha enriched compost (N4) significantly increased nitrogen, phosphorous and potassium content and uptake in plants at 60 DAS and of rice grain and straw and in its total uptake. There was no significant influence of crop establishment method on pH and organic carbon. However, available nitrogen, available phosphorous and available potassium in soil was significantly higher in wet seeding followed by transplanting method. Application of 5.0 t/ha of enriched compost (N4) resulted in significantly higher organic carbon, available nitrogen, available phosphorous and available potassium in soil followed by application of 2.5 t/ha of enriched compost (N3).

There was no significant carryover effect of crop establishment method of winter rice on summer rice. However, nutrient management of winter rice seemed to significantly improve growth and yield of summer rice and the best treatment was application of 5.0 t/ha enriched compost in winter rice with grain yield of 31.61 q/ha in 2016 and 33.44 q/ha in 2017, respectively. Organic carbon and available nitrogen, available phosphorous and available potassium in soil were found to be significantly higher due to the residual effect of application of 5.0 t/ha enriched compost in winter rice. The nitrogen, phosphorous and potassium content, uptake and total uptake were significantly higher in summer rice due to the residual effect of nutrient management in winter rice. Although SRI combined with application of 5.0 t/ha enriched compost resulted in highest gross, the comparative economics of the sequence revealed that SRI coupled with application of 2.5 t/ha enriched compost was better in terms of Benefit:Cost ratio (2.96 in 2016 and 2.86 in 2017) compared with that in case of association of SRI and application of 5.0 t/ha enriched compost (2.35 in 2016 and 1.93 in 2017).



# **Intensive food-forage cropping system under medium land situation as influenced by integrated nutrient management**

*Joshila Enghipi*

A field investigation entitled “Intensive food-forage cropping system under medium land situation as influenced by integrated nutrient management” was conducted at the Instructional-cum-Research farm, Assam Agricultural University, Jorhat during the year 2016-2017 and 2017-18 with a view to study the performance of food-forage cropping system under different integrated nutrient management and their effect on succeeding rice in *kharif* and thereafter rapeseed as relay crop during *rabi* season. The experiment was laid out in split-plot design with three replications for the teosinte+ricebean intercropping system during summer season and a split- split plot design for the treatments in rice crop during *kharif* season and relay crop rapeseed during *rabi* season. During summer the treatments comprised of four different cropping system in main plots *viz.*, C1= Sole teosinte, C2= Sole ricebean, C3=3:2 row proportion of teosinte+ ricebean and C4 =3:3 row proportion of teosinte + ricebean intercropping and four integrated nutrient management in sub plots *viz.*, M1 =RDF(inorganic), M2 =50% N of RDF + 50% N through FYM, M3 =50% N of RDF + 50% N through vermicompost and M4 =100% organic (50% N through vermicompost + 50% N through FYM). During *kharif* two treatments were superimposed in rice crop in sub-sub plot *i.e.* I1= Recommended INM packages and I2= Recommended INM package with 50% OM in rice. During *rabi* season rapeseed crop was grown as relay crop succeeding rice on residual fertility without application of fertilizer. The soils of the experimental site was sandy loam in texture, acidic in reaction, medium in organic carbon and available N, P2O5 and low in available K2O.

In intercropping system the highest green forage yield (163.74 and 170.74 q/ha) and dry matter yield (37.21and 39.83 q/ha) of teosinte was recorded with 3:2 row proportion of teosinte + ricebean during 2016 and 2017, respectively. Higher green forage yield of ricebean was recorded in sole ricebean and among the intercropping system 3:3 row proportion of teosinte + ricebean recorded the highest green forage yield (127.75 and 136.50 q/ha) and dry matter yield (31.18 and 33.48 q/ha) in both the year.

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The effect of integrated nutrient management on green forage yield and dry matter yield were significantly higher in 50% N of RDF + 50% N through vermicompost than other treatments in both the years. *Kharif* rice grown after sole ricebean and application of 50% N of RDF + 50% N through vermicompost resulted in significantly higher values in respect of plant height, LAI, CGR, RGR, panicles/m<sup>2</sup>, filled grains/panicle, grain yield (47.24 and 49.62 q/ha) and harvest index as compared to other cropping systems and other integrated nutrient management treatments. Recommended INM packages increased the rice yield in both the years as compared to recommended INM package with 50% OM. In respect of relay crop of rapeseed the higher values of all the growth and yield attributes, seed yield, harvest index and oil content were found under sole ricebean-rice-rapeseed sequence where 50% N of RDF + 50% N through vermicompost were applied to sole ricebean followed by recommended INM package in rice as compared to other cropping systems/treatments. The highest green forage equivalent yield of the cropping system as a whole was observed in teosinte + ricebean at 3:3 row proportion with 50% N of RDF + 50% N through vermicompost followed by rice with recommended INM packages followed by rapeseed as relay cropping in both the years. Economics of the cropping system as a whole revealed that sole ricebean with (50% N of RDF + 50% N through vermicompost) - rice with recommended INM package followed by succeeding crop of relay rapeseed on residual fertility recorded the highest net return of Rs. 73896 and Rs. 80312 and benefit–cost ratio of 1.41 and 1.53 in both the years, respectively. Among the intercropping system the highest net return and benefit–cost ratio was observed in 3:3 row proportion in both the years. The energy use efficiency was found to be the highest in sole ricebean-rice-rapeseed cropping system where 50% N of RDF + 50% N through vermicompost was applied to ricebean and recommended INM packages to rice. Among the intercropping system the highest energy use efficiency was found in teosinte+ricebean intercropped at 3:3 row proportion with 50% N of RDF + 50% N through vermicompost followed by rice with recommended INM packages in the two successive years. The highest energy productivity ratio of 0.377 and 0.400 kg/MJ were recorded in teosinte+ricebean intercropping at 3:3 row proportion with 50% N of RDF + 50% N through vermicompost followed by rice with INM packages followed by rapeseed in both the years of experimentation.

In a nutshell, based on the finding of the two years of experimentation teosinte+ricebean intercropping at 3:3 row proportion along with 50% N of RDF + 50% N through vermicompost followed by rice with recommended INM packages succeeded by rapeseed relay cropping may be a suitable cropping sequence for medium land situation of Assam from the view point of improving and sustaining higher food and forage productivity, economic feasibility and maintenance of soil health.

## **Evaluation of weed management practices under organic production in Rice (A) – Rice (W) – Toria cropping sequence**

*Jyoti Rekha Hazarika*

An experiment entitled “Evaluation of weed management practices under organic production in autumn rice-winter rice-toria cropping sequence” was conducted for two consecutive years during 2018-19 and 2019-20 at Instructional-Cum-Research Farm of Assam Agricultural University, Jorhat. This study forms a part of the long-term experiment under All India Coordinated Research Project on Integrated Farming System with a view to evaluate the efficiency of cultural and mechanical weed management practices under organic production system. The experiment was laid out in Randomized Block Design replicating thrice with seven treatments *viz.*, T1: two hand weeding (HW) in rice and 1 HW in toria, T2: one mechanical weeding (MW) + one HW in rice and one HW in toria, T3: intercropping (dhaincha in autumn and winter rice and french bean in toria, at 2:1 ratio in replacement series, T4: stale seedbed + reduced spacing (25%) + mulching with previous crop mulch + 1 HW ( in all the three crops), T5: locally available dry weed mulch (3 *inch* thick) + 1 hand pulling (in all the three crops), T6: incorporation of oilcake (5 t/ha) + 1 HW (in all the three crops) and T7: deep ploughing during summer + 1 HW (in all the three crops). Recommended doses of N were applied as 1/3 rd N through FYM + 1/3 rd N through vermicompost + 1/3 rd N through mustard oil cake to each crop of the sequence. The soil texture of the experimental site was sandy loam with acidic in soil reaction (pH 5.40). The initial soil status was medium in organic carbon (6.82 mg/kg) and available nitrogen (340.50 kg/ha), low in available phosphorus (8.80 kg/ha), available potash (95.23 kg/ha) and in soil available sulphur content (6.50 kg/ha). The results revealed that plant height and other yield attributing parameters as well as grain (30.90 q/ha in autumn rice and 33.51 q/ha in winter rice) and straw (42.37 q/ha in autumn rice and 43.17 q/ha in winter rice) yield of rice were recorded to be the highest in the treatment with stale seedbed + reduced spacing (25%) + mulching with previous crop mulch + 1 hand weeding (HW) *i.e.* treatment T4, while the lowest values were recorded under the treatment receiving 1 mechanical weeding + 1 hand weeding in rice and 1 HW in toria (T2). The yield attributing parameters as well as

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seed (5.92 q/ha) and stover yield (18.82 q/ha) of toria was the highest in T6 treatment. The highest REY of rice-rice-toria sequence was recorded in T4 (75.39 q/ha) and the lowest (66.03 q/ha) was under T2 treatment. The highest total weed density and dry weight of the sequence were found in T2 at 30 DAP/DAS (34.53 no./m<sup>2</sup> and 14.56 g/m<sup>2</sup>), 60 DAP/DAS (35.40 no./m<sup>2</sup> and 21.02 g/m<sup>2</sup>) and at harvest (48.69 no./m<sup>2</sup> and 22.78 g/m<sup>2</sup>), whereas the lowest was observed in T4 treatment. The total N, P and K uptake by the crops were the highest in T4 treatment with values of 147.6, 49.9 and 154.6 Kg/ha respectively and the highest total N, P and K uptake while that by weeds were recorded in T2 treatment with 102.09, 19.93 and 170.21 Kg/ha in rice-rice-toria cropping sequence. Soil available N, P, K and S content as well as soil microbial parameters after completion of the sequence were recorded to be the highest in T3 treatment.

In the present investigation, the gross return (₹178974.00), net return (₹27877.00) and B:C ratio (1.18) were found to be the highest under T4 treatment [stale seedbed + reduced spacing (25%) + mulching with previous crop mulch + 1 HW (in all the three crops)] and the lowest were recorded under T6 treatment [receiving mustard oilcake (@5 t/ha) + 1 HW (in all the three crops)]. Thus, considering the system productivity, and economic feasibility, the practice of stale seedbed + reduced spacing by 25% + mulching with previous crop mulch + 1 HW in all the three crops (T4) could be considered as the best organic weed management practice in case of rice- rice- toria cropping sequence under the prevailing climatic condition of Assam. However, this practice needs multi-locational trials in all the agro-climatic conditions to derive valid conclusion before putting forwarded for recommendation to the farmer's. There is also need for further study on long term effect of these organic weed management practices on soil physical, chemical and biological properties.

## **Integrated Nutrient Management in Rice - buckwheat cropping sequence**

*Mahadev Uzir Basumatary*

A field experiment entitled “Integrated Nutrient Management in Rice - buckwheat cropping sequence” was conducted during *kharif* of 2016 and 2017 and *rabi* of 2016-17 and 2017-18 at Krishi Vigyan Kendra (KVK) farm of Kokrajhar district under Lower Brahmaputra Valley Zone (LBVZ) of Assam. The treatment consisted of Integrated Nutrient Management (INM) viz., T1 (control), T2 (100% RDF), T3 (100% RDF + FYM @ 10 t ha<sup>-1</sup>), T4 (75% RDF + 25% N through FYM), T5 (75% RDF + 25% N through vermicompost), T6 (50% RDF + 50% N through FYM), T7 (50% RDF + 50% N through vermicompost) and T8 (FYM @ 1 t ha<sup>-1</sup> + mixture of *Azospirillum amazonens* A-10 and *Bacillus megaterium* P-5 @ 4 kg ha<sup>-1</sup>, + Rock phosphate @ 10 kg, MOP @ 40 kg ha<sup>-1</sup>) applied to *kharif* rice (as main-plot treatment in *rabi* season) in randomised block design and replicated three times. In succeeding *rabi* season, each main- plot treatment was splitted into three sub plot treatments with three levels of recommended dose of fertilizers viz., B1 (0% RDF i.e. control), B2 (50 % RDF) and B3 (100% RDF) to buckwheat resulting into twenty four treatment combinations and replicated three times in split plot design. The result revealed that the highest grain yield (54.13 and 52.71 q ha<sup>-1</sup>) and straw yield (64.23 and 64.18 q ha<sup>-1</sup>) of rice were recorded with the application of treatment T3 (100% RDF + FYM @10t ha<sup>-1</sup>) during *kharif*, 2016 and 2017, respectively. Most of the growth and yield attributes, nutrient content and their uptake by the crop, organic carbon and available NPK status of soil after harvest of the *kharif* rice were maximum under application of T3 (100% RDF + FYM @ 10 t ha<sup>-1</sup>) followed by treatment T5 (75% RDF + 25% N through vermicompost) during both the years of experimentation. The highest net return (Rs.36417 ha<sup>-1</sup>) and B: C ratio (1.99) were obtained with the treatment T3 (100% RDF + 10 t FYM ha<sup>-1</sup>) followed by T5 (75% RDF + 25% N through vermicompost) having net return of Rs.32534 ha<sup>-1</sup> and B:C ratio of 1.92 to *kharif* rice. During *rabi* season, the residual effect of treatment T3 (100% RDF + FYM @10 t FYM ha<sup>-1</sup>) showed higher growth, yield attributes, seed and stover yields of buckwheat as well as nutrient content and their uptake by the crop during both the years of experimentation. The highest seed yield (12.76 and 13.65 q ha<sup>-1</sup>) and stover yield (23.52 and 25.47 q ha<sup>-1</sup>) were recorded with the residual effect of

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the treatment T3 (100% RDF + FYM @ 10 t FYM ha<sup>-1</sup>) in *rabi* 2016-17 and 2017-18, respectively. Lower bulk density and higher organic carbon value and improvement in status of available NPK in soil after harvest of buckwheat (end of the rice – buckwheat sequence) were also recorded with the residual effect of T3 (100% RDF + FYM @ 10 t ha<sup>-1</sup>) applied to the preceding *kharif* rice. In terms of monetary return, the highest net return (Rs. 19070 ha<sup>-1</sup>) and B: C ratio (2.26) were recorded with the residual effect of T3 (100% RDF + FYM @ 10 t ha<sup>-1</sup>) followed by T5 (75% RDF + 25% N through vermicompost) with net return (Rs. 15630 ha<sup>-1</sup>) with B: C ratio (2.03) to buckwheat on the basis of average of two year (2016-17 and 2017-18) data. The result further revealed that the treatment B3 (100% RDF) resulted in higher values of growth, yield attributes, seed and stover yields, harvest index of *rabi* buckwheat as well as nutrient content and its uptake by crop, organic carbon and available NPK status with lower bulk density of soil after harvest of crop among the different levels of RDF (NPK) directly applied to buckwheat crop during both the years of investigation. Among RDF levels to buckwheat, maximum net return (Rs.14894 ha<sup>-1</sup>) with B: C ratio (1.89) was obtained with B3 (100% RDF). The treatment combination of T3B3 *i.e.* 100% RDF + FYM @ 10 t ha<sup>-1</sup> with 100% RDF calculated highest net return (Rs.26674 ha<sup>-1</sup>) and B:C ratio (2.60) followed by treatment combination of T5B3 (75% RDF + 25% N through vermicompost with 100% RDF) with net returns of Rs. 19758 per hectare with B:C ratio of 2.18. The performance of rice-buckwheat cropping sequence was assessed on the basis of rice equivalent yield, net monetary returns and B:C ratio. In respect of all the above assessment, the application of 100% RDF + FYM @ 10 t ha<sup>-1</sup> to *kharif* rice and 100% RDF to buckwheat was the most beneficial combination compared to rest of the treatments. However, the interaction differences were not up to the significant extent.

# **Performance of bud chip seedlings under integrated nutrient management in autumn planted sugarcane (*Saccharum officinarum* L.)**

*Mahima Begum*

A field experiment entitled “Performance of bud chip seedlings under different integrated nutrient management practices in autumn planted sugarcane (*Saccharum officinarum* L.)” was conducted at Sugarcane Research Station, Buralikson, Assam for two consecutive years 2017-18 and 2018-19. The experiment consisted of three crop establishment techniques in main plot *viz.*, M1: Conventional method of planting M2: Planting of bud chip seedling at 90 cm x 60 cm, M3: Planting of bud chip seedling at 120 cm x 60 cm and five integrated nutrient management practices under sub plot *viz.*, F1: 100 % RDF, F2: 100 % RDF + vermicompost @ 1 t ha<sup>-1</sup> + green manuring (cowpea incorporation) + biofertilizers @ 10 kg ha<sup>-1</sup> F3: 100 % RDF + enriched compost @ 1 t ha<sup>-1</sup> + green manuring (cowpea incorporation), N4: 75 % RDF + FYM @ 5 t ha<sup>-1</sup> + vermicompost @ 1 t ha<sup>-1</sup> + green manuring (cowpea incorporation) + biofertilizers @ 10 kg ha<sup>-1</sup> and F5: 75% RDF + FYM @ 5 t ha<sup>-1</sup> + enriched compost @ 1 t ha<sup>-1</sup> + green manuring (cowpea incorporation). The treatments were laid out in split plot design and replicated thrice. The soil of experimental plot was clay loam in texture, acidic in reaction (pH 5.46 and 5.48) and medium in organic carbon content (0.71 and 0.68%) and available K<sub>2</sub>O (194.33 and 187.66 kg ha<sup>-1</sup>), low in available N (231.42 and 226.77 kg ha<sup>-1</sup>) and P<sub>2</sub>O<sub>5</sub> (19.28 and 18.64 kg ha<sup>-1</sup>) during 2017-18 and 2018-19, respectively. Experimental findings revealed that the most of the plant growth parameters were significantly affected by crop establishment techniques. The planting of bud chip seedling at 120 cm x 60 cm (M3) recorded significantly higher values of plant growth parameters *viz.*, total number of shoots ha<sup>-1</sup>, number of shoots plant<sup>-1</sup>, plant height, root growth, above ground biomass, LAI, LAD and CGR throughout the crop growing period, but was *at par* with planting of bud chip seedling at 90 cm x 60 cm (M2) in respect of physiologically active leaves plant<sup>-1</sup> and leaf area stalk<sup>-1</sup> during both the years. However, in case of few growth parameters such as chlorophyll content, green seeker NDVI, crop canopy temperature and RGR, no significant variation was observed among the crop establishment techniques.

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The planting of bud chip seedling at 120 cm x 60 cm (M3) also revealed significantly higher values of most of the yield attributing parameters such as length of millable cane, number of millable canes, number of internodes millable cane-1, length of internodes, average cane weight and eventually the cane yield of both individual years 7 as well as in pooled analysis. Results revealed that planting of bud chip seedling at 120 cm x 60 cm (M3) produced significantly higher cane yield for both the individual years (123.20 t ha<sup>-1</sup> during 2017-18 and 118.64 t ha<sup>-1</sup> during 2018-19) as well as in pooled analysis (120.92 t ha<sup>-1</sup>). Similarly, significantly higher values of green top, trash as well as total biological yield were also obtained under the planting of bud chip seedling at 120 cm x 60 cm (M3). The same crop establishment technique (M3) also registered significantly higher CCS as well as jaggery yield during both the years, but did not exert any significant effect on juice quality parameters over other crop establishment techniques.

Likewise, significantly higher uptake of nutrients by different plant parts as well as the whole plant was obtained under the planting of bud chip seedling at 120 cm x 60 cm (M3). However, no significant differences were observed in case of soil physico-chemical characteristics *viz.*, soil pH and organic carbon during both the years.

All the integrated nutrient management treatments produced significantly higher plant growth, root growth and physiological parameters over 100% RDF (F1). Application of 100 % RDF + vermicompost @ 1 t ha<sup>-1</sup> + green manuring (cowpea incorporation) + biofertilizers @ 10 kg ha<sup>-1</sup> (F2) produced significantly higher values in case of all the plant growth such as total number of shoots ha<sup>-1</sup>, number of shoots plant<sup>-1</sup>, plant height, leaf area stalk<sup>-1</sup>, dry weight of above ground biomass, root growth and other physiological parameters like LAI, LAD, CGR, and RGR. But in few parameters such as number of physiologically active leaves plant<sup>-1</sup>, chlorophyll content, canopy temperature and green seeker NDVI all the treatments were at par with each other except 100% RDF.

The integrated supply of 100% RDF + vermicompost @ 1 t ha<sup>-1</sup> + green manuring (cowpea incorporation) + biofertilizers @ 10 kg ha<sup>-1</sup> (F2) also recorded significantly higher results in case of yield attributing characters *viz.*, length of millable cane, number of millable canes, number of internodes millable cane-1, length of internodes, average cane weight and finally resulted in higher cane, green top as well as trash yield. Results revealed that the integrated application of 100% RDF + vermicompost @ 1 t ha<sup>-1</sup> + green manuring (cowpea incorporation) + biofertilizers @ 10 kg ha<sup>-1</sup> produced the highest cane yield for both individual years (115.46 t ha<sup>-1</sup> in 2017-18 and 111.11 t ha<sup>-1</sup> in 2018-19) as well as in pooled analysis (113.28 t ha<sup>-1</sup>) which was at par with all other treatments, but superior over 100% RDF. Similarly, significantly 8 higher green top as well as trash were also obtained under the treatment receiving 100% RDF + vermicompost @ 1 t ha<sup>-1</sup> + green manuring (cowpea incorporation) + biofertilizers @ 10 kg ha<sup>-1</sup> (F2) for both individual years as well as in pooled analysis. The same treatment (F2) also recorded the significantly higher biological yield (142.08 and 136.78 t ha<sup>-1</sup>), commercial cane sugar (14.62 and 13.95 t



ha-1) and jaggery yield (10.67 and 10.13 t ha-1) during both the years. But except CCS%, the integrated nutrient management treatments failed to exert any significant effect on other juice quality parameters like field brix content, juice recovery and purity %.

The N in content in all the plant parts *viz.*, cane stalk, green top, trash and K content in cane stalk was significantly influenced by integrated management practices and maximum values were obtained due to application of 100% RDF + vermicompost @ 1 t ha-1 + green manuring of cowpea + biofertilizers @10 kg ha-1 (F2). Significantly higher N, P and K uptake by cane stalk, green top, trash as well as whole plant were also obtained under integrated application of 100% RDF + vermicompost @ 1 t ha-1 + green manuring of cowpea + biofertilizers @10 kg ha-1 (F2). All the integrated nutrient management practices significantly influenced the soil physico-chemical and biological characteristics over 100% RDF. The application of 75% RDF + FYM @ 5 t ha-1 + vermicompost @ 1 t ha-1 + green manuring (cowpea incorporation) + biofertilizers @ 10 kg ha-1 (F4) produced the highest soil organic carbon (0.85 and 0.84%), fungal ( $5.44 \times 10^4$  cfu g-1 and  $5.38 \times 10^4$  cfu g-1) and bacterial population ( $6.51 \times 10^6$  cfu g-1 and  $6.45 \times 10^6$  cfu g-1) as well as available N and P<sub>2</sub>O<sub>5</sub> in soil during both the years.

The interaction effect was found to be significant in few growth parameters like total number of shoots, number of shoots plant-1 and leaf area duration. The planting of bud chip seedling at 120 cm x 60 cm along with 100 % RDF + vermicompost @ 1 t ha-1 + green manuring (cowpea incorporation) + biofertilizers @10 kg ha-1 (M3F2) recorded the highest values in the above parameters. In case of economics the higher gross return (₹ 3, 82,906 ha-1 and ₹ 3,67,546 ha-1), net return (₹ 2,62,388 ha-1 and ₹ 2,45,628 ha-1) as well as B-C ratio (3.18 and 3.01) was also recorded under the planting of bud chip seedling at 120 cm x 60 cm along with 100% RDF + vermicompost @ 1 t ha-1 + green manuring (cowpea incorporation) + biofertilizers @10 kg ha-1 (M3F2) during both the years.

# **Real time nitrogen application in winter rice under different crop establishment techniques**

*Milon Jyoti Konwar*

A field experiment entitled “Real time nitrogen application in winter rice under different crop establishment techniques” was carried out in the year 2017 and 2018 in the Instructional-Cum-Research (ICR) farm, Assam Agricultural University, Jorhat to study the relative performance of *winter* rice varieties with LCC- based N application under different crop establishment techniques. The experiment was comprising of 45 treatment combinations with three varieties *viz.*, V1: Ranjit, V2: Bahadur, V3: Gitesh; three crop establishment techniques *viz.*, M1: Transplanting, M2: System of Rice Intensification, M3: Direct seeding by drum seeder and five nitrogen application techniques *viz.*, N0 : Recommended dose of N (60 kg ha<sup>-1</sup>); N1 : 30 kg N as basal + 15 kg ha<sup>-1</sup> N when LCC ≤ 2; N2 : 30 kg N as basal + 15 kg ha<sup>-1</sup> N when LCC ≤ 3; N3 : 30 kg N as basal + 15 kg ha<sup>-1</sup> N when LCC ≤ 4; N4 : 30 kg N as basal + 15 kg ha<sup>-1</sup> N when LCC ≤ 5, laid out in a split-plot (split-split) design with varieties in the main plots, crop establishment techniques in the sub-plots and nitrogen application techniques in the sub-sub plots and were replicated thrice. The soil of the experimental site was sandy loam, acidic in reaction, medium in organic carbon and available N, low in available P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O. Among the different growth and physiological parameters *viz.*, plant height, tillers m<sup>-2</sup>, dry matter accumulation, CGR, RGR and NAR, the highest values recorded in the variety Ranjit followed by Bahadur and Gitesh. Similarly, in case of crop establishment techniques and nitrogen application techniques, SRI and 30 kg N as basal + 15 kg ha<sup>-1</sup> N when LCC ≤ 5 recorded the highest values in different growth and physiological parameters *viz.*, plant height, tillers m<sup>-2</sup>, dry matter accumulation, CGR, RGR, NAR during 2017 and 2018, respectively. Root volume was also significantly affected by different varieties and was found to be the highest in Ranjit followed by Bahadur and Gitesh. Similarly, in case of crop establishment techniques, the root volume was recorded highest in SRI method followed by transplanting and direct seeding by drum seeder whereas the root volume was found to be highest in application of 30 kg N as basal + 15 kg ha<sup>-1</sup> N when LCC ≤ 5 as compared to recommended dose of nitrogen in different nitrogen application techniques. The results from the pooled data revealed that the variety Ranjit recorded significantly the highest yield attributing

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characters and grain as well as straw yields of 47.22 q ha<sup>-1</sup> and 87.12 q ha<sup>-1</sup> during 2017 and 2018. In case of methods of crop establishment, SRI recorded significantly higher grain and straw yields of 46.54 q ha<sup>-1</sup> and 85.86 q ha<sup>-1</sup> as compared to sowing by drum seeder. Application of 30 kg N as basal + 15 kg ha<sup>-1</sup> N when LCC ≤ 5 recorded significantly the highest grain as well as straw yields of 53.65 q ha<sup>-1</sup> and 94.48 q ha<sup>-1</sup>, respectively as compared to other treatments. Pooled data of the treatment combinations showed that application of 30 kg N as basal + 15 kg ha<sup>-1</sup> N when LCC ≤ 5 with Ranjit establishing with SRI method registered significantly higher grain and straw yields over other treatment combinations. The highest grain and straw yields of rice from the pooled data was recorded with the application of 30 kg N as basal + 15 kg ha<sup>-1</sup> N when LCC ≤ 5 in Ranjit when SRI method of crop establishment was followed. The uptake of N, P, K and total uptake had been significantly affected by different varietal treatments. The highest uptake was found in case of Ranjit followed by Bahadur and Gitesh. In different crop establishment techniques N, P, K and total uptake was found to be the highest in case of SRI method followed by transplanting and direct seeding by drum seeder. Highest uptake was also found in application of 30 kg N as basal + 15 kg ha<sup>-1</sup> N when LCC ≤ 5 in comparison to other treatments. Results from the apparent nitrogen balance sheet indicated that the highest net gain in available N in soil was recorded in application of 30 kg N as basal + 15 kg ha<sup>-1</sup> N when LCC ≤ 5 in Ranjit when SRI method was followed during 2017 and 2018, respectively, as compared to other treatment combinations. In case of economics, the higher net returns and B:C ratio (1.65 and 1.62) was recorded under treatment combinations of 30 kg N as basal + 15 kg ha<sup>-1</sup> N when LCC ≤ 5 with Ranjit and drum seeder method of crop establishment in 2017 and 2018, respectively.

## **Direct seeded upland rice based cropping system as influenced by different moisture conservation practices under *rainfed* ecosystem**

*Nikhilesh Baruah*

A field experiment was conducted during 2016–17 and 2017–18 at the Research field of All India Coordinated Research Project on Dryland Agriculture, Biswanath College of Agriculture, AAU, Biswanath Chariali to study the efficacy of moisture conservation practices along with crop residue incorporation for sustainable productivity of upland direct-seeded rice-based cropping sequences as well as on physico-chemical properties of the soil under *rainfed* ecosystem. Treatments comprised of six moisture conservation practices *viz*; flat bed with crop residue (M1), flat bed without crop residue (M2), BBF 60-30cm with crop residue (M3), BBF 60-30cm without crop residue (M4), BBF 120-30cm with crop residue (M5), and BBF 120-30cm without crop residue (M6) and four rice-based crop sequences *viz*; direct seeded rice-greengram-toria (S1), direct seeded rice-greengram-linseed (S2), direct seeded rice-greengram-niger (S3), and direct seeded rice-greengram-buckwheat (S4). The experiment was laid out in a split-plot design with four replications taking the moisture conservation practices in the main plots and crop sequences in the sub-plots. The cropping systems parameters were analysed in split plot design, however, the effect of moisture conservation practices on *summer*, *kharif* and *rabi* crops was evaluated in a randomized block design. The soil of the experimental site was acidic (pH 5.4), sandy loam in texture, medium in organic carbon (0.59%), low in available N (259.10 kg ha<sup>-1</sup>), medium in available P<sub>2</sub>O<sub>5</sub> (25.65 kg ha<sup>-1</sup>) and low in available K<sub>2</sub>O (112.30 kg ha<sup>-1</sup>).

The moisture conservation practice BBF 60-30cm with residue incorporation recorded higher growth, yield attributes and yields of different summer-*kharif* and *rabi* crops (rice-greengram-toria/linseed/niger/buckwheat) grown as rice-based cropping systems. The uptake of nutrients N, P and K, water use and water use efficiencies of these crops and soil physico-chemical properties after the crop harvest were also favorably influenced by the treatment. This was followed by the treatments BBF 60-30cm without residue and BBF 120-30cm with residue incorporation, which was also equally effective and showed better crop performance over the flatbed methods of

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sowing. However, the effects of the crop sequences on growth yield as well as uptake of nutrients, water use and water use efficiencies of direct seeded *ahu* rice and *kharif* greengram and soil physico-chemical properties after the crop harvest were not significant. The integrated effect of the moisture conservation practices and rice-based cropping systems were also evaluated in terms of some important biometrics of the cropping, physico-chemical properties of the soil and economics of the practices. The treatment BBF 60-30cm with residue recorded the highest rice equivalent yield of the crops which was being at par with BBF 60-30cm without residue and BBF 120-30cm with residue but significantly higher over the flatbed methods. The increase in yield due to BBF 60-30cm with residue, BBF 60-30cm without residue and BBF 120-30cm with residue over the flatbeds were 29.67%, 22.24% and 21.24% , respectively. The total crop duration and land utilization index of the cropping did not differ due to moisture conservation practices. But, BBF 60-30cm with residue recorded significantly higher production efficiency and rain water productivity of the system over the BBF 120-30cm without residue and flatbeds. Improvement in soil physico-chemical properties in terms of reduced bulk density, increased water-soluble aggregates, water holding capacity and available N and K<sub>2</sub>O due to BBF 60-30cm with residue was also observed. The highest cost of cultivation, gross and net return with equivalent B:C ratio as well as higher employment and economic efficiency was also recorded under the said treatment.

The crop sequences, direct seeded *ahu* rice-greengram-toria, direct seeded *ahu* rice -greengram-linseed and direct seeded *ahu* rice-greengram-niger resulted in statistically similar rice equivalent yield and BBF 60-30cm with residue produced significantly higher value over the direct seeded *ahu* rice-greengram-buckwheat. The crop sequence direct seeded *ahu* rice-greengram-toria recorded the lowest cropping duration and land utilization index and considerably higher production efficiency and rain water productivity over other systems. However, it failed to register any positive impact on soil physico-chemical properties. The direct seeded *ahu* rice-greengram-toria also recorded the highest cost of cultivation, gross return, net return, employment generation and economic efficiency over rest of the sequences.

# **Climate smart Irrigation Schedule and Nutrient Management Practice for Yield and Methane flux of Transplanted Autumn Rice (*Oryza sativa*)**

*Pompy Deka*

A field experiment was conducted at Instructional cum Research Farm, AAU, Jorhat (26°71'N, 94°18'E, 91.0 m above MSL) during the years 2017 and 2018 to study the effect of irrigation schedules and nutrient management practices on growth, yield of transplanted autumn rice (Variety: Dishang) and methane flux from rice field. The experiment consisted of four different irrigation schedules *viz.*, Continuous submergence (I1), 5 cm irrigation at 3 days after disappearance of ponded water (DADPW) [I2], 5 cm irrigation at 5 DADPW (I3), 5 cm irrigation at 7 DADPW (I4) in main plot and four different fertilizers levels *viz.*, F1: Control plots (no fertilizer and manures), F2: Compost @ 5t/ha, F3: INM package (compost @ 1 t/ha along with mixture of *Azospirillum amazonense* A-10 and *Bacillus megaterium* P-5 @ 4 kg/ha + rock phosphate @ 56 kg/ha + MOP @ 67 kg/ha + Urea @ 10 kg/ha) and F4: Recommended fertilizer dose (compost @ 5t/ha + N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O @ 40-20-20 kg/ha) in sub plot. The experiment was laid out in a split plot design with three replications. The soil of the experimental site was sandy loam in texture, acidic in reaction (pH 5.80 in 2017 and 5.82 in 2018), medium in organic C (0.68% in 2017 and 0.70% in 2018), medium in available N (316.53 kg/ha in 2017 and 348.43 kg/ha in 2018), medium in available P<sub>2</sub>O<sub>5</sub> (25.70 kg/ha in 2017 and 27.31 kg/ha in 2018) and medium in available K<sub>2</sub>O (137.64 kg/ha in 2017 and 139.56 kg/ha). The rainfall received during the crop season was 767.2 mm in 2017 and 536.60 mm in 2018. The weekly average maximum temperature ranged from 25.6°C to 32.9°C and 23.73°C to 34.51°C during 2017 and 2018, respectively and minimum temperature ranged from 11.34°C to 25.3°C and 11.57°C to 25.06°C during 2017 and 2018, respectively. The weekly average RH during the crop season was ranged from 91% to 97% in the morning hours and 44% to 82% in the evening hours in 2017. During 2018, weekly average RH ranged from 85% to 97% in the morning hours and 55% to 79% in the evening hours. The mean weekly bright sunshine hours varied from 1.6 to 7.4 hours and 1.5 to 7.3 hours during 2017 and 2018, respectively. The results revealed that irrigation schedules influenced growth parameter of rice in terms of plant height, shoot

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and root dry weight, root volume, leaf area index and crop growth rate. Application of 5 cm irrigation at 3 DADPW (I2) recorded the highest values for all growth characters like plant height (56.13 cm, 70.28 cm and 94.24 cm at panicle initiation, flowering and harvesting stage, respectively), shoot dry weight (3.43 to 30.13 g/hill at different phenological stages), root dry weight (1.13 to 10.42 g/hill) and root volume. The maximum values for yield attributing characters, grain yield (4.08 t/ha in 2017 and 4.13 t/ha in 2018) and straw yield (6.26 t/ha in 2017 and 6.45 t/ha in 2018), N, P, K-uptake and Irrigation Water Use Efficiency (22.21 kg/ha-cm in 2017 and 22.26 kg/ha-cm in 2018) were recorded under 5 cm irrigation at 3 DADPW (I2). On the other hand, the highest irrigation water used (229.63 cm in 2017 and 231.68 cm in 2018) and soil pH were observed under continuous submergence (I1). The highest methane flux (7.00 and 7.02 mg/m<sup>2</sup>/hr in 2017 and 2018, respectively) and cumulative methane flux values of 275.70 mg/m<sup>2</sup> in 2017 and 278.81 mg/m<sup>2</sup> in 2018 were recorded by continuous submergence (I1) followed by the 5 cm irrigation at 3 DADPW (I2). Different nutrient management practices brought about significant differences in plant height, shoot and root dry weight, root volume, leaf area index and crop growth rate. For these parameters, the highest values were recorded under application of recommended fertilizer dose (RDF). The highest yield attributing characters like number of effective tiller/hill and number of grains/panicle, grain and straw yield were observed under RDF (F4) which was *at par* with INM (F3). The INM treatment recorded the highest WUE and soil pH. RDF (F4) recorded the highest methane flux and CME followed by the INM treatment (F3). The treatment combination of 5 cm irrigation at 3 DADPW with RDF (I2F4) recorded the highest plant height, root and shoot weight. The highest grain (4.70 t/ha in 2017 and 4.80 t/ha in 2018) and straw yield (6.71 t/ha in 2017 and 7.07 t/ha in 2018) were recorded by 5 cm irrigation at 3 DADPW with RDF (I2F4) which was statistically *at par* with 5 cm irrigation at 3 DADPW with INM (I2F3). Continuous submergence with RDF (I1F4) recorded the highest seasonal methane flux followed by the treatment 5 cm irrigation at 3 DADPW with RDF (I2F4). In term of economics, the highest gross return (Rs. 1,07,138.00/ha in 2017 and Rs.1,09,287.00/ha in 2018) was obtained by treatment combination 5 cm irrigation at 3 DADPW with RDF (I2F4) and net return (Rs. 70,553/ha in 2017 and Rs. 70,114/ha in 2018) was obtained by treatment combination of 5 cm irrigation at 3 DADPW with INM (I2F3). The highest B:C (2.19 in 2017 and 2.18 in 2018) was obtained by the treatment combination of 5 cm irrigation at 3 DADPW with INM (I2F3). Thus, from the present investigation, 5 cm irrigation at 3 DADPW with INM can be concluded to be the best management practice in minimizing the methane flux from the transplanted autumn rice field and without any effect on grain yield of the crop.

# **Resource use efficiency in winter rice [*Oryza sativa* L.] under SRI concept as influenced by microclimate**

*Rekhashree Kalita*

A field experiment entitled “**Resource use efficiency in winter rice (*Oryza sativa* L.) under SRI concept as influenced by microclimate**” was carried out during the year 2016 and 2017 at the farmer’s field located at *Nepalikhuti* Village (Lat. 26°06’99” N, Long. 93°06’26”E) in Bokakhat sub-division of Golaghat district, Assam to study the performance of winter rice with respect to production maximization, resource use efficiency and economic return under varied microclimatic regime imposed by methods of crop establishment, dates of transplanting and hill densities. The experiment was comprised of 24 treatment combinations with two crop establishments viz. C1: System of Rice Intensification (SRI), C2 : Conventional; three dates of transplanting viz. D1 : 26th June, D2 : 10th July, D3 : 25th July and four hill densities viz. H1 : 20 cm x 15 cm (*i.e.* 33 hills m<sup>-2</sup>); H2 : 20 cm x 20 cm (*i.e.* 25 hills m<sup>-2</sup>); H3: 20 cm x 25 cm (*i.e.* 20 hills m<sup>-2</sup>); H4 : 25 cm x 25 cm (*i.e.* 16 hills m<sup>-2</sup>), laid out in a factorial split-plot design with crop establishment methods and dates of transplanting in the main plots and hill densities in the sub plots and were replicated thrice. The soil of the experimental site was sandy loam; acidic in reaction; medium in organic carbon and available N; low in available P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O. The phenological study revealed that SRI crops required significantly lesser days to attain various phenophases viz. MTS, panicle emergence, flowering and physiological maturity as compared to the conventional crops in both the years of investigation. On the other hand, both early transplantation (26th June) and lower hill density (16 hills m<sup>-2</sup>) took more days for attainment of different phenophases.

Among the different growth and physiological parameters viz. plant height, tillers m<sup>-2</sup>, leaf area, dry matter production, LAI, chlorophyll content, CGR, RGR and NAR; the highest had been recorded by SRI with an exception of lower magnitude of leaf area, LAI and chlorophyll content at the tillering stage. Similar results were also observed in case of lower hill density showing better growth and physiological parameters. The early transplanting showed significant improvement in growth

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parameters, however, failed to show any significance with respect to physiological parameters *viz.* CGR, RGR and NAR. SRI portrayed lower magnitude of microclimatic parameters such as light intensity, light transmission ratio (LTR), AGDD throughout the crop growth, and AIPAR, AHTU and APTU at maturity. However, comparatively higher RUE (1.37 g MJ<sup>-1</sup>) and HUE (2.48 kg ha<sup>-1</sup> 0d) was recorded under SRI method. Throughout the crop growth, early crops recorded highest value of AGDD, and lowest value of light intensity and LTR. In both the years, superior values of AIPAR and APTU were found in early 29 crops; however, improved HUE of 2.16 kg ha<sup>-1</sup> 0d and RUE of 1.22 g MJ<sup>-1</sup> were noticed in 2016 and 2017, respectively. In case of hill density, increased value of light intensity and LTR were recorded with increase in hill density and highest were observed at higher hill density of 33 hills m<sup>-2</sup>, whereas higher AGDD, AIPAR, AHTU, APTU, RUE and HUE were found in lower density (16 hills m<sup>-2</sup>). Marked variation with respect to yield attributes was observed due to methods of crop establishment. Significantly higher numbers of panicles m<sup>-2</sup>, longer panicle length, more filled grains panicle<sup>-1</sup> and heavier test weight were registered in SRI. Improvement in yield attributes was also observed in early transplantation as well as under reduced hill density.

The results from the pooled data revealed that SRI recorded significantly the higher grain yield, straw yield and harvest index of 57.13 q ha<sup>-1</sup>, 61.43 q ha<sup>-1</sup> and 48.15 per cent, respectively, compared to conventional method. In case of date of transplanting, higher grain yield of 56.51 q ha<sup>-1</sup> along with 62.00 q ha<sup>-1</sup> of straw yield and 47.60 per cent of harvest index was documented in early date of 26th June. Further, crops raised under lower hill density of 16 hills m<sup>-2</sup> showed significant improvement in terms of grain yield (56.75 q ha<sup>-1</sup>), straw yield (61.83 q ha<sup>-1</sup>) and harvest index (48.01%).

The water use studies revealed comparatively higher magnitude of consumptive use (CU) of water (535.43 to 543.76 mm) and WUE (10.20 to 10.95 kg ha<sup>-1</sup>mm<sup>-1</sup>) in SRI than that of conventional method during transplanting to maturity stage. It was observed that the quantum of CU coupled with WUE were maximum in early transplanting (26th June) which got reduced with delaying of dates. Further, the lowest hill density (16 hills m<sup>-2</sup>) recorded the maximum quantum of CU and an increased magnitude of WUE in 2016 and 2017 as well. Results showed more quantum of CO<sub>2</sub> efflux of 5935.42 to 6082.47 mg CO<sub>2</sub> m<sup>-2</sup> d<sup>-1</sup> in 2016 and 2017, respectively in SRI whereas conventional establishment recorded 5481.31 and 5626.03 mg CO<sub>2</sub> m<sup>-2</sup> d<sup>-1</sup> during the respective years of investigation. In 2016, highest efflux (5816.50 mg CO<sub>2</sub> m<sup>-2</sup>d<sup>-1</sup>) was recorded in 10th July planting, which was comparable to late planting (25th July) and significantly superior to the early one. However, in 2017, maximum emission of (5972.25 mg CO<sub>2</sub> m<sup>-2</sup>d<sup>-1</sup>) was registered in late planting which was followed by 10th July and lastly by 26th June planting. Moreover, CO<sub>2</sub> emission was found to be increasing significantly with the increase of hill density the maximum release of 6102.28 to 6247.78 mg CO<sub>2</sub> m<sup>-2</sup>d<sup>-1</sup> was recorded at highest density *i.e.* 33 hills m<sup>-2</sup>. The N, P, K and total uptake was found to be significantly more under SRI.

The crop transplanted early showed comparatively better result in respect of NPK uptake barring the K- uptake by straw. In the case of hill density, the higher density 30 recorded significantly lower uptake of nutrient, and with the reduction of density, uptake increased and reached the maximum at the lowest density *i.e.* 16 hills m<sup>-2</sup>. There were no such significant variations in available N, P and K status at harvest barring N (289.59 kg ha<sup>-1</sup>) and P<sub>2</sub>O<sub>5</sub> (28.37 kg ha<sup>-1</sup>) in 2017, where SRI as a crop establishment method observed to be better.

Correlation study on pooled data showed that grain yield was strongly correlated with LAI, chlorophyll content in all the stages, and RUE and HUE at harvest. On the other hand, significant but negative relationship was noticed with LTR in MTS and AHTU at harvest. Similar correlation pattern was also recorded in cases of straw yield, panicles m<sup>-2</sup>, filled grains panicle<sup>-1</sup>, test weight and harvest index. The seven models of significant linear relationship for yield and yield attributes with microclimatic parameters showed that the value of high determining factors (R<sup>2</sup>) for combination of microclimatic parameters to explain the variability in grain yield, straw yield, panicles m<sup>-2</sup>, panicle length, filled grains panicle<sup>-1</sup>, test weight and harvest index were 0.987, 0.995, 0.947, 0.954, 0.991, 0.874 and 0.926, respectively. A magnitude of 98.7 per cent variation in grain yield was found to be predicted collectively by chlorophyll content and LTR at MTS, and AGDD and RUE at maturity. At MTS, chlorophyll content, LTR and AGDD was found to be critical influencer whereas at maturity, AGDD and HUE were significant predictive factors of yield determining parameters and yield. Amongst all, RUE was found to be outstanding as the most determining factor for predicting yield attributes and yield followed by chlorophyll content and LTR at MTS and, AGDD and HUE at maturity. On the economic analysis of different treatments, maximum net return (₹ 90,703.73) along with the highest net return per rupee invested (2.06) was obtained by the crop transplanted on 26th June with a spacing of 25cm x 25cm (16 hills m<sup>-2</sup>) under SRI establishment method.

# **Integrated Nutrient Management in potato-baby corn cropping sequence and its residual effect on succeeding sesamum**

*Roji Chutia*

A field experiment entitled “Integrated nutrient management in potato-baby corn cropping sequence and its residual effect on succeeding sesamum” was conducted during *rabi*, summer and *kharif* seasons of 2016-17 and 2017-18 at the instructional cum research farm of Assam Agricultural University, Jorhat, Assam. The experiment consisting of sixteen treatments *viz.*, 100% RD of N (T1), 75% RD of N+ 25% N through FYM (T2), 75% RD of N+ 25% N through Poultry manure (T3), 75% RD of N+ 25% N through vermicompost (T4), 75% RD of N + 25% N through enriched compost (T5), 50% RD of N + 25% N through FYM + 25% N through vermicompost (T6), 50% RD of N + 25% N through Poultry manure + 25% N through enriched compost (T7), 50% RD of N + 25% N through FYM + 25% N through Poultry manure (T8), 50% RD of N + 50% N through FYM (T9), 50% RD of N + 50% N through Poultry manure (T10), 50% RD of N + 50% N through vermicompost (T11), 50% RD of N + 50% N through enriched compost (T12), 50% RD of N + 25% N through FYM (T13), 50% RD of N + 25% N through poultry manure (T14), 50% RD of N + 25% N through vermicompost (T15), 50% RD of N + 25% N through enriched compost (T16) was laid out in randomized block design with three replications. The soil of the experimental site was sandy loam in texture, acidic in reaction (pH 5.57), medium in organic carbon (0.75%), available N (292kg/ha), P<sub>2</sub>O<sub>5</sub> (25.80kg/ha) and K<sub>2</sub>O (272.18kg/ha). The total rainfall received during the cropping sequence was 2336.40 mm in 2016-17 and 2107.10 mm in 2017-18 and max and min temperature ranged from 24.3 °C to 35.1 °C and 8.0°C to 26.1°C and 22.5 °C to 35.1 °C and 8.9 °C to 27.2 °C during 2016-17 and 2017-18, respectively.

The experimental findings revealed that application of 50% RD of N + 25% N through FYM + 25% N through vermicompost (T6) recorded the highest values for most of the growth as well as yield attributing characters *viz.*, number of shoots per plant, grade wise tuber yield, total tuber yield, dry matter yield of haulm, dry matter yield of tuber, per cent dry matter content of haulm and tuber and nutrient uptake by potato crop,

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respectively. The highest tuber yield pooled over two years (27.77t/ha) was also observed in T6. In case of baby corn grown in sequence, the highest response in terms of growth as well as yield attributing characters viz., No. of leaves per plant, No. of cobs per plant, length of cobs with husk and without husk, yield of cobs with husk and without husk, stover yield and dry matter yield were observed in integrated nutrient management (INM) practices with application of 50% RD of N + 25% N through FYM + 25% N through vermicompost (T6). This treatment also gave the highest cob yield with husk of 23.09 and 24.83 t/ha during both the years. Similar trend was observed in case of cob yield without husk during both the years. In case of succeeding sesamum crop, the highest response in growth, yield and yield attributing characters viz., no. of branches per plant, no. of capsules per plant, no. of seeds per capsule, 1000 seed weight were also found with application of 50% RD of N + 25% N through FYM + 25% N through vermicompost (T6). The highest seed yield of sesamum pooled over two years (542.72 kg/ha) was also registered at T6.

The effect of INM on N, P and K uptake by haulm and tuber was also found to be significant under different treatments. The highest N uptake of 92.55 and 90.37 kg/ha was registered at T6 followed by 78.51 and 74.27 kg/ha in the INM practice with 50% RD of N + 25% N through FYM + 25% N through poultry manure (T8). Similar trend was observed in case of baby corn and sesamum during both the years.

Integrated nutrient management had significant influence on soil physico-chemical parameters and highest values for all the soil parameters viz., organic carbon (0.98 and 1.02%), available N (391.33 and 423.33kg/ha), P (28.88 and 29.50kg/ha) and K (336.55 and 347.90kg/ha) after completion of sequence were recorded at T6 during both the years of experimentation. This INM practice with combination of 50% RD of N + 25% N through FYM + 25% N through vermi compost (T6) improved soil biological characters with statistically higher microbial biomass carbon (364.44 and 372.18 $\mu$ g g<sup>-1</sup> soil), dehydrogenase activity (193.19 and 202.65  $\mu$ g TPFg-124hr<sup>-1</sup>), phosphomonoesterase activity (351.82 and 371.36  $\mu$ g *p*-nitrophenol g<sup>-1</sup> hr<sup>-1</sup>), fluorescein di-acetate hydrolysis activity (8.11 and 8.48  $\mu$ g fluorescein g<sup>-1</sup> hr<sup>-1</sup>), bacterial population (8.77 and 9.01 No. X 10<sup>-6</sup> cfu g<sup>-1</sup>) and fungal population (6.57 and 6.80 No. X 10<sup>-4</sup> cfu g<sup>-1</sup>) followed by the INM practices with 50% RD of N + 25% N through FYM + 25% N through poultry manure (T8). The total tuber yield established strong correlation with MBC (0.655\*) and dehydrogenase enzyme ( $r=0.687^*$ ). Similarly the OC showed strong correlation with MBC ( $r=0.806^{**}$ ) and enzyme phosphomonoesterase established significant correlation with available P<sub>2</sub>O<sub>5</sub> ( $r=0.781^*$ ) indicating the role of enzyme in releasing the P from organic sources.

In terms of economics, the highest net return of Rs 6,38,200.00 per ha and benefit – cost ratio (B:C) of 4.82 were obtained in the INM practices with application of 50% RD of N + 25% N through FYM + 25% N through vermicompost (T6) in potato-baby corn-sesamum cropping sequence. This was followed by T8 with net return of Rs 4, 85,600.00 per ha with B- C ratio of 4.21. Thus, application of 50% RD of N + 25% N through FYM + 25% N through vermicompost (T6) was found to be the best INM

practice for better crop growth, economic yield, system productivity and sustained soil health in potato – baby corn - sesamum cropping sequence.

# **Performance of some banana germplasm under moisture stress condition and its amelioration through chemical intervention**

*Amarjit Sakia*

A study was conducted at the Experimental Farm, Department of Horticulture and laboratories of Department of Crop Physiology, Assam Agricultural University, Jorhat during the period 2017-2019 with twenty nine germplasm of banana *viz.*, Athiya (BB), Manohar (ABB), Dwarf Jahaji (AAA), Barjahaji (AAA), Ketchulepa (ABB), Jatikal (ABB), Kachkal (white) (ABB), Kachkal (green) (ABB), Honda (AAB), Gobin Tulchi (AAB), Doodhsagar (AAB), Digjowa (AAB), Chenichampa (AAB), Malbhog (AAB), Amrit Sagar (AAA), Man Jahaji (AAA), Agnisagar (AAA), Bhimkal (BB), Lesari Manohar (ABB), Simolu Manohar (ABB), Suti Jahaji (AAA), Bhat Manohar (ABB), Sahabhal (AAA), Fesa manohar (ABB), Dwarf Cavendish (AAA), Grand Naine (AAA), Bogimonohar (ABB), Odil (AAA) and Thengransu (ABB) to assess their performance under moisture deficit condition that prevails naturally during November to January every year in Assam due to lack of rainfall. The germplasm were also evaluated for any change in their tolerance level towards soil moisture deficit after receiving certain chemicals *viz.* maltose and trehalose through foliar spray. The experiment was laid out in Randomized Block Design (RBD) with twenty nine germplasm. The number of replications was five. The observations on various parameters were recorded on 3<sup>rd</sup>, 5<sup>th</sup>, 7<sup>th</sup> and 9<sup>th</sup> MAP in the main crop and one month after application of chemicals in the case of ratoon crop. The mean monthly temperature during the crop growing season ranged from 10.8°C to 29.8°C, the rainfall ranged from 0.0-42.7 mm and the relative humidity ranged between 55-97 per cent. The soil of the experimental field was acidic, well drained and sandy loam in texture with low available N and K and medium available P content. Moisture stress progressively reduced the values of relative leaf water content, leaf area, leaf area index, chlorophyll content (a, b, & total) from 3<sup>rd</sup> to 9<sup>th</sup> months after planting; while the contents of proline, total soluble protein, free amino acid and level of lipid peroxidation in leaf tissue increased with increase in the magnitude of moisture deficit during that period. Germplasm *viz.*, Barjahaji, Bhimkal, Athiya etc. recorded higher values for various physiological and

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biochemical parameters namely relative leaf water content, proline content, total soluble protein content, free amino acid content, leaf area, leaf area index, leaf chlorophyll content, number of functional leaves etc. especially during the period when the soil moisture content was very low. Observed higher efficiency in terms of physiological and biochemical parameters in these germplasm might have contributed immensely towards realisation of better yield attributing characters like fruit length, girth of finger, volume of finger weight of finger, weight of second hand, number of hands per bunch, number of fingers per hand and bunch weight under Assam condition which faces severe shortage in soil moisture (soil moisture content was only 33.70 per cent of the field capacity at 7<sup>th</sup> MAP) under rainfed situation during the months of winter mostly coinciding the reproductive stage of the crop. The germplasm Barjahaji was found to be the highest yielder followed by the germplasm Bhimkal and Athiya, whereas Gobin Tulchi was found to be the lowest performers. It may be concluded that the germplasm Barjahaji, Bhimkal and Athiya are physiologically more tolerant to moisture shortage. Application of chemicals (trehalose and maltose) could positively influenced various adaptive mechanism during water deficit condition. The characters like relative leaf water content, proline content, total soluble protein content, free amino acid content, chlorophyll content, leaf area, leaf area index etc. did show positive and significant correlation with bunch yield per plant. On an average with foliar application of maltose (60 mM), trehalose (60 mM) and maltose (60 mM) + trehalose (60 mM) during December, increased the yield by 1.18, 1.76 and 2.44 per cent, respectively over control (spray with distilled water). The highest benefit: cost ratio in case of dwarf germplasm, medium tall germplasm and tall germplasm were found to be 4.66 (Dwarf Jahaji), 4.39 (Barjahaji) and 4.41 (Athiya) respectively all with distilled water spray.

# **Impact of elevated night temperature on some rice genotypes**

*Ujjal Baruah*

The present investigation was carried out under fully automated bioreactors with temperature control facilities in the stress physiology laboratory, Department of Crop Physiology, AAU, Jorhat. The main objectives of the study were to characterize the responses of upland rice genotypes to high night temperature (HNT) and to elucidate the mechanism of such responses. The investigation was carried out during the month of March to July, in 2018 and 2019. The results of the studies revealed variability in various morpho physiological, biochemical and anatomical studies under HNT. A significant variation in photosynthesis and its related parameters (*viz.* stomatal conductance, internal CO<sub>2</sub>, transpiration) affected the photosynthates production and their partitioning to root, shoot and reproductive organ under HNT. In some genotypes, maximal fluorescence (Fv/Fm), electron transfer rate, photochemical quenching, quantum yield of PSII showed less deviation from normal range whereas non photochemical quenching showed the maximum; indicating their adaptation under this stress condition. These factors ultimately affected growth efficiency and yield of the plant. Treatment III (TIII) consisting of HNT (+5OC above ambient) have higher detrimental effects as compared to Treatment I (Control). Nitrogen status of leaf, grain and nitrate reductase activity was altered by HNT. However under treatment II (TII) i.e. HNT (+2OC above ambient), some genotypes *viz.* Banglami and Inglongkiri showed some tolerance as compared to N22 (check variety). Amongst the HNT treatments, significant increase of H<sub>2</sub>O<sub>2</sub>, MDA content was recorded in TIII as compared to TII. Banglami and Inglongkiri also recorded higher SOD activity and lowest H<sub>2</sub>O<sub>2</sub> and MDA when compared to other local genotypes. Hence these two genotypes could maintain their plant water status as evidenced by their higher MSI under both the HNT treatments. The maintenance of higher plant water status in Banglami and Inglongkiri could be ascertained by higher RLWC and increased compatible solutes *viz.* proline content and non structural carbohydrate content. Moreover, tolerance efficiency studies indicated that amongst the tested local genotypes, Banglami and Inglongkiri were tolerant whereas Maibee and Haringa were found to be most susceptible one under

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imposed HNT. The present study recorded a non significant effect on vegetative growth *viz.* plant height, leaf numbers and tiller numbers when HNT was imposed at later stages of growth. But both the HNT treatments recorded a significant reduction in leaf area, LAI, SLW. Under both the HNT treatment, a significant reduction in root volume and biomass accumulation was recorded which might be due to improper biomass partitioning. This might be due to a significant reduction in root xylem and phloem size thereby affecting diversion of water and photosynthates toward the sink region as evidenced in the present study. A significant reduction in pollen viability was also observed in the genotypes *viz.* Maibee, Haringa, Dishang, Ronga Ahu. There was a significant variation in yield and yield attributing characters such as numbers of filled grain per panicle, spike per panicle, grain yield, panicle length, grain per panicle, test weight under HNT treatments. Amongst the genotypes tested, under HNT, Banglami and Inglongkiri recorded minimum percent reduction in these parameters when compared to other genotypes. Hence Banglami and Inglongkiri can be considered as adaptable genotypes under HNT.

## **Efficacy of certain botanicals on *Tribolium castaneum* (Herbst) and *Sitophilus oryzae* (L.) and their effect on detoxifying enzyme activities of these insects**

*Awaneesh Kumar*

Efficacy of certain botanicals on *Tribolium castaneum* (Herbst) and *Sitophilus oryzae* (L.) and their effects on detoxifying enzyme activities of these insects” was carried out during 2017-2020. The all experimental works were done at Toxicology Laboratory, Department of Entomology and the biochemical analysis was done at the PG laboratory Department of Biochemistry and Agricultural Chemistry Assam Agricultural University Jorhat- 13. Twelve botanicals viz. *Aegle marmelos* (L.), *Annona reticulata* (L.), *Artemisia nilagirica* (L.), *Azadirachta indica* (A. Juss.), *Catharanthus roseus* (L.), *Clausena heptaphylla* (Roxb.), *Datura stramonium* (L.), *Eucalyptus tereticornis* (Sm.), *Heteropanax fragrans* (Roxb.), *Lawsonia inermis* (L.), *Matteuccia struthiopteris* (L.) and *Vitex negundo* (L.) were tested to know the efficacy against *T. castaneum* and *S. oryzae*.

The LD50 (wt/wt g) values of dry leaves powder of *A. indica* (2.09%), showed lowest against *T. castaneum* after 24hrs followed by *E. tereticornis* (2.81%), *D. stramonium* (2.97%), *A. nilagirica* (3.85%) which were comparatively more effective than other botanicals and lowest in *M. struthiopteris* (19.40%) during 2018 experiment. Similarly, after 48 hrs and 72 hrs also *A. indica* (1.71% and 1.49%, respectively) registered minimum LD50 value followed by *D. stramonium* (2.01% and 1.52%), *E. tereticornis* (2.49%, 2.02 %) and *A. nilagirica* (2.95%, 1.80%). The maximum LD50 was observed in case of *M. struthiopteris* (14.64%) and *H. fragrans* (4.58%) at 48 and 72 hrs, respectively. Similar trend of results were also found during 2019 with lowest LD50 (wt/wt g) on *A. indica* followed by *E. tereticornis*, *D. stramonium* and *A. nilagirica* after 24, 48 and 72 hrs..

During 2018, when dry leaves powder was used against *S. oryzae* the LD50 was lowest in *A. indica* (1.94%, 1.84% and 1.70%) after 24, 48 and 72 hrs. *E. tereticornis* (2.98%, 2.49% and 2.02%), *D. stramonium* (3.05%, 2.36% and 1.97%) and *A. nilagirica*

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(3.75%, 2.62% and 2.14%) which were comparatively lower LD50 than other botanicals at 24, 48 and 72 hrs of treatment. *M. struthiopteris* showed highest LD50 values (30.66%, 15.22% and 4.27%) with XII toxicity rank after 24, 48 and 72 hrs of treatment. Same trend of results was also observed in 2019 against *S. oryzae* where *A. indica* (2.21%, 1.89% and 1.73%), *D. stramonium* (2.86%, 1.83% and 1.68%), *E. tereticornis* (3.36%, 2.29% and 1.93%) and *A. nilagirica* (3.77%, 2.54% and 1.86%) gave lowest LD50 in comparison to other botanicals after 24, 48 and 72 hrs of treatment.

When leaf aqueous extracts were tested against *T. castaneum*, during 2018 and 2019 *A. indica* (2.20%) recorded lowest LC50 values after 24, 48 and 72 hrs. In case of *S. oryzae* also, leaf aqueous extracts *A. indica* recorded lowest LC50 (1.93%, 1.70% and 1.42%) in 2018 and 2019 (2.05%, 1.55% and 1.43%), after 24, 48 and 72 hrs of treatment.

From the repellency experiment of plant dry powder, it was found that *A. indica* showed highest mean repellency percent against *T. castaneum* (82.21%, 83.61%) and *S. oryzae* (78.19%, 77.03%) in 2018 and 2019 experiment. Similarly, in case of aqueous extract also *A. indica* registered highest repellency rate against *T. castaneum* (86.84%, 85.25%) and *S. oryzae* (81.69%, 78.51%) in both the year.

Based on LD50 and LC50 experiment of both the years, *A. indica*, *D. stramonium*, *E. tereticornis* and *A. nilagirica* were observed best among all the botanicals against *T. castaneum* and *S. oryzae*. Therefore, to observe the mortality in stored wheat grains, these four botanicals were used and found that *A. indica*, *D. stramonium*, *E. tereticornis* and *A. nilagirica* recorded hundred per cent mortality after 35 days of treatment in case of *T. castaneum* and 45 days after treatment for *S. oryzae*. The lowest grain weight loss was found in *A. indica* (5.27%, 8.64%) followed by *D. stramonium* (12.05%, 9.87%), *E. tereticornis* (12.05%, 17.38%) and *A. nilagirica* (15.19%, 13.97%) during 2018 and 2019 against *T. castaneum*, when the dry powders were applied. Similarly, the lowest grain weight loss was recorded in aqueous extract of *A. indica* followed by *D. stramonium*, *E. tereticornis* and *A. nilagirica* during 2018 and 2019 against *T. castaneum* and *S. oryzae*. *A. indica*, *D. stramonium*, *E. tereticornis* and *A. nilagirica* had no significant effect on quality parameters of wheat grains viz., crude protein, soluble protein, gluten, reducing sugar, starch and moisture, after 6 months of storage.

Enzyme assay was done to find out the detoxifying enzyme viz. acetylcholinesterase and glutathione-S-transferases activities on *T. castaneum* and *S. oryzae* after treatment of *A. indica*, *D. stramonium*, *E. tereticornis* and *A. nilagirica*. It was found that all the botanicals significantly reduced the activity of acetylcholinesterase (AChE) in comparison to control. *E. tereticornis* showed significantly highest reduction in the AChE activity in both the year. *A. nilagirica* and *D. stramonium* also showed more reduction of AChE activity which was significantly higher than *A. indica* against *T. castaneum*. In case of *S. oryzae*, *D. stramonium* and *A. indica* showed maximum reduction of AChE activity, which were statistically at par and

significantly different from *E. tereticornis* and *A. nilagirica*. No reduction of AChE activity was observed in control treatment during 2018 and 2019.

The activity of glutathione-s-transferase was significantly lowest in *A. indica* followed by *A. nilagirica*, *D. stramonium* and *E. tereticornis* which were statistically different from each other, while in control activity of GST was significantly high in both the years against *T. castaneum*. In case of *S. oryzae*, significantly less activity of GST was observed in *E. tereticornis* followed by *A. nilagirica*, *D. stramonium* and *A. indica* in 2018 and 2019. Activity of GST was significantly low in all these treatments than the control. *A. indica* and *D. stramonium* showed statistically similar activity of GST with each other and significantly different from *A. nilagirica* and *E. tereticornis*. Based on LD50, LC50, mortality, repellency and enzyme assay experiment *A. indica*, *A. nilagirica*, *D. stramonium* and *E. tereticornis* were found equally effective botanicals against *T. castaneum* and *S. oryzae* and can be used for storing of wheat grains up to 6 months without affecting the quality of wheat.

## **Efficacy of certain biopesticides against mustard aphid (*Lipaphis erysimi*) and their toxicity on honey bees (*Apis cerana* F.) (Hymenoptera: Apidae)**

*Abhinandan Yadav*

Studies on efficacy of certain biopesticides against mustard aphid (*Lipaphis erysimi* Kalt.) and their toxicity on honey bees (*Apis cerana* F.) (Hymenoptera: Apidae) were carried out under both laboratory and field conditions in the Apiculture Laboratory and in the Apiary of AICRP on honey bees, Department of Entomology, Assam Agricultural University, Jorhat during 2017 to 2019. Laboratory bioassays were carried out to determine the LC<sub>50</sub> values of *Beauveria bassiana*, *Verticillium lecanii* and neem seed oil against honey bee and *Lipaphis erysimi*. For calculation of relative toxicity, neem seed oil was considered as standard check. The LC<sub>50</sub> values of *Beauveria bassiana*, *Verticillium lecanii* and neem seed oil were found to be 1.91, 2.04 and 3.07 when observed after 24 hours; 1.25, 1.35 and 1.30 as observed after 48 hours and 1.15, 1.25 and 1.24 when observed after 72 hours of treatment. The order of toxicity of the selected biopesticides in respect to LC<sub>50</sub> values was *Beauveria bassiana* > *Verticillium lecanii* > neem seed oil when applied against *Lipaphis erysimi* Kalt. in varying exposure period (24, 48 and 72 hours). The LC<sub>50</sub> and relative toxicity values of *Beauveria bassiana*, *Verticillium lecanii* and neem seed oil were found to be 5.00, 6.55 and 6.18 at 24 hours; 2.43, 3.88 and 4.28 at 48 hours and 2.18, 2.70 and 2.46 at 72 hours when used against *Apis cerana* F. The order of toxicity in respect to LC<sub>50</sub> values was observed as *Beauveria bassiana* > neem seed oil > *Verticillium lecanii* for exposure periods of 24 and 48 hours respectively. However, at 72 hours the order of toxicity was found to be as neem seed oil > *Beauveria bassiana* > *Verticillium lecanii* when *Apis cerana* F. was treated to those biopesticides. The highest population reduction of aphid (*Lipaphis erysimi* Kalt.) was recorded when plots were treated with *Beauveria bassiana* @ 3 ml/lit (10.92, 16.95, 28.46, 47.01 and 72.03%) at one, three, five, seven and ten days after spraying in both the years whereas the lowest population reduction was recorded at *Verticillium lecanii* @ 1 ml/lit (6.41, 13.23, 23.92, 35.47 and 47.12%) at one, three, five,

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seven and ten days after spraying during 2017-19. The highest yield was obtained from *Beauveria bassiana* @ 3 ml/lit treated plots (6.23 q/ha) followed by neem seed oil @ 3 ml/lit (5.86 q/ha), *Beauveria bassiana* @ 2 ml/lit (5.78 q/ha), *Verticillium lecanii* @ 2 ml/lit (5.72 q/ha), *Verticillium lecanii* @ 1.5, ml/lit (5.55 q/ha) and *Beauveria bassiana* @ 1 ml/lit (5.39 q/ha) whereas the lowest yield was recorded in *Verticillium lecanii* @ 1 ml/lit treated plots (5.32 q/ha). Though *Beauveria bassiana* @ 3 ml/lit gave highest mortality (72.03% population reduction) there was no significant difference with the treatment *Verticillium lecanii* @ 2 ml/lit after 10 days of treatment (64.76% population reduction). The highest benefit cost ratio (4.90:1) was found in *Beauveria bassiana* @ 3 ml/lit treated plots as the treatment of *Beauveria bassiana* @ 3 ml/lit successfully reduced the aphid population. The highest value of persistent toxicity (PT) and relative persistent of toxicity (RPT) were recorded in the treatment *Beauveria bassiana* @ 3 ml/lit (799.98 and 1.06 respectively) whereas the lowest value were recorded in the treatment *Verticillium lecanii* @ 1 ml/lit (613.28 and 0.81) respectively. All the biopesticidal treatments viz., *Beauveria bassiana* @ 1, 2, 3 ml/lit, *Verticillium lecanii* @ 1, 1.5, 2 ml/lit and neem seed oil @ 3 ml/lit were observed to be significantly superior over control (untreated). The highest population mortality of honey bee was obtained with neem seed oil when applied @ 3 ml/lit (10.00, 15.00, 25.00, 28.33 and 31.16%) whereas the lowest population reduction was found with *Verticillium lecanii* 1 ml/lit (3.33, 6.66, 1.00, 1.33 and 1.66%) at one, three, five, seven and ten days after spraying during 2017-19. Enzyme assay was done to determine the activities of detoxifying enzyme acetylcholine esterase on *Apis cerana* due to these biopesticidal treatments. In the present study, *Apis cerana* was treated with the selected biopesticides viz., *Beauveria bassiana*, *Verticillium lecanii* and neem seed oil. Results pertaining to the study suggested a non-significant effect on *Apis cerana* and no reduction was found in the activity of acetylcholine esterase (AchE) after 24 hours and 48 hours. Therefore, *Beauveria bassiana* 3 ml/lit or *Verticillium lecanii* @ 2 ml/lit might be used to manage *Lipaphis erysimi* in rapeseed crop without affecting the activity of pollinator, *Apis cerana* in IPM.

## **Plant mediated synthesis of silver nanoparticles and their efficacy against certain sucking pests**

*Della Thomas*

Experiments were carried out in the Department of Entomology and Plant Pathology, Assam Agricultural University, Jorhat during 2017-18 and 2018-19 to study the efficacy of plant mediated synthesized silver nanoparticles against certain sucking pests. The silver nanoparticles were successfully synthesized by using plant extracts such as Tulsi (*Ocimum sanctum*), Bakul (*Mimusops elengi*), Garlic (*Allium sativum*) and Posotia (*Vitex negundo*). The synthesized silver nanoparticles were characterized by UV-Vis spectrophotometer, Zeta sizer, Fourier Transform Infrared Spectroscopy (FTIR) and Transmission Electron Microscopy (TEM). The UV-Vis spectra recorded peak at 425 nm, 427nm, 420 nm and 430 nm for Tulsi, Bakul, Garlic and Posotia AgNPs, respectively. FT-IR analysis for Tulsi, Bakul, Garlic and Posotia AgNPs showed strong peaks at ranges of 400-4000  $\text{cm}^{-1}$  which exhibited different types of functional groups viz., (O-H, C-H, N-H, H-H and C-C). Zeta potential was determined and recorded the charge of green synthesized silver nanoparticles as -24.2, -24.1, -16.7 and -33.0 mV for Tulsi, Bakul, Garlic and Posotia, respectively. TEM study revealed that the synthesized silver nanoparticles from different plant extracts were spherical and circular in morphology and the average size of 8 to 25 nm.

The efficacy of plant mediated synthesized silver nanoparticles against mustard aphid (*Lipaphis erysimi*), papaya mealybug (*Paracoccus marginatus*), rugose spiralling whitefly (*Aleurodicus rugioperculatus*) and two spotted spider mite (*Tetranychus urticae*) was investigated in the dilutions of 100, 200, 300, 400 and 500 ppm. Nanoparticles obtained from Tulsi were found to be effective against *L. erysimi* and *A. rugioperculatus* for both the years 2017-18 and 2018-19 with nymphal mortality of *L. erysimi* (88.89% and 84.44%) and *A. rugioperculatus* (86.67% and 84.44%) after the fifth day of treatment. Nanoparticles extracted from Garlic were found to be effective against *P. marginatus* with 84.44% and 82.22% nymphal mortality for the year 2017-18 and 2018-19. Incase of *T. urticae*, nanoparticles extracted from Garlic showed the highest mortality of 73.33% and 77.78% for the year 2017-18 and 2018-19, respectively.

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The LC<sub>50</sub> was estimated for all the tested sucking pests against all the synthesized AgNPs in 2017-18 and 2018-19. For *L. erysimi* the lowest value was calculated from Tulsi AgNPs after the fifth day of treatment for both the years 2017-18 and 2018-19, recorded 119.12 ppm and 109.76 ppm, respectively. For *P. marginatus*, lowest LC<sub>50</sub> of 109.21 ppm was recorded from Garlic AgNPs after the fifth day of the treatment during 2017-18. In 2018-19 also the lowest LC<sub>50</sub> value 116.33 ppm was obtained from Garlic AgNPs. For *A. rugioperculatus*, the lowest LC<sub>50</sub> from Tulsi AgNPs was found to be 123.12 ppm during 2017-18 and in 2018-19 also Tulsi AgNPs showed the lowest LC<sub>50</sub> value of 139.27 ppm. For *T. urticae* the lowest value was calculated from Garlic AgNPs after the fifth day of treatment for both the years 2017-18 and 2018-19, recorded 142.57 ppm and 130.39 ppm, respectively.

Behavioural changes in selected pests have also been noticed after treating with synthesized silver nanoparticles for both the years 2017-18 and 2018-19. For *L. erysimi*, the movement became slower, decreased feeding activity and colour changed to brown-black, paralysed, body contents became dry and subsequently death. After application of AgNPs on the eggs of *P. marginatus*, the colour changed to light orange to dark brown and did not hatch. The neonate crawlers die within 2-3 days after spray, survival was zero in some replicated plates, deformed and swelled body, sluggish if touched brown liquid ooze out. The cream colour changed to dark brown which was often died. For *A. rugioperculatus* the viability of eggs reduced and nymphs changed their colour from light cream to dark brown and die soon. While incase of *T. urticae*, legs became folded, move only when it disturbed, body contents come out and dry on the 5<sup>th</sup> day of post spray.

In the pot experiments with biosynthesized AgNPs against *L. erysimi* showed the highest per cent reduction by Tulsi AgNPs (79.40%) and the least per cent reduction was observed with Posotia AgNPs (61.55%). For *P. marginatus*, Garlic AgNPs was highly toxic as this caused 58.40% reduction at one day after spraying which was increased to 75.17% after 5 days of spraying. Among different biosynthesized AgNPs, Garlic AgNPs was found to be most effective against *T. urticae* population which resulted in 69.33% reduction in 5 days after application in potted plants.



## **Interaction of *Beauveria bassiana* (Bals.) Vuill. with *Leptocorisa oratorius* Fab. (Hemiptera: Alydidae) with special reference to chitinase**

*Karishma Das*

Rice earhead bug, *Leptocorisa oratorius* Fab. and *Leptocorisa acuta* Thun. (Hemiptera: Alydidae) are the most important sucking pests of rice. The insect cause significant yield losses to the rice crop in the field condition. Therefore, the present investigation was carried out with a view to study the seasonal incidence of *L. oratorius* in relation to the meteorological parameters, their damage potential, biology, pathogenicity of *Beauveria bassiana* (Bals.) Vuill. against different stages of *L. oratorius* and to characterize the *B. bassiana*-chitinase that secreted during insect fungus interaction.

To study the seasonal incidence of *L. oratorius*, an experiment was conducted at Instructional Cum Research (ICR) Farm, Assam Agricultural University, Jorhat during Ahu, 2018 & 2019 and Sali (Kharif), 2018 & 2019. During Ahu, 2018 & 2019, the population of *L. oratorius* was first appeared on 2nd week of May i.e. 20th standard meteorological week (SMW) with an average of 0.33 and 0.30 adult per hill, respectively. The population was gradually increased with a peak of 2.66 and 1.56 adult per hill on 24th SMW (2nd & 3rd week of June), respectively. During Sali (Kharif) 2018 & 2019, the population of *L. oratorius* was first appeared on 41st standard (SMW) with an average of 0.30 and 0.36 adult per hill, respectively. The population was found to be highest at 1st week of November i.e. 44th SMW with an average of 1.20 and 1.13 adult per hill, respectively. The correlation studies between incidences of *L. oratorius* with meteorological parameters showed non significant correlation with all the meteorological parameters during Ahu, 2018 and Sali (Kharif), 2018 and 2019. However, during Ahu 2019, it showed significant positive correlation with maximum ( $r = 0.802$ ) & minimum ( $r = 0.711$ ) temperature and BSSH ( $r = 0.631$ ) whereas, significant negative correlation with morning ( $r = -0.849$ ) & evening ( $r = -0.750$ ) relative humidity and non significant negative correlation with rainfall ( $r = -0.255$ ). Multiple regression analysis during Ahu 2019, revealed that only morning relative humidity determined the

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incidence of *L. oratorius* in concert with  $R^2 = 0.721$  (72.10%) and adjusted  $R^2 = 0.691$  (69.10 %). The „best fit model“  $Y = 12.82531 - 0.13115 * \text{Mor. RH} (\%)$  expressed the magnitude of the relationship.

The percent grain infestation due to rice earhead bug were recorded as 39.34 and 37.11 during Ahu, 2018 & 2019 and 35.43 & 36.28 during Sali (Kharif), 2018 & 2019, respectively. The biology of *L. oratorius* and *L. acuta* were studied under laboratory condition. The preoviposition and oviposition period of *L. oratorius* were found to be  $12.00 \pm 7.17$  and  $11.60 \pm 4.35$  days whereas,  $7.40 \pm 3.50$  and  $10.20 \pm 5.71$  days were recorded incase of *L. acuta*, respectively. A gravid female of *L. oratorius* laid on an average  $99.20 \pm 22.01$  number of eggs during her life span whereas,  $76.80 \pm 21.79$  number of eggs was laid by *L. acuta*. The incubation period of *L. oratorius* and *L. acuta* were  $5.80 \pm 1.09$  and  $5.00 \pm 1.00$  days, respectively. Both the species have five nymphal instars. The duration of each instar of *L. oratorius* were  $3.80 \pm 0.84$ ,  $2.20 \pm 0.45$ ,  $3.60 \pm 0.89$ ,  $6.80 \pm 0.84$  and  $4.80 \pm 0.84$  days whereas,  $4.40 \pm 1.14$ ,  $4.80 \pm 1.09$ ,  $3.40 \pm 1.14$ ,  $3.80 \pm 1.48$  and  $6.00 \pm 1.22$  days incase of *L. acuta*. The total nymphal period and total developmental period of *L. oratorius* were found to be  $21.20 \pm 1.09$  and  $27.00 \pm 1.58$  days whereas,  $22.40 \pm 1.14$  and  $27.40 \pm 2.02$  days were found incase of *L. acuta*, respectively. Adult male of *L. oratorius* lived for  $28.60 \pm 2.40$  days and female lived for  $57.60 \pm 7.06$  days. The longevity of both male and female of *L. acuta* were  $28.40 \pm 5.81$  and  $51.80 \pm 6.37$  days, respectively.

The morphometric study of *L. oratorius* revealed that the average length of eggs, first, second, third, fourth and fifth instar were  $1.02 \pm 0.06$ ,  $1.49 \pm 0.06$ ,  $2.82 \pm 0.05$ ,  $5.05 \pm 0.06$ ,  $10.61 \pm 0.09$  and  $14.03 \pm 0.15$  mm whereas, width were found as  $0.75 \pm 0.05$ ,  $0.28 \pm 0.04$ ,  $0.40 \pm 0.05$ ,  $0.48 \pm 0.05$ ,  $1.07 \pm 0.07$  and  $1.39 \pm 0.06$  mm, respectively. The female *L. oratorius* was slightly shorter than the male and measured  $17.08 \pm 0.16$  mm in length and  $1.98 \pm 0.09$  mm in width while the male bug was slightly longer than female measured  $18.01 \pm 0.16$  mm in length and  $2.11 \pm 0.11$  mm in width. In case of *L. acuta* the average length of eggs, first, second, third, fourth and fifth instar were recorded to be  $1.27 \pm 0.04$ ,  $1.39 \pm 0.05$ ,  $2.41 \pm 0.08$ ,  $3.75 \pm 0.07$ ,  $5.46 \pm 0.11$  and  $6.68 \pm 0.12$  mm whereas, width were found to be  $0.52 \pm 0.03$ ,  $0.55 \pm 0.07$ ,  $0.59 \pm 0.05$ ,  $1.38 \pm 0.08$ ,  $1.75 \pm 0.05$  and  $2.29 \pm 0.04$  mm, respectively. The average length and width of male bug were  $10.23 \pm 0.12$  and  $2.31 \pm 0.04$  mm whereas, female bug were  $9.85 \pm 0.12$  and  $2.39 \pm 0.44$  mm, respectively. The head length and width of *L. oratorius* varied as  $2.35 \pm 0.07$  and  $0.82 \pm 0.07$  mm whereas, incase of *L. acuta*  $1.29 \pm 0.02$  and  $0.53 \pm 0.02$  mm, respectively. Likewise thorax length, thorax width, abdomen length, abdomen width, distance between two compound eyes, length of compound eyes, width of compound eyes, antennal length, stylet length, fore wing length, fore wing width, hind wing length, hind wing width, fore leg length, middle leg length and hind leg length of *L. oratorius* were also measured as  $3.16 \pm 0.15$ ,  $2.05 \pm 0.07$ ,  $12.65 \pm 0.13$ ,  $2.23 \pm 0.14$ ,  $1.03 \pm 0.13$ ,  $0.89 \pm 0.10$ ,  $0.73 \pm 0.08$ ,  $14.74 \pm 0.12$ ,  $5.60 \pm 0.05$ ,  $12.20 \pm 0.19$ ,  $2.00 \pm 0.14$ ,  $8.51 \pm 0.16$ ,  $2.02 \pm 0.09$ ,  $9.07 \pm 0.25$ ,  $9.85 \pm 0.27$  and  $14.22 \pm 0.20$  mm whereas,  $1.60 \pm 0.02$ ,  $1.94 \pm 0.04$ ,  $6.00 \pm 0.07$ ,  $2.61 \pm 0.05$ ,  $1.8 \pm 0.08$ ,  $0.41 \pm 0.03$ ,  $0.29 \pm 0.02$ ,  $5.20 \pm 0.04$ ,  $4.85 \pm 0.06$ ,  $6.38 \pm 0.07$ ,

1.87±0.08, 4.64±0.07, 1.79±0.05, 3.43±0.16, 4.11±0.21 and 5.37±0.16 mm were found incase of *L. acuta*, respectively.

The pathogenicity test of *B. bassiana* against different stages of *L. oratorius* was carried out under laboratory condition and found to be effective against all the stages of this pest. The *B. bassiana* treated eggs showed 72.00±3.74 percent egg hatchability as compared to the untreated control (100±0.00). The mean percent mortality of first, second, third, fourth, fifth instar and adult were recorded as 84.00, 80.00, 66.00, 70.00 and 62.00 and 58.00, respectively at 9 days after treatment (DAT). However, significant differences ( $P \leq 0.05$ ) were found among the mean percent mortality of nymphal and adult stages at different DAT. Infection process of *B. bassiana* in insects is mainly triggered by the chitinase which is secreted during insect fungus interaction. Therefore, an experiment was conducted in the Department of Agricultural Biotechnology, Assam Agricultural University, Jorhat during the period 2016-2021 to optimize the growing condition of *B. bassiana* for chitinase production, reaction condition for chitinase activity assay and to purify the enzyme. For the production of *B. bassiana*-chitinase, different growth parameters viz., growth period, media composition (peptone concentrations, colloidal chitin concentrations and ferrous sulphate concentrations), media-pH and growth temperature were optimized. Along with the different growth parameters, reaction parameters viz., temperature and pH were also optimized for the estimation of *B. bassiana*-chitinase activity. The optimum incubation time required for chitinase production by *B. bassiana* was found to be 5 days, peptone concentration as 0.07%, colloidal chitin concentration as 0.4% and ferrous sulphate ( $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ ) concentration as 0.015%, media pH as 5.0 and growth temperature as 28°C, whereas, for *B. bassiana*-chitinase activity the optimum reaction temperature and reaction pH were found to be 37°C and 5.0, respectively.

Chitinase was purified by ammonium sulphate precipitation method by using different salt fractions, 55%, 65%, 75%, 85% and 95%. Chitinase activity and protein were estimated in crude enzyme as well as in its different salt fractions after proper dialysis. From the estimated chitinase activity and protein, the specific activity, fold purification and yield were calculated. Among the different fractions, with 75% ammonium salt saturation showed the best result as it purified the enzyme to the maximum fold of 2.68 with a yield of 14.34% and specific activity of 2.60 U/mg. The purity of the enzyme was examined by SDS-PAGE and determined the molecular weight at the highest purified fraction i.e. 75% ammonium salt saturation. The molecular weight of purified chitinase was estimated to be around 60 kDa.

## Ecology of Aphid Vectors of Citrus Tristeza Virus

*Maongkar T. Changkiri*

A field survey was conducted to study the incidence of citrus tristeza virus (CTV) and its aphid vectors, in different citrus growing locations of Assam and Nagaland. 190 samples were collected from four districts of Assam (Jorhat, Tinsukia, Sivasagar and Golaghat) and two districts of Nagaland (Mokokchung and Wokha). Citrus leaf samples were used for detection of CTV infection by double antibody sandwich-enzyme linked immuno-sorbent assay (DAS-ELISA) and RT-PCR. According to the results, 75 per cent CTV disease incidence was detected in surveyed areas of Assam and 24.55 per cent CTV disease incidence was detected in Nagaland. District wise, the highest CTV disease incidence (96.67 %) was detected in Tinsukia district of Assam and the lowest (21.43 %) was detected in Mokokchung district of Nagaland. RT-PCR confirmed the results of DAS-ELISA. The survey result also indicated the presence of the vector *Toxoptera citricida* in all the locations. The elevations of the different location surveyed ranged from 79-1130 m AMSL.

The study on population dynamics of *T. citricida*, revealed that the aphid reached its highest peak population of 416.68 on the 4<sup>th</sup> of June, during 2017 and 431.28 on 15<sup>th</sup> May, during 2018. *T. citricida* was observed to have two population peaks per year. The minimum temperature was the most dominant factor which showed positive and significant correlation, for mean population of *T. citricida*. 15 species of coccinellid predators and one species of syrphid were observed in the field plot of Assam Lemon and *Micraspis discolor*, *Cheilomenes sexmaculata*, *Coelophora bisellata* and *Coelophora saucia*, were the most abundant and they were found actively feeding on *T. citricida*. The population of *T. citricida*, showed positive and significant correlation, with all four coccinellid beetles, indicating that the populations of the predators, increased or decreased with the abundance or scarcity of *T. citricida*. The data on the two year study of the biology of the four coccinellid beetles revealed that the longest incubation period ( $3.43 \pm 0.07$  days) was recorded on *C. sexmaculata*. The longest total larval period ( $11.52 \pm 0.26$  days) was recorded on *C. sexmaculata*. The longest pupal period ( $3.90 \pm 0.08$  days) was recorded on *C. sexmaculata*. The longest total developmental (egg to adult emergence) period was recorded on *C. sexmaculata*, with an average duration of  $18.85 \pm 0.31$  days. *C. sexmaculata* had the longest adult

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longevity with an average of  $50.90 \pm 1.16$  days and the longest total life cycle ( $69.75 \pm 1.17$  days) was recorded on *C. sexmaculata*. Pooled data analysis of the two year study of predatory efficiency of the four coccinellid beetles reared on *T. citricida*, indicated that there was significant difference among the different predators. It was observed that the feeding potential of all the beetles increased gradually through each larval stage with the fourth being the most voracious. The predatory efficiency of the larval stages of the four coccinellid beetles from highest to lowest was recorded in the following order. *C. Sexmaculata* ( $27.04 \pm 0.32$ ) > *C. bissellata* ( $24.63 \pm 0.23$ ) > *C. saucia* ( $23.44 \pm 0.26$ ) > *M. discolor* ( $20.13 \pm 0.17$ ). The predatory efficiency of the adult stages of the four coccinellid beetles from highest to lowest was recorded in the following order. *C. saucia* ( $82.66 \pm 0.69$ ) > *C. bissellata* ( $78.94 \pm 0.81$ ) > *C. sexmaculata* ( $66.36 \pm 0.83$ ) > *M. discolor* ( $53.01 \pm 0.59$ ).

# **Diversity of mites in promising flower crops and their management in Gerbera, *Gerbera jamesonii*, Bolus**

*Nilofar Altaf*

Mites are among the most diverse arachnid group in terrestrial ecosystem. Therefore, a survey was carried out during the year 2018-2020 on “Diversity of mites in promising flower crops and their management in gerbera, *Gerbera jamesonii* Bolus in five different districts under Upper, Central and Lower Brahmaputra Valley Zones of Assam to know the diversity of phytophagous mites attacking flower crops. A random survey was carried out at different locations covering five different districts of Assam. The infested leaves were brought to the Acarology Laboratory, Dept of Entomology, AAU, Jorhat for the identification of different mite species collected from different flower crops like rose, gerbera, hibiscus, anthurium, orchid and marigold. A total of five different mite species belonging to the family Tetranychidae viz., *Tetranychus pacificus* McGregor, *T. truncatus* Ehara, *T. okinawanus* Ehara, *T. bunda* Flechtmann and *T. piercei* McGregor and five species under the family Tenuipalpidae viz., *Brevipalpus californicus* Banks, *B. chilensis* Baker, *B. yothersi* Baker, *B. lewisi* McGregor and *B. obovatus* Donnadieu were recorded. However, *B. yothersi*, *T. bunda*, *T. pacificus* and *T. piercei* are supposed to be new record from our country. Out of five districts, maximum number of 5463 individuals was collected from Kamrup district. The species diversity index (1.582) and richness indices (0.587) of mite species was found to be highest in Experimental Farm, Dept of Horticulture, Assam Agricultural University of Jorhat district, whereas the lowest species diversity index (0.342) and richness indices (0.133) were observed in Changamari Habigaon of Dibrugarh district. In case of Pielou’s evenness index for phytophagous mites, highest value of 0.892 was recorded from Potia gaon of Jorhat district and lowest value of 0.494 was recorded from Changamari Habigaon of Dibrugarh district.

The major mite species collected from different locations during survey were brought to the Acarology laboratory, Dept of Entomology, AAU, Jorhat for morphometric study. The body measurements were taken under labovision phase contrast microscope. The study revealed that the male of *T. pacificus* possessed highest

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body length of  $371.207 \pm 0.001 \mu\text{m}$  compared to the females with body length of  $289.625 \pm 0.003 \mu\text{m}$  whereas lowest body length of  $338.354 \pm 0.001 \mu\text{m}$  was observed in the male of *T. okinawanus*. The morphometric study of the major false spider mite species revealed that the *B. obovatus* showed the highest body length of  $287.392 \pm 0.001 \mu\text{m}$  whereas the lowest body length of  $269.257 \pm 0.400 \mu\text{m}$  was observed in *B. yothersi*. The principal component analysis was done under SPSS 20.0 Statistical package which showed that in case of adult false spider mite species among 25 morphometric characters used for analysis of variance two parameters, viz., length of body and width of body significantly contributed towards variation among them. The Principal Component Analysis of two different morphometric characters indicates two Eigen values which were greater than one that explained 81.977 per cent variation amongst the false spider mite species. In case of adult male and female of spider mite species among 22 morphometric parameters used for analysis of variance, four parameters viz., body length, body width, length of gnathosoma and length of leg I significantly contributed towards variation among them. The principal component analysis of four different morphometric characters indicates four Eigen values which were greater than one that explained 93.590 per cent variation amongst the male and female spider mite species.

# **Management of greater wax moth, *Galleria mellonella* (Lepidoptera: Pyralidae) and characterization of its gut bacteria**

*Rokozeno*

Field and laboratory experiments were carried out at the Department of Entomology and Department of Agricultural Biotechnology, Assam Agricultural University, Jorhat during 2018 and 2019 to study the management of greater wax moth, *Galleria mellonella* (Lepidoptera: Pyralidae), a serious pest of the honey bee using different integrated modules and to characterize the gut bacterial community. Different life stages of the wax moth were studied to provide a concise information on the population trend. Laboratory studies confirmed the occurrence of multiple generations of *G. mellonella* in a year. In the present study, five generations of *G. mellonella* were recorded in a single year. The duration of each developmental stages showed variation in each generation. Mean incubation period was found to be  $4.60 \pm 0.49$  days (1<sup>st</sup> generation),  $4.40 \pm 0.49$  days (2<sup>nd</sup> generation),  $3.20 \pm 0.40$  days (3<sup>rd</sup> generation),  $4.20 \pm 0.75$  days (4<sup>th</sup> generation) and  $8.00 \pm 0.63$  days in the 5<sup>th</sup> generation. Throughout each generation a total 6 (six) numbers of larval instars were recorded. Mean duration of the total larval period was observed to be  $32.40 \pm 2.33$  days (1<sup>st</sup> generation),  $25.20 \pm 0.40$  days (2<sup>nd</sup> generation),  $25.40 \pm 1.62$  days (3<sup>rd</sup> generation),  $25.60 \pm 1.36$  days (4<sup>th</sup> generation) and  $45.80 \pm 1.17$  days (5<sup>th</sup> generation). The mean duration of the pre-pupal period was recorded to be  $5.20 \pm 0.75$  days (1<sup>st</sup> generation),  $3.40 \pm 0.49$  days (2<sup>nd</sup> generation),  $3.80 \pm 0.75$  days (3<sup>rd</sup> generation),  $4.20 \pm 0.40$  days (4<sup>th</sup> generation) and  $10.60 \pm 0.80$  days (5<sup>th</sup> generation). The mean duration of the pupal period was found to be  $9.80 \pm 1.17$  days (1<sup>st</sup> generation),  $9.60 \pm 0.49$  days (2<sup>nd</sup> generation),  $8.00 \pm 0.63$  days (3<sup>rd</sup> generation),  $8.60 \pm 0.49$  days (4<sup>th</sup> generation) and  $18.00 \pm 1.67$  days in the last generation. The longevity of the male adult wax moth recorded a mean duration of  $17.80 \pm 0.75$  days (1<sup>st</sup> generation),  $20.60 \pm 1.02$  days (2<sup>nd</sup> generation),  $20.20 \pm 0.75$  days (3<sup>rd</sup> generation),  $21.40 \pm 1.02$  days (4<sup>th</sup> generation) and  $8.40 \pm 0.80$  days (5<sup>th</sup> generation). The adults recorded a longer period of longevity over the adult female moths. The longevity of the adult female moth recorded a mean duration of  $10.40 \pm 2.33$  days (1<sup>st</sup> generation),  $11.40 \pm 1.85$  days (2<sup>nd</sup> generation),  $11.20 \pm 0.40$  days (3<sup>rd</sup> generation).

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generation),  $11.20 \pm 0.40$  days (4th generation) and  $13.40 \pm 1.02$  days (5th generation). The larval stages of wax moth are the damaging stage of the pest, in order to manage them, different integrated module incorporating cultural, biological and cold treatment was carried out. In determining the effectiveness of different integrated modules, all the treatments were found to be effective over the control. Combs kept in deep freezer at  $-7^{\circ}\text{C}$  recorded least damage of 1.53 per cent comb in the initial period however, with the elapsing of time *Bt. var. kurstaki* at 1 per cent in module III(b) proved to be better over the other modules. Pertaining to larval mortality, *Bt. var. kurstaki* at 1 per cent showed highest mortality as compared to the other modules and exhibited mortality per cent up to 36.66 per cent. In the context of reducing adult emergence as a measure of managing wax moth, the least per cent adult emergence of 33.33 per cent was recorded in module III where *Bt. var. kurstaki* @ 1 per cent was incorporated. All the modules comparatively showed satisfactory performance in managing the wax moth over the control in which no external intervention was employed. For best preventive measures all the modules can be suggested, with emphasis on regular and timely monitoring. For an effective and desirable management, module III with *Bt. var. kurstaki* at 1 per cent would be recommended against the pest.

*G. mellonella* larva has been reportedly known to degrade polyethylene (PE), as such it has been assumed that certain microbes residing in the gut may be responsible. The investigation of the gut led to the isolation of 14 microbial isolates. The morphological characteristics of the fourteen isolates were mostly circular in shape, and had an entire margin, the colony color was chiefly white with raised elevation and exhibited smooth surface. Utilising 16S rRNA sequencing and analysing them on BLAST, the isolates were identified: it constituted of thirteen numbers of bacteria and one microalgae. The bacterial species ascertained were shown to be 2 strains of *Acinetobacter radioresistens*, 2 strains of *Bacillus circulans*, 2 strains of *Enterococcus faecalis*, *Agrobacterium* sp., *Exiguobacterium aestuarii*, *Microbacterium zeae*, *Microbacterium paraoxydans*, *Sphingomonas pseudosanguinis*, *Sphingobium yanoikuyae*, and one number of uncultured bacterium. The lone algae out of the 14 (fourteen) microbes isolated was confirmed as *Picochlorum oklahomensis*. A number of the above species has been reportedly known to degrade aromatic hydrocarbon, low density polyethylene, high density polyethylene, polystyrene etc. The precise mechanism of this microbes in degrading PE, function of the host i.e. *G. mellonella* larva and the microbes in degrading the plastic whether individually or together, merits further investigation. The process of PE degradation could be used to devise a biotechnological solution on an industrial scale for managing polyethylene waste.

Key words: Greater wax moth, *Galleria mellonella*, management, gut bacteria, PE degradation

## **Botanicals for rodent pest management**

*Sanghomitra Sarma*

A ethnobotanical survey was conducted in different villages of seven districts of Assam i.e., Karbi anglang, Kokrajhar, Jorhat, Sivasagar, Dibrugarh, Lakhimpur and Dhemaji to collect the information about the botanicals having antifertility and abortifacient effect. Altogether 32 plant species belonging to 22 families were recorded in the survey conducted in 35 villages of 7 districts. Majority of the ethno-medicinal plants were recorded from Fabaceae, Maliaceae, Caricaceae, Combretaceae, Bromeliaceae, Lamiaceae followed by Malvaceae, Lythraceae, Euphorbiaceae, Apocynaceae. *Azadirachta indica* A. juss was found most frequently used by the local people of the districts followed by *Carica papaya* L; *Ananas Comosus* (L.) Merr; *Mimosa pudica* L; *Hibiscus rosa-sinensis* L; *Ricinus communis* L; and *Lawsonia inermis* L. These seven botanicals were used for study the antifeeding, antifertility and abortifacient effect against *Bandicota bengalensis*. To evaluate the efficacy of the botanicals against *B. Bengalensis*, a choice and nochoice feeding trials were conducted. The treated bait was prepared by mixing the desired concentration i.e., 2, 5 and 7% of botanicals extract mixed with 960 gm broken rice+ 20 g of sugar. No significant difference was observed among the treatments for the antifeedant index and bait acceptance percentage under both choice and no choice test at 2% concentration. The highest antifeedant index (57.89% in male and 55.78% in female) was also recorded with *A. indica* at 5% followed by *R. communis* (54.76% in male and 53.45% in female) under choice feeding trial. The highest acceptance percentage was also recorded with *H.rosa sinensis* (46.64% in male and 48.34% in female) under choice feeding trial. The rats treated with *C. papaya* showed highest anti-implantation activity (67.32%) followed by *M. pudica* (60.63%) and *H. rosa sinensis* (57.56%). Among all the treatments the highest antifertility activity was found in *M. pudica* (61.78%), *C. papaya* (61.23%) and *H. rosa sinensis* (60.12%) against female *B. bengalensis*. Female rat by the administration of *C.papaya* showed the lowest fertility index (39.28%), which are significantly different from *M. pudica* (45.21%), *R. communis* (48.15%) and *H. rosa sinensis* (50.57%). In female, maximum weight reduction of the uterus was found in *A. indica* (110.99±8.52 mg/100 gm bw) followed by *C.papaya* (115.89±7.52 mg/100 gm bw), *R. communis* (119.90±3.52 mg/100 gm bw) and *H. rosa sinensis* (120.90±5.76

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mg/100 gm bw) significant as compared to control (137.90±8.12 mg/100 gm bw). In male animals, administration of treatments viz., *A. indica*, *H. rosa sinensis* and *C. papaya* decreased the testis weight i.e., (1308.90±3.18), (1456.12±5.90) and (1598.98±1.12) as compared to Control group (1711.52±3.80). Biochemical analysis of surveyed plants showed highest amount of phenol, flavenoid, tannin and alkaloid content (mg/g) in *A. indica* i.e., (6.56±0.67), *H. rosa sinensis* (8.89± 0.86), *H. rosa sinensis* (5.62±0.21) and *H. rosa sinensis* (11.45±0.31). Mortality percentage viz. (56.87% male and 63.89% female) in *M. pudica* and (55.18% male and 58.83% female) in *L. inermis* was recorded in both sexes of *B. bengalensis* in Choice test. In no choice test mortality per cent was highest in *M. pudica* ( Male 65.78% and 60.89% female) followed by *L. inermis* (55.67% in male and 57.89% in female).The weight of vital organs i.e., kidney and liver related to botanicals *A. indica*, *M. pudica* and *L. inermis* of treated animals significantly increased in comparison to that of untreated animals. Histopathology study reveals that in case of animal kept on *M. pudica* and *A. indica* showed mild to moderate haemorrhage and congestion, degenerative changes in few areas with fatty changes and necrosis, presence of severe infiltration inflammatory cells in the sub capsular area in liver. *B. bengalensis* kept on *H. rosa sinense* and *A.indica* showed the regressed condition of seminiferous tubule with decreased spermatogenic activity with few spermatogonia, and empty lumen in the seminiferous tubule in testis. Present study suggested that among all the ethnobotanicals *A. indica* seed kernel and *R. communis* leaf have good antifeedant properties whereas in *C. papaya*, *H. rosa sinensis* have good antifertility properties for both male and female rat and *M. pudica* and *L. inermis* showed toxic effect on rodent.

# **Study on impact of “Bringing Green Revolution to Eastern India” (BGREI) programme in UBVZ of Assam in promotion of farm mechanization**

*Moromi Buragohain*

Agricultural mechanization technology plays a key role in improving agricultural production in developing countries, and should be considered as an essential input to agriculture. In Assam most of the farm operations are done using animal power, hence, there is great scope of selective mechanizing in Assam where, small hand tools are used involving drudgery. In order to bring about a change, a programme under Farm Asset Building Activity has also been proposed under BGREI programme. The major component of the BGREI programme is farm mechanization, and promotion of farm mechanization has been recognized as one of the essential requirement and need of the hour for agricultural development in Assam especially in rice cultivation. Keeping this in view primarily, the present study entitled- “A study on impact of Bringing Green Revolution to Eastern India (BGREI) programme in UBVZ of Assam in promotion of farm mechanization” was carried out in three district of Assam namely Golaghat, Johan and Sivasagar. The objectives of the study are as follows:

## **OBJECTIVES:-**

1. To assess the extent of utilization of farm machineries by the beneficiary and neighbouring farmers
2. To determine the level of knowledge on operation of different farm machineries and extent of adoption on scientific practices of applying farm machineries and tools in selected crops
3. To analyze the factors influencing the extent of utilization of farm machineries and tools.
4. To study the change in farming in terms of cropping intensity, cropping pattern, crop, diversification, intensification, productivity and profitability as a result of using farm machineries.
5. To identify the constraints face by the beneficiary and non beneficiary farmers in utilization and application of farm machineries and to pool suggestions thereof.

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**Major Adviser: Dr. P.K. Neog**

A multistage purposive cum random sampling design was used for selecting 300 farmers as respondents. Appropriate statistical methods were used for analysis and interpretation of data.

The findings reveal that majority (57.33%) and (49.33%) of the BGREI beneficiary farmers and non-beneficiary farmers had medium and low level of utilization for farm machineries and tools respectively. Majority (68.67%) and (55.33%) of the beneficiary farmers and non-beneficiary farmers had medium and low level of knowledge on different farm machineries and tools respectively. Majority (60.00%) and (53.33 %) of the BGREI beneficiary farmers and non-beneficiary farmers belong to medium and low adoption category towards scientific practices of farm machineries and tools respectively.

Paired “t” test was applied to compare between the BGREI beneficiaries’ farmers and non-beneficiaries farmers related to their extent of utilization of farm machineries and tools and it revealed that the beneficiary’s farmers had significantly higher utilization as compared to non-beneficiaries farmers. Likewise, beneficiary’s farmers had significantly higher level of knowledge on operation of farm machineries and tools as well as higher adoption on scientific practices of applying farm machineries and tools as compared to non-beneficiaries farmers.

For extent of utilization of farm machineries and tools of the BGREI beneficiary farmers, correlation table revealed a positive and significant relationship between annual income, information source utilization, credit orientation, mass media and social media use and attitude towards farm mechanization. In case of non-beneficiary farmers, correlation table revealed a positive and significant relationship between social participation and labour availability. For level of knowledge on operation of different farm machineries and tools of the BGREI beneficiary farmers, correlation table revealed a positive and significant relationship between information source utilization, credit orientation, scientific orientation and attitude toward farm mechanization. In case of non-beneficiary farmers, correlation table revealed a positive and significant relationship between age, annual income, scientific orientation, extension contact and mass media and social media use. For extent of adoption on scientific practices of applying farm machineries and tools of the BGREI beneficiary farmers, correlation table revealed a positive and significant relationship between age, size of operational land holdings, annual income, information source utilization, mass media and social media use, and participation in farm machineries related training. In case of non-beneficiary farmers, correlation table revealed a positive and significant relationship between size of operational land holdings, annual income, labour availability, mass media and social media use, participation in farm machineries related training and attitude towards farm mechanization.

Among economic factors, social factors, personal factors and organizational factors subsidies availability, after seeing neighbours development, self-reliance or independence and guidance from ADO respectively were the major factors influencing the extent of utilization of farm machineries and tools for majority of the BGREI

beneficiary farmers and non-beneficiary farmers. The changes has taken place for more than 50 per cent of the beneficiary farmers in terms of cropping intensity, cropping pattern, crop diversification, productivity and profitability. The constraints face by the beneficiary and non-beneficiary farmers in utilization and application of farm machineries and tools are as follows: Economic constraints includes high initial cost of implements (Rank I), Infrastructural constraints includes non availability of spare parts in nearby places (Rank I), Information constraints includes farmers faced lack of skilled labour to operate farm machineries and tools (Rank I), The major situational constraint faced by the respondents was most of the farm machines and tools were not suitable for women farmer (Rank I) and frequent repairing (Rank I) was the most felt technological constraint by the BGREI beneficiary and non-beneficiary farmers.

# **A study on determinants of different stages of adoption process of post-harvest management practices of potato in Meghalaya**

*Nisha .V. Kharjana*

The study entitled “**A study on determinants of different stages of adoption process of post-harvest management practices of potato in Meghalaya.**” was carried out to identify the most relevant factors affecting the different stages of adoption process and along with it to also analyse the extent of adoption of post-harvest management practices of potato in East Khasi Hills and West Khasi Hills of Meghalaya. The present study has been undertaken with the following specific objectives.

1. To identify the factors influencing stages of adoption process of post- harvest management practices of potato.
2. To assess the extent of adoption of post-harvest management practices of potato by the growers.
3. To analyse the relationship of socio-personal and economic variables with the extent of adoption of post-harvest management practices of potato.
4. To identify constraints faced by potato growers and to find out the measures suggested by them.

The study was conducted in East Khasi Hills and West Khasi Hills district of Meghalaya which were selected purposively. East Khasi Hills is a district which has 11 (eleven) community and rural development blocks and West Khasi Hills is a district which has 6 (six) community and rural development blocks. Amongst all these blocks, a total of four blocks were selected randomly for the study. Two blocks namely, Mawphlang Block and Myllem Block, from East Khasi Hills while the other two blocks namely, Mairang and Mawthadraishan were selected randomly from the West Khasi Hills. From each of the selected blocks, 5(five) villages were randomly selected for the investigation. Thus, a total of 20 villages were selected for the present study. For selection of respondents, simple random sampling technique was used and a total of fifteen numbers of respondents were selected from each of the selected villages making it a total of 300 number of respondents. Altogether fifteen independent variables viz., age, educational level, farm experience, size of operational land holding, annual income,

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availability of family labour, availability of hired labour, training exposure, extension contact, social participation, scientific orientation, marketing orientation, risk preference, economic motivation and knowledge level and one dependent variable i.e., extent of adoption were included in the study. As for descriptive variables, we have factors influencing different stages of adoption process and problems cum suggestions given by respondents. Data collection was carried out by personal interview technique administering a structured schedule. Statistics like frequency, mean, percentage, standard deviation, coefficient of variation, Karl Pearson's correlation coefficient, multiple regression and ranking were used for analysis of data. The study revealed that majority of the respondents were of middle age group (51.33%) and had literacy up to middle school (26.34%). Majority of the respondents (52.34%) were found to have medium farm experience. In case of size of operational land holding, it was found that majority (50.67%) had marginal land holdings. Most of the respondents (86.00%) had medium annual income followed by (53.66%) respondents who had 1-2 members, in terms of availability of family labour. And about (49.67%) respondents who could not avail hired labour as and when required. In regards to social participation, majority of the respondents (53.00%) had no membership in any organization. With respect to training exposure, it was found that about (39.00%) of the respondents were not exposed to any training related to post harvest management of potato. Extension contact was also found to be medium in majority (60.67%) of the respondents. Scientific orientation and marketing orientation were found to be medium with (71.67%) and (78.00%) respectively. The risk preference of the respondents, majority (92.00%) were found to be medium and (84.00%) of the respondents were found to be medium in economic motivation. Lastly, regarding the knowledge level, it was found that majority (65.67%) of the respondents had medium level of knowledge. The study revealed that more than, 50 per cent of the respondents had perceived high level of influence on six factors which include agriculture pamphlets (51.00%), friends or neighbours (55.00%), opinion leaders (61.33%), ATMA functionaries (59.00%) market intermediaries (52.33%), and market demand (52.67%) on the 'Awareness stage' of adoption process. The study also revealed that majority of the respondents, above 50 per cent had perceived high level of influence of five factors which include agriculture pamphlets (54.00%), friends or neighbours (53.33%), ATMA functionaries (54.00%) market intermediaries (50.67%), and market demand (53.33%) on the 'Interest stage' of adoption process. This table indicates that majority of the respondents, above 50 per cent had perceived high level of influence of four factors which include, agriculture pamphlets (55.00%), availability of family labour (54.00%), market demand (52.00%) and availability of input (53.00%) on the 'Evaluation stage' of adoption process. The study also revealed that majority of the respondents, above 50 per cent had perceived high level of influence of five factors which include agriculture pamphlets (56.67%), availability of family labour (52.33%), market demand (50.00%), size of land holding (53.00%) and availability of inputs (58.33%) on the 'Trial stage' of adoption process. The study also revealed that majority of the respondents, above 50.00 percent had perceived high level of influence of seven factors



which include agriculture pamphlets (51.00%), market intermediaries (54.67%), availability of storage (57.00%), availability of family labour (51.33%), market demand (52.33%), size of land holding (50.33%) and availability of inputs (56.67%) on the 'Adoption stage' of the adoption process. The study also revealed that majority (65.33%) of the respondents had medium level of adoption in terms of overall extent of adoption of post-harvest management practices of potato followed by 23.00 per cent of the respondents who had high level of adoption and only 11.67 per cent of the respondents were found to be low in the adoption category. The study revealed that more than 50 per cent of the respondents, fully adopted 10 (ten) of the practices which include timely (78.33%), harvesting under good weather conditions (73.33%), washing of potato tubers after harvesting (70.00%), drying of potatoes under the shade (curing) (69.00%), sorting and grading of harvested potatoes (66.00%), grading of potato according to different sizes (55.00%), storing of potatoes after they are properly dried (72.33%), maintenance of proper aeration while storing (67.33%), proper storage method (77.33%), and use of recommended packaging material (68.33%). Reasons for their full adoption was because level of knowledge of these respondents was also high for these practices. Correlation coefficient revealed a positive and significant relationship between the extent of adoption and the variables namely educational level, farm experience, annual income, availability of family labour, availability of hired labour, training exposure, extension contact, scientific orientation, economic motivation and knowledge level. Whereas, for multiple regression analysis the variables which were found to have significant relationship with the dependent variable were considered. The multiple regression analysis with all the ten predictors produced  $R^2=0.831$ . Thus, this signifies that ten variables taken together could explain 83.1 per cent of the total variation in respondent's extent of adoption. The most important constraints faced by majority of the respondents was the unavailability of cold storage facilities in and around the area and this was ranked as first amongst the other major constraints. The respondents have also suggested a number of measures regarding solving of the problems they were facing but the most important measure suggested by majority of the respondents were that the development of cold storage facilities by the concerning authorities and this was ranked first amongst other measures.

# **Determinants of Adoption in Regard to Recommended Cultivation Practices of Rice (*Oryza sativa*) and Maize (*Zea mays*) in the State of Nagaland**

*Zujanbemo Khuvung*

Agriculture is considered as the backbone of Nagaland's economy where the majority of the population depends on agriculture. Major variants of cereals produced in Nagaland are rice, maize and millet. The two methods of cultivation among the Naga tribes are jhum and terrace cultivation which makes about 86 per cent of the total cultivable area in Nagaland. Emphasis on improving the production and productivity of agriculture is crucial to bridge the gap between the demand and supply of food grains. The present study on Determinants of adoption in regard to recommended cultivation practices of rice (*Oryza sativa*) and maize (*Zea mays*) in Nagaland was carried out in the state of Nagaland. The objectives of the study were measure the extent of adoption in regard to recommended cultivation practices of rice and maize in Nagaland, find out determinants of adoption of rice & maize production technology, identify the constraints faced by the farmers while adopting recommended cultivation practices, solicit suggestions from the research scientists, development workers and policy makers on measures for enhancing the production and productivity of rice and maize in Nagaland and develop a strategy to increase the rate of adoption of recommended rice and maize production technology. The study was taken up in six districts of Nagaland with a sample size of 300 farmers. Eighteen independent variables viz., age, gender, education, family type, family size, occupation, operational land holding, annual income, farming experience, social participation, information sources utilization, extension contact, cosmopolitaness, innovativeness, economic motivation, scientific orientation, achievement motivation and attitude towards shifting cultivation with extent of adoption as dependent variables were studied. The respondents were interviewed personally with the help of structured interview schedule. The data collected were coded, tabulated and analyzed using frequency, percentage, mean, standard deviation, co-efficient of variance, Karl Pearson's co-efficient of correlation and multiple linear regression analysis. The profile

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of the farmers revealed that more than half (59.7%) of the respondents were medium aged and were males (65.7%), less than one-third of them were illiterates (31.7%), majority belonged to nuclear family type (86%) and more than half (51.7%) of them had family size of 3-5 members. A little more than two-third (67.7%) of the farmers did cultivation as occupation, majority (46%) had marginal operational land holding, 80.67 per cent had medium (<Rs. 12009->Rs. 80905) income level, more than half (57.7%) of them had 13-32 years of farming experience, less than half (49.3%) of the farmers had no membership in any organization, 47.67 per cent of them had medium level of information sources utilization and 51.67 per cent had medium level of extension contact. Majority (23.66%) of them had contact with ATMA officials, 67 per cent of them visited town for agriculture purpose. More than half (69.67%) of the respondents had medium level of innovativeness, 45.67 per cent had medium level of economic motivation, 62 per cent having medium level of scientific orientation, 56.67 per cent having medium level of achievement motivation while 63.7 per cent of them had moderate level of attitude towards shifting cultivation. Majority (60.67%) of the farmers had medium level of adoption of recommended cultivation practices of irrigated rice, 60 per cent had medium level of adoption of recommended cultivation practices of upland rice and 69 per cent had medium level of adoption of recommended cultivation practices of maize. The computed correlation coefficient value of family size ( $r=0.946^*$ ) showed a positive significant relationship with extent of adoption of recommended cultivation practices of irrigated rice, while sixteen independent variables with the extent of adoption of recommended practices of irrigated rice taken on multiple linear regression analysis gave the co-efficient of multiple determination ( $R^2$ ) value of 0.913. The variables namely family size ( $b=2.209^*$ ), social participation ( $b=0.377^*$ ) and economic motivation ( $b=1.121^*$ ) were found to be positively significant and can be termed as good predictors of extent of adoption of recommended cultivation practices of irrigated rice. The computed correlation coefficient values of family size ( $r=0.944^*$ ) and annual income ( $r=0.160^*$ ) were positively and significantly correlated with the extent of adoption of recommended cultivation practices of upland rice, while sixteen independent variables with the extent of adoption of recommended practices of upland rice by the farmers taken on multiple linear regression analysis gave the co-efficient of multiple determination ( $R^2$ ) value of 0.905. The variables namely age ( $b=0.103^*$ ), family size ( $b=3.449^*$ ) and scientific orientation ( $b=0.121^*$ ) were found to be positively significant and can be termed as good predictors of extent of adoption of recommended cultivation practices of upland rice. The computed correlation coefficient values of operational land holding ( $r=0.197^*$ ), information sources utilization ( $r=0.931^*$ ), extension contact ( $r=0.905^*$ ), innovativeness ( $r=0.958^*$ ), economic motivation ( $r=0.941^*$ ) and achievement motivation ( $r=0.945^*$ ) were positively and significantly correlated with the extent of adoption of recommended cultivation practices of maize and annual income ( $r=-0.263^*$ ) was found to be negatively significant. Sixteen independent variables with the extent of adoption of recommended practices of maize by the farmers taken on multiple linear regression analysis gave the co-efficient of multiple

determination (R<sup>2</sup>) value of 0.954. Variables namely family size (b=0.097\*), information sources utilization (b=2.050\*) and innovativeness (b=1.067\*) were found to be positively significant and can be termed as good predictors of extent of adoption of recommended cultivation practices of maize. Whereas annual income (b=-4.685\*) and extension contact (b=-0.452\*) were found to be negatively significant with extent of adoption of recommended cultivation practices of maize. Non-availability of quality seeds, lack of proper financial assistance and subsidies, non-availability of timely farm inputs and machineries, pest and disease incidence, lack of storage facilities and processing units, low market value for crops, lack of marketing facilities and channels, lack of proper interactions between farmers and extension service providers, lack of result-oriented trainings and demonstrations, weather uncertainty, high cost of fertilizers and lack of knowledge of government schemes and incentives and proper irrigation and drainage facilities were some of the major constraints highlighted by the farmers while adopting recommended cultivation practices of rice and maize. Some of the strategy proposed to increase the production of rice and maize in Nagaland were timely supply and use of high yielding varieties and hybrid seeds, System of Rice Intensification, Crop Diversification in maize crop, Integrated Nutrient Management (INM), Integrated Pest & Disease Management (IP&DM), Water Resource Management, Improved farm mechanization, Integrated Farming System (IFS) Approach and Participatory Research and Development.

## **Morpho-Biochemical characterization of *Citrus reticulata* cv. “Khasi Mandarin” of Assam**

*Dorodi Priyom Duarah*

Khasi Mandarin (*Citrus reticulata*), commonly known as „Komola tenga“ or is a commercially popular subtropical citrus species in the North Eastern Himalayan region of India including Assam exhibiting common reproductive trait polyembryony. It is propagated commonly by seeds and hence it exhibits a tremendous variation in morpho-biochemical traits among its population. People follow this variation to identify different ecotypes of Khasi mandarin. Facts of genetic diversity is essential for betterment of fruits. Therefore, an investigation was undertaken during 2017-2018 and 2018-2019 on „Morpho-biochemical characterization of *Citrus reticulata* cv. „Khasi Mandarin“ of Assam“ to study the variability. Seven major mandarin growing districts were chosen and five plants were selected in each district, comprising thirty five plants. Wide range of variability was observed among the selected Khasi mandarin accessions for qualitative and quantitative characters of tree, leaf, flower, fruit and seed. The maximum fruit weight (145.29g) was recorded in AKM03T2 and minimum (110.80g) was in AKM01T4. In terms of biochemical constituents, the highest TSS was recorded in AKM07T2 (11.9 0Brix) and lowest in AKM06T2 (6.22 0Brix). Some morphological traits i.e. fruit volume, fruit length, fruit seeds per fruit, juice percentage showed significant variation among different districts. Three different fruit shapes were recorded viz. spheroid, pyriform and oblate. Variations in pulp colour i.e. orange, light yellow and dark orange were recorded in in the selected mandarin oranges. Dendrogram based Cluster analysis of thirty five accessions considering 33 polymorphic qualitative traits and 4 traits of disease (powdery mildew, citrus canker and pest (Trunk borer and leaf minor) occurrence using UPGMA (Unweighted Pair Group Method with Arithmetic Mean) resulted in grouping of Khasi Mandarin accessions into 6 groups and 6 subgroups at Euclidean distance of 10.95 with an average Euclidean distance of 8.64. The highest coefficient of dissimilarity (11.08) was observed between accessions AKM01T5 and AKM02T3 from Jorhat and Tinsukia district with eleven characteristics features. The lowest coefficient of dissimilarity (6.00) was recorded between accessions AKM03T3 and AKM05T4 which were from the Golaghat and Dima Hasao with twelve

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characteristics features signifying that they are closely related. No groups were formed based on geographical location indicating that qualitative traits were largely influenced by genetic factor. The principal component analysis of quantitative traits gave 33 principal components, but in our study eigen values of the principal component for quantitative traits indicated that first 4 components accounted for 91.7% of the total variation. On the other hand, eigen values of the principal component for qualitative traits indicated that first 16 components accounted for 90.2% of the total variation. The clustering pattern based on PCA and correlation matrix of 66 characters of qualitative and quantitative traits, 30 minimum descriptors were found to be identical for easy evaluation and characterization of Assam Khasi Mandarin germplasm that the prepared minimum descriptor is likely to cover the existing genetic diversity of the cultivar.

## **Characterization and evaluation of sponge gourd [*Luffa cylindrica* (L.) Roem.] germplasm of Assam**

*Ira Sarma*

The present investigation entitled “Characterization and evaluation of sponge gourd [*Luffa cylindrica* (L.) Roem.] germplasm of Assam” was conducted at the farm site of Krishi Vigyan Kendra, Jorhat, Assam Agricultural University (AAU) during 2017 and 2018 and at the Department of Horticulture, AAU, Jorhat during 2019. The experimental material comprised of thirty-three genotypes of sponge gourd collected from different parts of Assam during 2016 and 2017. The experiment was laid out in a Randomized Block Design (RBD) with two replications. For the qualitative traits observed during 2017, it was found that all the genotypes had angular stems, branched tendrils, dentate leaf margins, prostrate growth habit, yellow coloured flowers, monoecious sex type, low dorsal and ventral leaf pubescence, white coloured flesh and black coloured seeds indicating monomorphism of these traits. Leaf lobe with shallow, intermediate or deep types, fruits with elliptical, elongate elliptical, elongate tapered or elongate slim shapes and fruits with green, light green or dark green colour were noticed as polymorphic traits to distinguish the sponge gourd germplasm in to phenotypic classes. Analysis of variance during 2017 and 2018 revealed significant mean square due to genotype for all the quantitative characters under study. The characters studied were primary branches (PB), internode length (IL), petiole length (PL), days to appearance of first male flower (DAFMF), days to appearance of first female flower (DAFFF), internode number (IN), vine length (VL), node number to first female flower appearance (NNFFFA), days to first fruit harvest (DFFH), peduncle length (PDL), fruit length (FL), fruit diameter (FD), female flowers per plant (FFPP), fruits per plant (FPP), fruit weight (FW), male-female flower ratio (MFFR), seeds per fruit (SPF), marketable fruit yield per plant (MFYPP) and marketable fruit yield per hectare (MFYPH). Across the years, SGG29 and SGG30 gave the highest estimates of PB and FL, respectively while SGG30 had the highest FPP. SGG29, SGG26 and SGG32 had the highest FW while SGG29 and SGG26 had the lowest DFFH across the years. SGG29 gave the highest value of MFYPP while the genotypes *viz.*, SGG29, SGG30, SGG33 and SGG7 gave the highest MFYPH across the years. GCV was high for the characters namely,

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PB, IL, PDL, FL, FPP, SPF and MFYPP during 2017 while it was high in PB, PDL, FL, SPF and MFYPP during 2018. All the characters except VL in 2017 had high heritability ( $h^2$ ) coupled with high genetic advance as per cent of mean (GAM%). These traits indicate preponderance of additive genetic effects. Correlation studies revealed that MFYPP had highly significant positive correlation with PB, IN, FFPP, FPP and FW at both genotypic and phenotypic levels in both the years. MFYPP had significant to highly significant negative correlation with IL, DAFMF, DAFFF and DFFH at both genotypic and phenotypic levels. Path analysis studies showed that direct effects of FPP and FW on MFYPP were large at both genotypic and phenotypic levels. FFPP and IN had large and positive indirect effects on MFYPP via FPP in both the years at both genotypic and phenotypic levels. Among the nutritional traits analyzed from the marketable fruits of 2018, the highest protein content was observed in the genotypes *viz.*, SGG7, SGG12, SGG16, SGG15, SGG32 and SGG26. Both the ash as well as iron contents were the highest in SGG10, SGG22, SGG16, SGG27 and SGG12. Highest fat content was observed in five genotypes namely SGG32, SGG20, SGG30, SGG4 and SGG15. Two genotypes exhibited the highest amount of carbohydrates in the investigation and they were SGG7 and SGG29. The genotypes were constellated in to various clusters using unweighted neighbor-joining (UNJ) method based on Euclidean distances as dissimilarity measures for the quantitative characters. Each of cluster I and cluster II was divided into two sub-clusters while the cluster III contained only one and the same genotype during both 2017 and 2018. The cluster mean values suggest that superior performing genotypes of cluster I should be crossed to those of cluster II based on the data of 2017 and superior performing genotypes of cluster II should be crossed to those of cluster I as per data of 2018 to produce productive hybrids.



# **Quality planting material generation of tomato (*Solanum lycopersicum* L.) and cabbage (*Brassica oleracea* var. *capitata*) in greenhouse for higher production and productivity**

*Mainu Hazarika*

Quality seedling can ensure higher crop yield. The present investigation was carried out at the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat-13, Assam and at Farmer's Field (Karangakhat gaon, Dhekiajuli, Jorhat, Assam) during rabi season of 2018-19 and 2019-20 to assess the impact of different seedling growing media on growth, quality and vigour of tomato and cabbage seedling and subsequent performance in the main field. The treatments consisted of four different nursery media composition viz., M1: Cocopeat (60): Vermiculite (20): Perlite (20), M2: Cocopeat (50): vermicompost (50), M3: Cocopeat (50): vermicompost (50): Microbial consortium, M4: Conventional nursery (soil: sand: FYM), two Crops viz., C1: Tomato (Arka Rakshak), C2: Cabbage (Rare Ball) and two growing conditions viz., G1: Experimental Farm, Dept of Horticulture, AAU, Jorhat; G2: Farmer's field (Karangakhat gaon, Jorhat). Thus sixteen treatment combinations viz., M1C1G1, M1C1G2, M2C1G1, M2C1G2, M3C1G1, M3C1G2, M4C1G1, M4C1G2, M1C2G1, M1C2G2, M2C2G1, M2C2G2, M3C2G1, M3C2G2, M4C2G1 and M4C2G2 were laid in Randomized Block Design (RBD) with three replications. The effect of different seed sowing media on seedling quality and their performance in the main field was found to be significant. The results revealed that tomato seedlings raised in plug trays with seed sowing media coconut (50) : vermicompost (50) i.e. M2 recorded higher seedling emergence percentage (98.42), seedling height (15.47 cm), seedling vigour index (2268.54), dry matter accumulation (24.18%), total chlorophyll content (1.61 mg g<sup>-1</sup> fw), palisade ratio (1.27) and mesophyll layer thickness (82.88 µm). The same seedling raised media showed better performance in the main field of horticultural Experimental Farm, Dept of Horticulture, AAU, Jorhat and farmer's field, recorded less days to seedling establishment (4.29), higher leaf area index (5.45), leaf area duration at 45-60 DAT (75.24 days), chlorophyll content at 60 DAT (2.31 mg g<sup>-1</sup> fw), membrane stability

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index (70.71%), relative leaf water content (79.48%), root dry weight (15.95g), days to 50% flowering (31.71), number of fruits per plant (42.78), individual fruit weight (66.78g), yield per hectare (105.63 t) and less disease incidence viz., Bacterial wilt (1.11%) and tomato leaf curl virus (2.10%). 7 In case of cabbage seedlings raised in plug trays with seed sowing media coconut (50) : vermicompost (50) : microbial consortium i.e. M3 recorded higher seedling emergence percentage (92.67), stem diameter (3.12 mm), root length (12.01 cm), seedling vigour index (2358.43), seedling fresh weight (1.72 g), seedling dry weight (0.38 g), total chlorophyll content (0.99 mg g<sup>-1</sup> fw), palisade ratio (1.23) and mesophyll layer thickness (95.26 µm). The same seedling raised media showed better performance in the main field of Experimental Farm, Dept of Horticulture, AAU and farmer's field, recorded less days to seedling establishment (3.34), higher leaf area index (12.16), leaf area duration at 15-30 DAT (68.25 days), leaf area duration at 45-60 DAT (126.34 days), specific leaf weight (17.56 mg cm<sup>-2</sup>), membrane stability index (63.71%), root length (22.07 cm), less days required to head initiation (41.64) and harvesting (62 days), higher head weight (1.58 kg), head compactness (4.09) and head yield per hectare (77.42 t). Soil microbial analysis after harvest of crop recorded the higher microbial count (Bacteria and fungi), microbial biomass carbon and enzyme activities (dehydrogenase and phosphomonoesterase) where seedlings were raised in seed sowing media cocopeat (50) : vermicompost (50) : microbial consortium (M3). Computation of production economics resulted in the higher cost benefit ratio of 5.28 and 3.88 in tomato and cabbage in seed sowing media - cocopeat (50) : vermicompost (50) i.e. M2 and cocopeat (50) : vermicompost (50) : microbial consortium i.e. M3, respectively. From the present investigation it can be concluded that M2 [cocopeat (50) : vermicompost (50)] is the best seed sowing media for tomato and M3 [cocopeat (50) : vermicompost (50) : microbial consortium] is best for cabbage.

# **Influence of radish as cover crop and vegetable cropping system on crop productivity and soil health of sandy soil of Gossaigaon, Assam**

*Sanchita Brahma*

The present investigation entitled “*Influence of radish as cover crop and vegetable cropping system on crop productivity and soil health of sandy soil of Gossaigaon, Assam*” was carried out during *Rabi* season of 2017-18 and 2018-19 and *Summer* season of 2017-18 and 2018-19 at KrishiVigyan Kendra (KVK) farm of Kokrajhar district under Lower Brahmaputra Valley Zone (LBVZ) of Assam State. The soil of experimental site was sandy loam in texture with strongly acidic soil reaction, with low EC, CEC, high bulk density, particle density, low in organic carbon, low in available nitrogen medium in phosphorus and low in potassium. The treatment details were: cover crop (CC) ,followed by CS-I (okra followed by bitter gourd), CS-II (chilli followed by dolichos bean) and cropping system-III (cowpea followed by amaranthus). The experiment was laid out in randomized block design (RBD). Forage radish CC was sown during 10th October, 2017-18 and 15th October, 2018-19 with seven replications, 100 % CC (30cm x 30cm), 75% CC (45cm x 30cm) and 50 % CC at 60cm x 30cm, respectively. At young, decomposable harvesting maturity (60DAS), the CC was incorporated in the soil manually in all the plots. After one month of CC incorporation vegetable crops viz., Orka, chilli and cowpea were sown/transplanted during January, 2018 & 2019 with five replications. Vegetable crop biomasses were also incorporated in soil after harvest and followed by the second vegetable crops viz., bitter gourd, dolichos bean and amaranthus, respectively in respective vegetable sequence(s). The influence of cover crop and crop biomasses on soil chemical and physical parameters were studied at different sampling depths for both years. Soil chemical and physical parameters after incorporation of forage radish cover crop recorded significant improvements over control. Most of the growth parameters, yield attributes and yield of vegetable crops, soil chemical parameters (EC, CEC, available NPK, organic carbon, organic matter and C/N ratio), soil physical attributes viz., WHC, total porosity and reduction in bulk density, particle density of soil after harvest and incorporation of crop biomasses were

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maximum under cent per cent surface cover (T1) during both the year of experimentation. Significantly, the highest okra yield (17.11 and 18.86 q/ha), chilli yield (31.32 and 32.19 t/ha), cowpea yield (27.59 and 28.92t/ha), bitter gourd yield (18.31 and 19.00 t/ha), dolichos bean yield (18.64 and 19.00 t/ha) and amaranthus yield (25.21 and 26.23t/ha ) were obtained with the application of 100 % cover crop (T1) followed by 75 % per cent cover crop (T2) over the control(T0) without surface cover. Among the different levels of cover crop, cent per cent cover crop (T1) resulted in significant EC, CEC, organic carbon (%), organic matter (%), soil available NPK, C/N ratio after crop harvest. Similarly the soil physical parameters also showed improvements in cent per cent cover crop treatment which recorded the highest WHC (%), total porosity (%) lowest bulk density (gmcm-3) and particle density (gmcm-3) over other cover crop treatment as well as control after crop harvest in all the vegetable cropping system. Among the vegetable cropping system, the highest net return (Rs. 7,56,195/ha) with benefit : cost ratio (6.39) were recorded by CS-II (chilli followed by dolichos bean) under 100 % cover crop (T1) followed by the same cropping system under 75 % surface cover (T2) with net returns (Rs. 6,14,595/ha) with B:C ratio (5.38). On the basis of experimental results, it can be concluded that for getting higher returns and improvement of soil health, vegetable crops *viz.*, chilli (spring-summer) followed by dolichos bean (summer) can be grown after cent per cent surface cover with radish cover crop in sequence for sustainable vegetable production in sandy soil of Gossaigaon, under Lower Brahmaputra Valley Zone of Assam.

# **Characterization of *Rhynchosyilis retusa* (L) genotypes of Assam and their growth and flowering behaviour under different shade conditions**

*Sanjib Sharma*

Investigation on “Characterization of *Rhynchosyilis retusa* (L) genotypes of Assam and their growth and flowering behaviour under different shade conditions” has been carried out in the experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during the period 2017-2018. Two sets of field experiments were laid out in Completely Randomised Design (CRD) with six treatments each. In one experiment, the treatments were the six different agro-climatic zones of Assam from where the genotypes were collected and in the second experiments the six growing conditions were created with different shade per cent and cladding materials. (T1: Bamboo frame structure covered with a 35% shade net as a roof and on all sides; T2: Same as T1 with a 50% shade net; T3: Same as T1 with a 75% shade net; T4: Bamboo frame structure with a 200 micron UV stabilized polyethylene as a roof with 35% shade net on all sides with a ceiling; T5: Same as T4 with 50% shade net on all sides with a ceiling; T6: Same as T4 with 75% shade net on all sides with a ceiling). The genotypes from Upper Brahmaputra Valley zone exhibited maximum for growth and flower characters, viz., plant height (34.61 cm), Length of leaf (31.46 cm), breadth of leaf (3.10 cm), number of spikes (2.21), number of florets per inflorescence (73.47), self-life (14 days) followed by North Bank Plain zone. The estimates of genotypic and phenotypic coefficient of variation for the characters revealed that the estimates were generally low for the characters. It was also observed that most of the characters exhibited low to moderate heritability ( $h^2$  b.s). Correlation studies revealed that the spike length exhibited positive and significant correlation with florets numbers, days to bud visibility and days to full bloom. Florets number showed positive and significant correlation with days to bud visibility, days to full bloom and self-life of the inflorescence. The molecular studies were carried out by following PCR based Random Amplification of DNA Polymorphism (PCR-RAPD) with 13 numbers OPA and OPD markers and six inter simple sequence repeat (ISSR) markers. The present study

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revealed 92.31% of RAPD markers were polymorphic whereas only 66.67% of ISSR markers were found polymorphic. The DNA analysis and genetic similarity coefficient revealed that the genotypes have a high similarity of DNA character. T7 and T8 share maximum similarity of 0.9166 while T12 and T13 share a similarity which ranges between 0.5 to 0.6 with other variables. The results of the growing condition revealed that growth and flowering were significantly influenced by different shade conditions. Among the treatments, T2 was found to be the best in respect of growth parameters viz., plant height (38.16 cm), numbers of leaves (7.95), Leaf length (34.16 cm), leaf breadth (3.58 cm) and leaf area (806.94 cm<sup>2</sup>). T2, also resulted better flower parameters viz., spike length (36.90 cm), number of spike (2.68), number of florets (76.30), flower across (2.35 cm), lip size (1.27 cm), spike length (15.45 days), vase life (10.65 days), fresh weight of the inflorescence at harvest (17.85 gm), fresh weight of the inflorescence at senescence (4.23 gm), dry weight of the inflorescence at harvest (2.50 gm), except days taken from flower bud visibility to first floret opening and blooming where T4 took minimum number of days. Maximum total chlorophyll content was also recorded by T2 (0.43 mg per g of FW). Growing conditions with polyethylene as roofing material recorded early initiation of flower bud but the longest flowering period was recorded by T2. On the basis of the morphology and molecular studies, it may be summarized that the genotypes have a broad similar history of evolution of the species resulting in inherently lower variation, even though growth and flower characters like length of leaf, plant height and flower across showing moderates genetic advance provide scope for genetic improvement. Based on the results of different shade conditions, T2 (Bamboo frame structure covered with a 50% shade net as a roof and on all sides) may be considered as the best for growing *Rhynchosyilis retusa* (L) commercially. The outcome of this study could be considered as a basic work for future line of research with further improving the structure of the green house by incorporating the provision of natural ventilations and nutrient management aspects may provide even better results.

## Vertical Farming through Hydroponics

*Subhankar Saha*

An experiment was carried out in a naturally ventilated polyhouse located in Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during the year 2017-19 with a view to standardize the nutrient solution and structure most suitable for Vertical Farming of flower and vegetable crops through Hydroponics in NFT System. The experimental structure was set up using PVC pipes and 0.5 HP water pump for nutrient circulation. Two crops each of flower and vegetable were selected for rabi and kharif season. The crops were subjected to four nutrient solutions viz. So 1 , So 2 , So 3 and So 4 in three different structures viz. S 1 , S 2 and S 3 to study their effect. The experiment was laid out in a factorial completely randomised block design with three replications and data of individual years were subjected to pooled analysis. The highest mean of plant height of 37.79 cm was recorded in So 4 and 33.79 cm in S 1 for chrysanthemum. This had been reflected in their interaction So 4 ×S 1 which recorded the highest among all the plant and flower characters with 6.86 number of flowers. It also recorded the longest vase life (16.75 days) and the longest duration of bloom (26.29 days). The results also revealed the highest chlorophyll content and Membrane Stability Index of 3.44 mg g<sup>-1</sup> FW and 77.44% respectively for So 4 ×S 1. The mean performance of growth and yield characters of lettuce revealed that the treatment So 4 ×S 1 significantly produced the highest plant spread (30.78cm), root length (30.75cm), root volume (45.47 cc) and leaf yield (108.46 g). The plant analysis further revealed 0.47 mg g<sup>-1</sup> FW chlorophyll content and 2.75 o Brix TSS in plant which were higher compared to other treatments. In summer marigold, the results revealed that the nutrient solution So 4 and structure S 1 had significant effect on growth, flower and flower attributing characters. Nutrient solution So 4 and structure S 1 recorded the highest for plant height (60.26cm), plant spread (37.21cm), root length (44.86cm) and root volume (116.52cm). Similarly, for flower characters the days to full bloom of 59.58 days was lowest and the flower diameter of 4.93cm was highest in treatment So 4 ×S 1 . Flower yield (233.79g) per plant and duration of flowering (52.80 days) was highest for So 4 ×S 1. Various growth characters of cucumber viz., vine length and number of leaves have been found to be significantly different for different treatments. The longest vine (218.32cm) and highest number of leaves (40.76) were

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produced by So 4 ×S 1. Among the yield characters, So 4 ×S 1 produced maximum number of fruits (8.13) and the highest yield per plant (1861.91 g). The maximum leaf chlorophyll content (1.10mg g<sup>-1</sup>) FW was observed for So 4 ×S 1 treatment. It may be inferred from the result of the present investigation, that nutrient solution So 4 (N: 300 ppm, P:60 ppm, K:400 ppm, Ca:200 ppm, Mg:43 ppm, S:68 ppm, Fe: 2.9 ppm, Cu:0.1 ppm, Zn: 0.1 ppm, Mn: 2.0 ppm, B:0.7 ppm and Mo:0.1 ppm) and structure S 1 (A-Type) can be considered for recommendation for vertical farming through hydroponics.



# **Isolation, characterization and evaluation of endophytic bacteria against root-knot nematodes**

*Binita Basumatary*

Fifteen endophytic bacteria were isolated from leaves and stems of *Solanum lycopersicum* and *S. pimpinellifolium*. Morphological characterization of these endophytes revealed that 6 bacteria were gram positive and 9 bacteria were gram negative, 10 bacteria were rod shaped, 3 were coccus shaped and 2 were diplococcus in shape. All 15 bacteria were motile in nature. Biochemical characterization of the isolated endophytes revealed that 9 bacteria showed positive reaction to KOH test while, 6 were negative to KOH test, 11 bacteria showed positive reaction to Citrate and 4 were negative to citrate test. All the 15 bacteria were positive for Gelatine hydrolysis and Catalase test. Six endophytic bacteria showed positive reaction and 9 showed negative reactions for Starch hydrolysis test. Four potential isolates were structurally analysed by using scanning electron microscope and revealed that the length and breadth of BETLI, BETL2, BETL4 and BETS2 were 701.70nm × 348.30nm, 954.10 nm x 303.10 nm, 984.10nm × 332.90nm and 1422.00nm × 742.00 nm, respectively. Five endophytic bacteria showing potentiality against root-knot nematode were identified by using 16S rRNA, and they were *Microbacterium arborescens* (BETLI), *Bacillus marisflavi* (BETL2), *Bacillus altitudinis* (BETL4), *Exigobacterium indicum* (BETS2) and *Bacillus marisflavi* (BETL6). Study on in vitro efficacy of bacterial endophytes against second stage juvenile of root-knot nematode (J2) revealed that all the isolates had the potentiality to significantly increase the mortality of nematodes however, the isolate BETL2 showed the best result on mortality rate (81.47%) of 2 stage juvenile (J2) of *Meloidogyne incognita*, followed by isolates BETL4 (81.43%) and BETLI (79.07%) Dose-response models were used to determine the concentration of bacterial culture filtrates required to kill 50 per cent juveniles of *M. incognita*. Four potential bacterial endophytes were tested with different methods of applications (seed treatment, seedling root dip treatment, soil application and their combinations) in pot condition against root-knot nematodes in tomato. All the tested endophytic bacteria significantly increased the plant growth parameters of tomato and reduced the nematode multiplication than untreated control. However, maximum increase in plant growth parameters and decrease in number of galls, egg mass and nematode population in soil was observed in combined application of seed treatment + root dip treatment + soil treatment of *Bacillus marisflavi* (BETL2) @ 1x 10<sup>10</sup> cfu/ml of crop.

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**Abstract of Ph.D. thesis**

**Department: Nematology**

**Major Adviser: Dr. Debanand Das**

## **Studies on introgression of drought tolerant QTLs in a short duration rice variety through MAS**

*Amrit Tamuly*

Rice is one of the important staple cereals which are consumed as a main part of diet by more than half of world's population. Rice production in India accounts to more than 40% of country's grain production. Rice is a major crop of Assam and it plays a major role in state's economy. A panel of 50 upland diverse rice cultivars collected from different parts of India were genotyped using SSR markers distributed across the 12 chromosomes in rice. The phenotyping using various yield traits were performed in rainout shelter as well as in open field conditions. A significant variation among the genotypes for all the characters under drought stress as well as in irrigated conditions study was obtained indicating the existence of considerable amount of variability among the genotypes selected for study. Grain yield is the most important character for selection under drought stress condition. Mannitol treatment may be an effective tool for selecting genotypes in drought stress. High heritability coupled with high genetic advance over mean was observed for days to 50% flowering, plant height, grain yield and days to maturity in both drought stress and irrigated conditions. Therefore, selection based on these characters may be effective for the improvement of drought tolerance. The log likelihood revealed by Structure showed the optimum subpopulations (K) value as 2 (K= 2), which indicated that the entire population can be grouped into two subgroups. The results clearly indicated that two subgroups were formed due to the different adaptation behaviour of cultivars to drought stress and yield attributes under drought. A total of forty-three cultivars were grouped in cluster I however, remaining seven cultivars were grouped in cluster II. The assessment of genetic diversity among the cultivars is pre requisite for any successful breeding programme. Kolong was selected as a recipient parent and it was crossed with a donor parent IR-64drought during *Rabi* 2016. Three SSR markers namely RM3825 (*qDTY1.1*), RM279 (*qDTY2.2*) and RM518 (*qDTY4.1*) exhibited polymorphism between the parents and these polymorphic markers were used for foreground selection during BC2F2 and BC2F4. Out of 300 SSR marker screened across the parental cultivars (Kolong and IR-64 drought), only 86 (28.66%) SSR markers revealed distinct polymorphism and 214 SSR

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markers (71.33%) were found monomorphic. Eighty six polymorphic SSR markers were used for analyzing background recovery of recurrent parent genome in two best performing BC<sub>2</sub>F<sub>4</sub> lines. The two BC<sub>2</sub>F<sub>4</sub> lines (7 and 8) were selected based on the superior phenotypic performance of cultivars under drought stress 7 conditions and analysed for background genome recovery. It was found that the line number 7 has got 83.07 percent background recovery of recurrent parent genome. Whereas, line number 8 has got only 78.48 percent background recovery of recurrent parent genome. The sixteen advance back cross population raised from the cross between 'Kolong' and 'IR-64 drought' were phenotyped along with the parents under drought stress conditions in rain out shelter and control conditions in the field at RARS, Titabar. Kolong was found to be lower in grain yield per plant as compared to the advanced generation lines. The grain yield per plant for Kolong (2.07 Kg/ha) and IR-64drought (4.07 Kg/ha) under drought stress condition. Kolong x IR-64drought-8 and Kolong x IR-64 drought-11 had 4.13Kg/ha which was 99.05% increases in grain yield per plant as compared to the parent 'Kolong' under drought condition. The duration of the drought introgressed lines *i.e.*, Kolong x IR-64 drought-7 is 100 days and Kolong x IR-64 drought-8 is 106 days which is similar to that of recurrent parent Kolong. Therefore, these drought tolerant lines may be suitable for cultivation during *Ahu* season.

# **Genetic analysis of adaptive traits and assessment of seed quality in response to high temperature in a diallel cross and molecular diversity in popular varieties of rapeseed (*Brassica rapa* L.)**

*Aradhana Phukan*

High temperature tolerance is assuming importance in breeding rapeseed-mustard. In the present investigation, an attempt was made to study genetic variation for traits related to yield, adaptation and seed quality in response to high temperature, to identify traits related to high temperature tolerance and intra and inter-population diversity in rapeseed varieties. Populations of diallel crosses involving three yellow sarson and two toria varieties were developed and screened for high temperature during flowering to pod formation stage. The diallel populations were exposed to high temperature in temperature gradient tunnel at Assam Agricultural University, Jorhat and at National Phytotron Facility, IARI, New Delhi and also grown in late sown field conditions which generally experience high temperature terminal stress. Significant variation was observed for almost all the characters in stress and non-stress conditions. Significant variation for GCA and SCA effects was observed. In stress, Jeuti showed desirable characters such as early maturity, cooler leaf temperature, high chlorophyll stability index, siliquae on main shoot, less flower drop, high siliqua density, seeds per siliqua, thousand seed weight and TS46 showed high mean performance for all these yield attributing characters in addition to heat tolerance. YSH401 showed good combining ability for heat tolerance. Crosses B9 x Jeuti, YSH401 x TS46, NRCYS05-03 x Jeuti and NRCYS05-03 x TS46 were found promising for high temperature adaptability traits. Under stress main shoot length was positively correlated with flowers on main shoot and siliquae on main shoot and seed yield per plant. Parents and the yellow sarson x yellow sarson and yellow sarson x toria crosses showed high germination percentage and seed vigour index after nine months of ambient storage of the seeds harvested from high temperature stressed plants. Under phytotron facility B9 x Jeuti, B9 x TS46, YSH401 x Jeuti and NRCYS05-03 x Jeuti were promising for yield attributes. In field experiments, Jeuti, B9 x NRCYS05-03, B9 x YSH401, B9 x Jeuti,

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NRCYS05-03 x Jeuti, YSH401 x Jeuti and YSH401 x NRCYS05-03 were found promising for seed yield and its attributes. Main shoot length, siliquae on main shoot, seeds per siliqua, percent flower drop, siliqua density and biological yield per plant showed high or moderate heritability with high genetic advance. SSR markers were used to study population diversity in six toria varieties. Diversity analysis of genomic DNA showed high intra-population variation in all the varieties. M27 and TS36 were found more diverse than the others. TS36, TS38 and Jeuti formed distinct clusters whereas M27, TS46 and TS67 could not be clearly distinguished.

# **Morphological, Biochemical and Molecular Characterization of Aromatic Joha Rice of Assam and Mutation Induction for Improvement of Morpho-Agronomic Traits**

*Dibosh Bordoloi*

The investigation on "Morphological, biochemical and molecular characterization of aromatic *Joha* rice of Assam and mutation induction for morpho-agronomic traits through M1 to M3" was carried out with 20 indigenous *Joha* rice cultivars. The cultivars' morpho-metric evaluation followed a randomized complete block design with three replications during *Sali*, 2018 and 2019. The radio-sensitivity study standardized the electron beam, X-rays and gamma-rays for the cultivars based on germination/seedling growth. Dry uniform seeds of *Kon Joha-Moran* were exposed to 100-400 Gy of gamma-rays from a 60Co source. The M1 generation used a randomized complete block design with four replications during *Sali* 2017. In M2 generation, 5998 M1 plant progenies were evaluated during *Sali* 2018. In M3 generation, 662 morpho-agronomic variants identified in the M2 generation were raised in plant rows during *Sali* 2019, and 66 mutants were confirmed. The seedling traits registered a decreasing trend towards increasing the mutagen doses in all the cultivars, showing differential radio-sensitivities. The LD50 values ranged from 515 to 615 Gy for electron beam and 421 to 537 Gy for X-rays and 414 to 481 Gy for gamma-rays. The GR50 values ranged from 138 to 315 Gy for the electron beam, 192 to 322 Gy for X-rays, and 185 to 291 Gy for gamma-rays. DUS characterization of the cultivars revealed polymorphism in thirty-seven traits. Thus, the phenotypic characterization of the aromatic cultivars established distinctiveness for their utilization in breeding programmes. UNJ clustering based on usual Euclidean distances for the polymorphic traits grouped the cultivars into three multi-genotypic clusters. The *Joha* rice cultivars showed highly significant differences for all the quantitative traits except for panicle length. The GCV and PCV estimates were high for grain yield per ha (24.62 & 24.85%) and filled grains per panicle (23.69 & 25.02%). All the traits except days to flowering and maturity, flag leaf breadth and spikelet fertility exhibited high heritability along with high to moderate genetic advance,

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indicating the most likely role of additive gene action. Mahalanobis  $D_2$  analysis revealed three multi-genotypic and four mono-genotypic clusters of the cultivars. The contribution towards the total variation was the maximum for flag leaf length (72.11%) followed by rice length (13.68%) and grain length (6.84%). The inter-cluster  $D_2$  value was the maximum between clusters IV and VI (7303.31) and hybridization would likely produce a broad spectrum of variability and transgressive segregations with high heterotic effects. The cultivars' average polyunsaturated fatty acids were 37.9% oleic acid, 39.22% linoleic acid and 0.5% linolenic acid. The fatty acid profile of *Local Joha* was better than the other cultivars as it showed a high level of linoleic and linolenic acid and low saturated fatty acid content. Thus, the *Joha* rice cultivars' fatty acid profile qualified for extraction of quality bran oil for consumption. *Kon Joha 4* and *Ronga Joha* contained the highest iron (82.88 mg kg<sup>-1</sup>) and zinc (47.39 mg kg<sup>-1</sup>), respectively while protein content of *Kon Joha-1* and amylose content of *Harinarayan* were the highest. *Joha-Bihpuria* showed the highest gel consistency of 140.50 mm. A strong aroma characterized the cultivars viz., *Kalijeera*, *Kunkuni Joha*, *Kon Joha-5*, *Manimuni Joha* and *Kon Joha 2*. The cultivar *Soru Joha-Tinsukia* with the highest yield (3012 kg ha<sup>-1</sup>), high spikelet fertility (90.9%) and Fe (61.09 mg kg<sup>-1</sup>) is a worth recommendation in Assam. PCR amplified 174 alleles with a mean value of 2.64 across the 66 polymorphic SSR markers. PIC values ranged from 0.091 to 0.698, with an average of 0.326. The highly informative (PIC>0.50) markers were RM316, RM283, RM585, RM1388, RM3562, RM171, R1M30, RM118, RM11 and RM29 for identification of the twenty aromatic rice cultivars. The UNJ clustering-based on Jaccard's coefficients classified the 20 cultivars into three significant clusters with eight, ten and two entries. The M1 of *Kon Joha* registered a reduction in germination, seedling height, pollen/spikelet fertility and plant survival at 400 Gy. All the traits showed highly significant differences among the doses in M2 generation. The shift in trait means was in both directions as influenced by the genotype and mutagen dose. The 66 mutants exhibited significant differences for all the traits in M3 generation. Fifty mutants were shorter than the parent *Kon Joha*. The GCV and PCV estimates were high (>20%) for grain yield, biological yield, productive tillers, filled grains, and average panicle weight. All the traits except panicle length exhibited high heritability coupled with high genetic advance, suggesting the predominance of additive gene action and the effectiveness of simple selection. Grain yield showed a significant positive correlation with plant height, panicle length, filled grains, spikelet fertility, the average panicle weight and harvest index in the mutant population. Thus, mutation induction in *Kon Joha* proved useful in inducing desirable changes in plant architectural traits. The study further emphasized the short stature high yielding mutants with strong aroma for wide-scale testing in the state.

# **Genetic characterization and relatedness assessment of maize landraces of North-east India**

*Hiramani Barman*

The present investigation was conducted to study genetic variation and diversity for local maize germplasms, quality analysis, and inbreeding tolerance. The experiment was conducted in the ICR Farm, Assam Agricultural University, Jorhat, during the *rabi* season of 2018-19 and 2019-20. Forty germplasms were evaluated in Augmented Randomized Complete Block Design with four blocks with spacing 60 x 20 cm. Analysis of variance revealed that the entries differed significantly for all the characters except ear leaf width and leaf width. Germplasm namely, ARR1, ASTSY, ASSV2, ASKAR and ASDJ were recorded high grain yield per plant. Moderate to high estimates of GCV and PCV were recorded for all the traits except days to 75% dryhusk, days to maturity and moisture content. Moderate to high estimates of heritability ( $h^2$ ) and genetic advance percent of mean Gs (%) for all the traits. High estimates of  $h^2$  with high to moderate Gs (%) were observed for all the traits indicating the preponderant role of additive gene action for their inheritance. Grain yield per plant had positive and highly significant correlations with traits namely ear length, ear diameter, kernel rows per ear, kernels per row, kernel length, kernel width and 100 kernel weights. Path analysis revealed that the highest positive direct effects were observed in days to 50% silk followed by 100KW while the highest negative direct effect was observed in days to 50% PS. Morphological diversity studies revealed that genotypes of cluster A showed earliness along with higher values of ear traits, leaf traits, and grain yield while the genotypes of cluster B exhibited the desirable trait short plant. Hence, the genotypes belonging to cluster A and cluster B could be useful in developing early, short and high yielding varieties. Based on phenotypic mean data, maximum dissimilarity was observed between ASKAY and MNY followed by NLY1 and MNY while minimum dissimilarity was recorded between ARY1 and ARW2. The molecular analysis of variance revealed that there was a highly significant variation in all sources. The maximum variance (52%) was due to the variation among the population. The variation within individuals was very low (3%), while among individuals variation was (45%). As a result, umc2322, identified on chromosome 6, showed the maximum number of alleles

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(7) as well as the highest PIC value of 0.80. F-statistics revealed that moderate to high  $F_{st}$  values with a range of 0.324 to 0.700 indicated variable genetic differentiation among the populations. The germplasms MZW1 and NLB2 with the maximum Nei's genetic distance were found to be the most dissimilar indicating a high degree of genetic diversity in these two genotypes. The biochemical study indicated that ARR1 exhibited high carbohydrate content, crude protein, and zinc content. The entries namely, ARW1, ARY5, ARR1 and ASKAW1 which showed the minimum level of ID from studies on inbreeding depression, can be used as components for developing high yielding and inbreeding tolerant composite variety in future.

# **Genetic Diversity and combining Ability Studies in Pumpkin (*Cucurbita moschata* L.) Landrace of Assam**

*Khirud Panging*

Thirty diverse landrace of pumpkin comprising from eight districts of Assam viz., four from each district of Sivasager, Dibrugarh, Karbi Anglong, Haflong, Jorhat & Majuli and three from each of Lakhimpur and Kokrajhar. With three objectives, the landraces were subjected to analyses of variance and covariance for estimation of genetic variability parameters, correlation coefficients and causal relationship among the 27 characters. The experiment was carried out at ICR Farm of Assam Agricultural University in a Randomized Block Design with three replications. From analysis of variance it was recorded presence of variation among thirty pumpkin landrace for all characters. The highest coefficient of variation (CV%) was for yield per plant (28.78%), indicating environmental effects for these characters. The highest genotypic coefficient of variability (GCV) was recorded for single fruit weight (51.47%) followed by yield per plant (43.58%) and female: male flower ratio (37.71%). The heritability in broad sense was recorded highest for the hundred seed weight. The GA calculated as per cent of mean was recorded for single fruit weight (99.44%), followed by yield per plant. In character association five traits were positively correlated with fruit yield per plant out of 27 yield correlations genotypic level. Among the characters, single fruit weight exhibited the highest positive direct effect (1.284) on the fruit yield per plant followed by fruits per plant and number of female flower. The highest positive indirect effect was recorded for number of female flower on fruit yield per plant *via* fruit per plant (0.693). The highest negative indirect effect was recorded for fruit per plant on fruit yield per plant *via* single fruit weight (-0.623). Residual effect was found to be 0.0023. From the Tocher's cluster divided into five group of cluster. The cluster I was composited highest (13) number of landraces. The highest intra-cluster distance was recorded for cluster V. Based on the performance of per cent of contribution towards diversity character ascorbic acid was shoed maximum (67.59%). Following the DUS guidelines 9 qualitative characters were observed, resulted three major clusters for all landraces. For nine qualitative characters, out of 30 landraces 11 were showed angular type and rests

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were in circular stem shaped type. Regarding the fruit skin colour pattern, uniform type were dominant with 20 landraces (66.67%), only two landraces *Dibrugarh-2* and *Majuli-4* were recorded striped fruit skin colour pattern and remaining landraces observed mottled type. In regards to leaf blade margin 14 landraces were found to very weakly incised margin, 7 landraces for moderately incised margin and rest landraces had weakly incised leaf margin type. The dendrogram revealed the existence of 3 major clusters in 30 pumpkin landraces. The cluster A comprised of 8 landraces, cluster B comprised of 12 landraces and cluster C comprised of 10 landraces. The molecular studies revealed out of 40 SSR primer only 14 primers were showed polymorphic. Within the 14 polymorphic primers, the primer CMTp19 was recorded lowest polymorphism. From the development of diversity tree the 30 landraces were divided into 3 major groups. For combining ability studies selection of 8 parents were taken from 30 landraces on the diversity and consumer preferred typed fruit. The mating design was followed by Line X Tester. 6 Lines and 2 Tester were crossed in 2018-19 *Rabi* season in ICR farm, AAU and the hybrids were studied in next season along with the parents. Analysis of variance revealed the presence of great genetic diversity among the parental lines used in the study. The estimates of *gca* for lines and *sca* for hybrids represent that the line *Dibrugarh-4*, *Haflong-4*, *Majuli-4* and tester *Haflong-1* were best general combiner for most of the traits where as the hybrids *Majuli-4 X Haflong-1*, *Dibrugarh-1 X Haflong-1*, *Majuli-2 X Haflong-1*, *Dibrugarh-1 X Karbi Anglong-1*, *Majuli-4 X Haflong-1* were the best specific combiner for yield and yield contributing characters. The variance due to *sca* was higher than *gca* for most of the character indicating presence of no additive gene action which can be utilized for the development of hybrids. The hybrids of *Haflong-4 X Haflong-1*, *Karbi Anglong-2 X Haflong-1*, *Dibrugarh-4 X Haflong-1*, *Dibrugarh-1 X Karbi Anglong-1* and *Majuli-4 X Haflong-1* showed maximum heterosis for yield and yield attributing characters over mid and better parent. The hybrid M-4 x H-1 (127.88 per cent) exhibited the maximum positive average heterosis for single fruit weight followed by hybrid M-4 x KA-1 (89.88 per cent) whereas the highly significant negative minimum average heterosis was recorded for the hybrid D-1 x KA-1 (-54.28 per cent). The hybrids M-4 x KA-1 and M-4 x H-1 can be well exploited through heterosis breeding to obtain higher yield. Heterobeltiosis for yield per plant ranged from -59.38 per cent (H-4 x KA-1) to 171.56 per cent (M-4 x H-1). Hybrid H-4 x KA-1 can be exploited for early maturity of the fruit. H-4 x H-1 can be useful for the exploited through heterosis breeding to obtain good fruit quality. The outstanding hybrids may utilize for commercialization.

## **Characterization of Deepwater rice of Assam for agro-morphological and biochemical traits**

*S. Yasmin Das*

Deep water rice is one of the world's most fascinating as well as challenging climate resilient crop which has elongation, kneeing and nodal tillering ability. They are rich in vital micronutrient like Fe and Zn content, have anti-oxidant property but low yielder about 1.0 to 1.5 tonnes per ha which is mainly due to its plant types, stresses encountered during growth period, low genetic potential and lack of effective breeding techniques. Hence, a study on the morphological, biochemical and biotechnological traits was done to characterize, to understand the extent of diversity and for identification of valuable traits and promising genotypes required for deepwater rice improvement. The experiment was conducted under direct seeded and transplanted conditions during 2017-18 and 25 selected genotypes from both the environment were transplanted during 2018-19. Morphological characterization consisted of 46 qualitative and 16 quantitative traits which consists of 13 monomorphic, 14 dimorphic, 11 trimorphic and 24 polymorphic traits indicating their potential for varietal characterization and distinctiveness. Kneeing ability was observed in 90 genotypes and elongation ability ranged from 3.15 cm to 132.75 cm. Maximum genotypes exhibited procumbent nature, presence of secondary branching, well exerted panicle, phenol reaction of lemma, white stigma colour, short grain length, medium amylose content and chalkiness, high gelatinization temperature, long stem length, medium test weight, red kernel colour, broad grain width and medium grain shape. Though maximum genotypes have semi-erect culm attitude but are lodging susceptible at maturity. The quantitative traits revealed significant difference under both the conditions and for 25 selected genotypes. The mean for the biochemical traits viz., protein content (7.99 %), starch content (71.38 %), amylose content (21.27 %), amylopectin (78.73%), Fe content (16.79 mg kg<sup>-1</sup>) and Zn content (23.19 mg kg<sup>-1</sup>) showed rich nutritional status of DWR which may serve as donor for future quality breeding programs. High magnitude of both GCV and PCV was recorded for elongation ability, leaf breadth and EBT per hill under direct seeded condition whereas culm diameter, EBT per hill and KL:KB showed under transplanted condition. High heritability coupled with high estimate of genetic advance

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as percent of mean was recorded for EBT per hill, leaf length, leaf breadth, GL:GB, kernel breadth, KL:KB, culm diameter and for yield per plant under both direct seeded and transplanted condition. Protein, iron and zinc content also showed high heritability coupled with high estimate of genetic advance as percent of mean. Study of correlation coefficients revealed that yield per plant is positively correlated with EBT per hill, leaf length, leaf breadth, panicle length, grains per panicle, 100-grain weight, culm diameter, kernel breadth, protein content, number of filled grain per panicle and harvest index which indicated the importance of these traits in DWR improvement, moreover, zinc content showed positive correlation with iron content. EBT per hill, leaf length, leaf breadth, grains per panicle, 100-grain weight, kernel length, culm diameter and protein content had positive direct effect and significant positive correlation with yield per plant, indicating the true relationship among these traits. D2 analysis grouped 115 germplasms into 14, 5 and 19 clusters under direct seeded, transplanted and for physico-chemical traits respectively. The maximum inter-cluster distance was observed between cluster XI and XIII, cluster II and VI, and cluster XVI and XVIII while highest intra-cluster distance in cluster VIII, Cluster III and cluster XIII under direct seeded, transplanted and for physico- chemical traits respectively. Under both the conditions, days to 50 per cent flowering, 100-grain weight and grain breadth were found the contributor of genetic divergence which prove their importance in DWR breeding programme while Zn and Fe content contributed highest towards genetic divergence for physico- chemical traits. Three markers Sub1BC2, RM 316 and RM 8300 were found to be highly scorable and informative among the thirteen markers used for screening of DWR for submergence tolerance. Three genotypes viz., Badam Bao, Betu Bao-1 and Happy Bao showed the similar banding pattern as to Ranjit-Sub1 on compiling the result of these three markers which showed that these lines are may be the haplotypes of Sub1 QTL which must be validated by sequencing of Sub1 QTL.

## **Taxonomic characterization of bacterial pathogens associated with vegetable crops of Assam**

*Joli Dutta*

Bacterial taxonomy helps bacteriologists to make predictions of disease occurrence and to frame management strategies for controlling the disease causing agents. Diseased samples of vegetable crops were collected from different locations of Assam viz., Golaghat, Nagaon, Darrang, Dibrugarh, Tinsukia, Jorhat and Kamrup Metropolitan and isolated. After conducting the pathogenicity tests, 24 bacterial isolates were proven pathogenic to their respective hosts and designated as Cabbage (J1), Ginger (J2), Carrot (J3), Citrus (J4), Onion (J5), Potato (J6), Tomato (J7), Common bean (J8), Sweet Potato (J9), King chilli (J10), Cabbage (J11), Colocasia (J12), Tomato (J13), Cucumber (J14), Okra (J15), Brinjal (J16), Common bean (J17), Pea (J18), Potato (J19), Dolichos bean (J20), Coriander (J21), Brinjal (J22), King chilli (J23) and Ridge gourd (J24). On the basis of cultural, morphological, biochemical and molecular characterization, nine bacterial isolates were identified as *Pectobacterium carotovorum*; four isolates as *Ralstonia solanacearum*; five isolates as *Xanthomonas* sp.; four isolates as *Pseudomonas* sp. and two isolates as *Clavibacter michiganensis* subsp. *michiganensis*. The isolated bacteria collected from different regions were grouped in different clusters showing different genetic relationship among the isolates through RAPD markers. Comparative biochemical based detection sheet was prepared among the bacterial pathogens which revealed the isolated bacteria collected from different regions were identified in different clusters showing the biochemical variations among the isolates. Five specific primer sets were designed for detecting five different pathogens viz., *Pectobacterium* spp., *Ralstonia* sp., *Xanthomonas* spp., *Pseudomonas* spp. and *Clavibacter* sp. All the primer sets were proved to be specific within the specific genus. An identification kit was developed based on comparative symptomatology, biochemical and molecular characterization. This kit will be helpful for identification of the bacterial plant pathogens.

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## **Bioprospecting actinobacteria of Assam for some rice disease management and growth promotion**

*Nripen Kumar Gogoi*

Actinobacteria, an important group of Gram positive bacteria are potent producers of wide variety of secondary metabolites with diverse biological activities including biocontrol and plant growth promotion abilities. The members of the genus *Streptomyces* are especially prolific as they alone constitute 50% of the total soil actinobacteria and 18% of all biologically active secondary metabolites (nearly 7600 out of 43,000) known so far. The present investigation was undertaken to explore potent actinobacterial strains to contain two major rice diseases viz. sheath blight (ShB) and bacterial leaf blight (BLB). Total seventy five isolates of actinobacteria were isolated and their morphological, biochemical and molecular characterization were carried out. Among twelve antagonistic actinobacterial isolates observed *in vitro*, isolate 'Act 116' and 'Act 119' recorded the maximum inhibition of ShB pathogen *Rhizoctonia solani* and BLB pathogen *Xanthomonas oryzae* pv. *oryzae* by 66.7% and 26.3%, respectively. Scanning electron microscopy of these two isolates showed rectiflexible and retinaculiaperti type of polysporous spore chains. Molecular identification of 'Act116' and 'Act 119' done through 16S rRNA gene sequencing revealed the strains as *Streptomyces corchorusii* and *S. sasae*, respectively. The partial gene sequences of the two isolates were submitted to NCBI GenBank (GenBank No.KY393359.1 & GenBank No. MH988751.1). The pot culture and field experiments showed significant reduction of per cent disease index (PDI) of ShB and BLB of rice (cv. Mahsuri) in strain 'Act 116' and 'Act 119' treated plants. The application of actinobacteria 'Act 116' and 'Act 119' as seed treatment, root dip and foliar spray could reduce PDI of ShB and BLB to 24.6% and 30.8%, respectively over control (70.4 and 66.7 PDI, respectively). These combinations were also resulted in significant plant growth promotion. In field experiments, the microbial population increased in treated plots compared to control. Significant uptake of nitrogen, phosphorous and potash were observed in actinobacteria treated plots compared to control. The crude bioactive compounds extracted were analyzed through LCMS and revealed the possible presence of antibiotic compounds like Difloxacin, Dicloxacillin, Nystatin, Tetracycline and Doxycyline. Hence, it can be

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inferred from the present study that actinobacterial strains 'Act 116' and 'Act 119' have significant biocontrol potential against the two major rice diseases ShB and BLB, respectively and can be efficient candidates for management of other plant diseases also.



# **Botanical and Bioagent Mediated Regulation of Defense Related Phytochemicals in Tea, *Camellia sinensis* (L.) O. Kuntze against Major Diseases and Pests**

*Popy Bora*

The present investigation aimed at exploring some native botanicals used by the small tea growers of Assam engaged in organic tea cultivation as well as microbial bioagents for management of major disease and pests of tea and their response in modulating defense related phytochemicals, response on green leaf yield and quality parameters of tea. Our preliminary studies identified grey blight as major disease and tea mosquito bug (TMB), red spider mite (RSM) and tea looper caterpillar (TLC) as predominant pests, hampering the quality production of tea in the study area of Experimental garden of plantation crops, AAU, Jorhat. The grey blight pathogen was identified as *Pseudopezalotiopsis curvatispora* based on cultural, morphological and molecular characterization through sequencing the ITS region of 18s rRNA of the fungus, the first ever report of such species from Assam. The initial *in vitro* screening of seven botanicals at three different concentrations (2.5%, 5.0% and 10.0%) showed that 10% concentration of two botanicals *viz.*, *X. strumarium* and *P. pinnata* were most effective against *P. curvatispora* and all the three tea pests considering type of botanicals, their concentration and their interaction effect. These two botanicals were selected for onward field study. Similarly, among the bioformulations, Biogreen (2%) and Biometa (2%) showing significant suppression of grey blight pathogen and mortality against tea pests *viz.*, tea mosquito bug, red spider mite and looper caterpillar were identified for subsequent field study. Attempts were further made to identify the antimicrobial and pesticidal phytoconstituents of *P. pinnata* and *X. strumarium*, which showed the presence of as many 27 and 42 different compounds, respectively, mostly secondary metabolites with known pesticidal/antimicrobial properties.

The field study involving *P. pinnata* and *X. strumarium* along with Biogreen and Biometa (singly as well as in combination) showed significant reduction of grey blight disease and tea pests, from 0 days to 150 days after spray. Combination of

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Biogreen and Biometa at 2% each, was most effective in terms of reduction of 87.52%, 88.41%, 88.97% and 90.52% against grey blight, tea mosquito bug, red spider mite and looper caterpillar respectively followed by sole application of Biogreen at 2%. Botanicals also showed significant reduction, however, inferior to bioagent consortium based treatment in field study. Combination of *P. pinnata* and *X. strumarium* was observed more effective than their individual counterparts in terms of post-treatment reduction of disease and pests. Assessment of the botanicals and bioformulations in triggering host defense in tea revealed that both microbial bioagents and botanicals showed similar response in modulating the activity of defense enzymes *viz.*, PAL, PPO,  $\beta$  1, 3 -glucanase and PO, although the magnitude of enzyme activity was observed higher in bioagent consortium treated plants than the botanical treated plants. Apart from these responses, tea leaves were also assessed for responses on polyphenol content and antioxidant activity, which revealed better performance of bioagents based treatments with corresponding higher antioxidant activity. The combination of Biogreen + Biometa proved most effective by registering the highest polyphenol (22.62%) and antioxidant activity (86.20%) followed by Biogreen and combination of botanicals in decreasing order. Field response of different botanicals and bioagents based treatments further showed the maximum biomass of green tea leaves of 88.4q/ha with Biogreen + Biometa followed by 85.0q/ha with Biogreen application and 72.6q/ha with *P. pinnata* + *X. strumarium* (5.0% each), corroborating further with higher concentration of caffeine content. The correlation study among grey blight and three important quality parameters of tea *viz.*, polyphenol content, antioxidant activity and caffeine content showed negative correlation of these parameters with grey blight incidence, thereby, establishing their definitive role in grey blight disease incidence and related plant defense involvement.

## **Synthesis of nanoparticle from bio-resources for management of blast diseases of rice**

*Pranjal Kumar Kaman*

Development of reliable and eco-friendly process for synthesis of metallic nanoparticle is an important steps in the field of nanotechnology. An effort was made for biosynthesis of gold nanoparticles from bioresources like microbes *Aspergillus niger*, *Metarhizium anisopliae*, *Lecanicillium lecanii*, *Purpureocillium lilacinus* and botanicals like *Ocimum gratissimum*, *Acorus calamus*, *Aloe barbadensis* and *Azadirachta indica*. Chloroauric acid was added as precursor for the synthesis of gold nanoparticles. Study on in vitro efficacy of biosynthesized gold nanoparticle from bioresources was tested at hundred percent concentration against *Magnaporthe grisea* and effective source was found to be *Metarhizium anisopliae* and *Ocimum gratissimum*. Further efficacy of biosynthesized gold nanoparticle from *Metarhizium anisopliae* and *Ocimum gratissimum*. Was tested against *Magnaporthe grisea* at three different concentrations (50, 100 and 150ppm) comparison was made with Tricyclozole @ 600 ppm. The result showed that the gold nanoparticles at 150 ppm significantly inhibit the mycelia growth of the pathogens as compared to the Tricyclozole @ 600 ppm. The effective biosynthesized gold nanoparticles was characterized by UV-Vis spectrophotometer, Dynamic Light Scattering (DLS), Fourier transform infrared spectrometer (FTIR), Zeta Sizer and Transmission Electron Microscope (TEM). Formation of gold nanoparticles were confirmed by UV-VIS spectroscopy study with absorption peaks at 550 nm. FTIR study showed that synthesized gold nanoparticle has all the required functional groups like OH, N-H, C-H and COO-. Study on surface properties of nanoparticles by using zetasizer resulted that gold nanoparticle from *Metarhizium anisopliae* was found to be negative and were stable in nature with zeta potential value of -20.7 mV. DLS analysis showed that the average size of the biosynthesized gold nanoparticles is 32.54 nm with polydispersity index of 0.560. TEM study showed that shape of the biosynthesized nanoparticle is from triangular to quasihedral and the size range from 9-54nm. Again, a pot experiment was conducted for studying its effect on morphophysiology as well as soil physico chemical and biological properties by different methods of application like seedling dip treatment, foliar spray

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and soil application. A positive effect was found on the morphology, soil physico chemical and biological properties when rice seedling was treated as seedling dip treatment + foliar spray + Soil application @ 150ppm.

# **Biochemical, histopathological and molecular characterization of sesamum phyllody disease in Assam**

*Shankar Hemanta Gogoi*

The field of phytoplasma diseases witnessed a new height of systematic study and research works throughout the world. An effort was made for biochemical, histopathological and molecular characterization of the sesamum phyllody disease. Sixteen (16) different alternate hosts were identified by molecular technique and out of that 9 were characterized. Three different groups of phytoplasma viz., aster yellows (16SrI), clover proliferation (16SrVI) and stolbur phytoplasma (16Sr XII) were identified to be associated with the phytoplasma alternate host samples. By using *iPhyClassifier* tool Brinjal phytoplasma isolate was grouped into the subgroup level 16SrVI-D. *Exitinus indicus* was detected for phytoplasma presence; characterization was done and it was found that it may play a new role for sesamum phyllody phytoplasma transmission. Ten (10) sesamum cultivars were grown in the field and pot conditions to observe the disease reactions and the cultivars were found moderately resistant (MR) to moderately susceptible (MS). The sesamum phyllody disease was successfully transmitted from infected to healthy sesamum plants by graft transmission (80%). Membrane-bound, phytoplasma-like bodies were detected in Transmission electron microscopy. Total chlorophyll content was reduced by 41.02 per cent in severely infected plants, while in mildly infected plant it was reduced by 28.20 per cent. Ratio between chlorophyll “a” and chlorophyll “b” progressively reduced as a result of infection. The ratio was 1.02 in healthy plants, while it was 1.01 and 0.96 in case of mild infection and severe infection, respectively. Phyllody disease considerably increased the dry matter content in the infected plant. Increase in dry matter content was 12.41 per cent and 19.85 per cent in mildly infected and severely infected plants, respectively. However, no considerable difference in moisture content was observed in both mildly and severely infected plants compared to the healthy ones. Phyllody disease decreased the total nitrogen as well as protein content. The reduction in protein content was 8.50 per cent in mildly infected leaves and 13.29 per cent in severely infected leaves. Phenol content was increased as disease advanced from milder to severe

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symptoms stage from 2.24 mg/g to 2.68 mg/g, respectively, as compared to healthy leaves i.e., 1.85 mg/g. Molecular characterization of Sesamum phyllody phytoplasma was done from all the agro-climatic zones of Assam and all the phytoplasma isolates were grouped into 16SrI-B. Restriction Fragment Length Analysis (RFLP) was done with three restriction enzymes viz., *BamHI*, *EcoRI* and *RsaI*. Sequence analysis, *iPhyClassifier* and the comparison between virtual and actual RFLP pattern revealed that there is no genetic difference among the Sesamum phyllody phytoplasma isolates of Assam.

# **Sulphur and boron fertilization on rapeseed- greengram cropping sequence as influenced by liming in acid soils of North Bank Plain Zone of Assam**

*Britan Rahman*

Application of optimum dose of micronutrient along with macronutrient will promote crop yield, quality of harvest and soil health. Keeping in this view, a field experiment was conducted to study the effect of S, B and lime application on soil properties, nutrient use efficiency and yield of rapeseed and greengram crop in a sequence. The direct effect of S, B and lime application was studied in rapeseed and residual effect was assessed in greengram. The experiment was conducted during *rabi* and *summer* seasons of 2016-17 and 2017-18 at the Instructional farm of KVK, Udalguri, Assam Agricultural University, Assam. The design of the experiment was factorial RBD with two factors (limed and unlimed) and four levels of S and B (S0B0, S15B0.75, S20B1.0 and S25B1.25 kg ha<sup>-1</sup>) and three replications. The recommended doses of NPK were applied to both the crop while S, B and lime were applied only to rapeseed crop. The soils of the experimental site was sandy loam in texture, moderately acidic with high organic carbon content, medium in available N and K and low in available P, S and B level. The combined application of S and B had significant direct effect on seed yield and its attributes of rapeseed. The treatment LT3 receiving RD of NPK + 20 kg S + 1.0 kg B + 490 kg lime ha<sup>-1</sup> had shown significantly highest seed yield (10.17 q ha<sup>-1</sup>) and stover yield (30.91 q ha<sup>-1</sup>) which are 13.38 and 43.50% higher over control respectively. The residual S, B and lime also showed significant influence on seed yield and its attributes of succeeding crop *summer* greengram. The same treatment LT3 applied to the preceding crop rapeseed recorded significantly highest seed yield (8.74 q ha<sup>-1</sup>) and stover yield (34.38 q ha<sup>-1</sup>) of greengram which are 15.17 and 44.35% higher over control respectively. A significant decrease in soil pH was observed with increasing S and B dose under both lime and unlimed conditions in all the three stages of the crop but could not show significant impact on organic carbon content of soil. The S and B resulted significant increase in available N, P<sub>2</sub>O<sub>5</sub>, S and HWS-B in treatment LT4 (S25+B1.25+L490 kg ha<sup>-1</sup>) and L0T4 (S25+B1.25+L0 kg ha<sup>-1</sup>) and K

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content in LT3 (S20+B1.00+L490 kg ha<sup>-1</sup>) and LOT3 (S20+B1.00+L0 kg ha<sup>-1</sup>) under limed and unlimed factor in all the three stages of crop. Identical results were also recorded in greengram crop reflecting the significant residual effect of S, B and Lime application. Significant decrease in soil pH with increasing S and B dose under both limed and unlimed factor was observed in greengram. The available S and HWS-B also showed a decreasing trend with successive increasing growth stages of greengram. The S and B exhibited a significant direct effect under both limed and unlimed factor on nutrient uptake by seed and stover of rapeseed. Among both factors, the total uptake of N, P and K was highest in treatment LT3 receiving RD of NPK + 20kg S + 1.0kg B + 490kg lime ha<sup>-1</sup> and total uptake of S and B was highest in treatment LT4 receiving RD of NPK + 25kg S + 1.25kg B + 490kg lime ha<sup>-1</sup>. The residual S and B exhibited a significant influence under both limed and unlimed factor on nutrient uptake by seed and stover of greengram. The total N, P and K-uptake under both the factor was highest in treatment LT3 and total S and B-uptake was highest in treatment LT4. The direct interaction effect of limed and unlimed treatments on yield and its attributes of rapeseed showed significant higher results in treatment T3 (receiving 20 kg S + 1.0 Kg B ha<sup>-1</sup> +RDF). Among treatment combinations, the limed factor treatments showed the significantly highest mean yield and its attributes of rapeseed compared to unlimed factor treatments. Similar observation was made in the succeeding greengram crop.

Both the direct and residual interaction effect of limed and unlimed treatments on soil pH showed significantly higher values at 30, 60 and 90 DAS in treatment T1 (Control with only RDF). Among treatment combinations, the direct and residual liming factor treatments showed significantly higher mean pH at 30, 60 and 90 DAS compared to unlimed factor treatments. The soil available N, K<sub>2</sub>O, S and B content also showed significant results due to direct and residual interaction effect of limed and unlimed treatments with significantly highest available N, S and B content in treatment T4 (S25+B1.25) and available K<sub>2</sub>O in treatment T3 (S20+B1.00). Both the direct and residual interaction effect did not show any significant influence on SOC and available P<sub>2</sub>O<sub>5</sub> content. Among treatment combinations, the both direct and residual liming factor treatments showed significantly higher mean available N, K<sub>2</sub>O, S and B content compared to unlimed factor treatments. The direct interaction effect of limed and unlimed treatments on N-uptake by seed and stover of rapeseed showed significant higher results in treatment T3, Seed P-uptake and stover K-uptake in treatment T3, stover P-uptake, seed K-uptake, seed and stover S and B uptake in treatment T4. Among treatment combinations, the liming factor treatments showed significantly higher mean seed and stover N, P, K, S and B-uptakes compared to unlimed factor treatments. The residual interaction effect of limed and unlimed treatments also exhibited similar results as on the direct effect. Among treatment combinations, the liming factor treatments showed significantly higher mean seed and stover N, P, K, S and B-uptakes compared to unlimed factor treatments. In economic expressions, the highest gross return, net return and B: C ratio was found under treatment LT3 in both rapeseed and succeeding crop greengram. Among both the crops, higher net return (₹ 32368.38) and B: C ratio (2.44)



was recorded on succeeding greengram crop. The S, B and lime application showed a clear impact on the comparative economics of rapeseed-greengram cropping sequence with highest gross return (₹ 105930.00), net return (₹ 61000.00), equivalent yield (9.46 q ha<sup>-1</sup>) and B: C ratio (2.36) in treatment LT3. Considering the positive effect on soil properties, fertility status, nutrient uptake, crop yield and economic returns, application of 20 kg S + 1.0 kg B + 490 kg lime ha<sup>-1</sup> along with recommended dose of NPK was found superior for rapeseed-greengram cropping system.

## **Assessment of soil quality under different land uses in Hill Region of Assam**

*Nilim Kalita*

Land use changes are known to have significant and long lasting effects on soil quality and productivity. There are different types of land uses in the hill region of Assam, but little quantitative information is available on the effects of these land uses on soil physical, chemical and biological properties and overall soil quality. The present study was undertaken to assess and compare influence of most common land uses namely, natural forest, Jhum land, rubber plantation, upland paddy/maize crop land, home garden and bamboo plantation on soil physical, chemical and microbiological properties in the hill region of Assam. The soil properties such as texture, bulk density, particle density, porosity, water holding capacity, water stable aggregates, mean weight diameter, pH, EC, CEC, organic carbon, available N, available P, available K, exchangeable Ca and Mg, MBC, MBN, DHA and soil errodibility were investigated for each land use system for assessment and comparisons of soil fertility, soil organic carbon stock, soil errodibility and overall soil quality as influenced by the land uses. One hundred and sixty two soil samples were collected at 0-15 cm, 15-30 cm and 30-50 cm depth from three randomly selected plots with identical slope and landscape positions representing six land uses from three selected villages totaling nine plots for each land-use type. Sand, silt and clay fractions showed variations by land use system and soil depth. On the surface layer (0 - 15 cm), the maximum mean sand was observed in paddy/maize crop land (52.67%) followed by jhum land (51.44%), rubber plantation (48.00 %), bamboo plantation (47.11%) and home garden (47.00 %), while the minimum in forest land use (44.56 %) with an maximum increase of 18.20 % in paddy/maize cropland over natural forest. The clay content in the surface layer was observed highest (30.44 %) in forest land use while the lowest was recorded in paddy/maize land (25.78 %). Different land uses exhibited significant impact on soil physical properties *viz.* bulk density, particle density, total porosity, water holding capacity, water stable aggregates and mean weight diameter. The bulk density varied from 1.14 to 1.40, 1.29 to 1.43 and 1.32 to 1.48 g cm<sup>-3</sup> at 0-15, 15-30 and 30-50 cm respectively. Lowest value (1.14 g cm<sup>-3</sup>) of bulk density was recorded in the surface

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layer under natural forest which was significantly lower than the bulk density noted under other land uses except bamboo plantation and home garden. A reduction of 5.0 % and 4.7 % total porosity due to shift of forest land to paddy/maize cultivation and Jhum cultivation respectively in the surface soil was observed. The maximum mean WHC in surface soil was found in forest soils followed by bamboo plantation, rubber plantation, home garden, jhum land and paddy/maize crop land. In the surface layer highest water holding capacity was recorded under bamboo plantation (47.68 %) which was statistically at par with forest (46.97%), rubber plantation (46.22 %) and home garden (44.00 %) and significantly higher than jhum land (40.10 %) and paddy/maize crop land (34.69 %). The highest per cent aggregation in both surface and sub-surface soils was found in forest soils followed by home garden, rubber plantation, jhum land, bamboo plantation and paddy/maize crop land. The pH ranged between 4.90 - 5.32, 4.53- 5.02 and 4.54 – 4.97 in 0-15 cm, 15 – 30 cm and 30-50 cm depth respectively. In the surface layer, highest (5.32) mean pH was observed in forest land followed by bamboo plantation (5.27), rubber plantation (5.18), home garden (5.05), jhum land (5.00) and lowest (4.90) in paddy/maize fields. The highest (10.11 cmol(p+)kg<sup>-1</sup>) CEC was recorded on the surface layer of forest land while the lowest (6.39 cmol(p+)kg<sup>-1</sup>) on the surface layer of cultivated land with a decrease of 33.5%. Among the land use types under study, higher organic carbon content was recorded for natural forest and lower for cultivated lands. SOC concentration was in the order: Forest > Home garden > Rubber plantation > Bamboo plantation > Jhum land > Paddy/maize crop land with profile weighted mean values of 0.77, 0.66, 0.62, 0.57, 0.51 and 0.42 per cent, respectively. Significantly highest available N (561.68 kg ha<sup>-1</sup>), available P (26.30 kg ha<sup>-1</sup>) and available K (312.46 kg ha<sup>-1</sup>) was recorded in natural forest and lowest in paddy/maize crop land (226.21 kg ha<sup>-1</sup>, 11.31 kg ha<sup>-1</sup> and 158.10 kg ha<sup>-1</sup> respectively) with significant differences among the land uses. The total soil organic carbon stock (SOC Stock) in the profile (0-50cm) followed the order as Forest > Home garden > Rubber plantation > Jhum land > Bamboo plantation > Paddy/maize crop land with the total SOC Stock in each land use being 44.30 Mg ha<sup>-1</sup>, 41.74 Mg ha<sup>-1</sup>, 38.56 Mg ha<sup>-1</sup>, 33.73 Mg ha<sup>-1</sup>, 32.26 Mg ha<sup>-1</sup> and 27.29 Mg ha<sup>-1</sup> respectively. A maximum loss of SOC Stock was recorded when forest was converted to crop land (-17.01 Mg ha<sup>-1</sup>) followed by bamboo plantation (-12.04 Mg ha<sup>-1</sup>), shifting cultivation (-10.57 Mg ha<sup>-1</sup>), rubber plantation (-5.74 Mg ha<sup>-1</sup>) and the least in home garden (-2.56 Mg ha<sup>-1</sup>). The conversion of natural forest into other land uses resulted in a significant decrease in the MBC, MBN and DHA. The highest mean dispersion ratio was found in paddy/maize crop land (20.30) followed by shifting cultivation (19.98), rubber plantation (17.52), bamboo plantation (18.09), home garden (17.21) and forest soils (16.34). The erosion ratio was in the order of paddy/maize crop land (17.72) > Jhum land (15.75) > rubber plantation (14.28) > bamboo plantation (14.38) > home garden (13.63) > forest (13.20) indicating soils under all land uses were highly vulnerable to erosion except forest and home garden land uses which are slightly erodible. The PCA identified nine key indicators viz. SOC, CEC, pH, WSA, MWD, available P, MBC, exchangeable Ca and

exchangeable Mg for estimation of soil quality index (SQI). In the surface 0-15 cm soil, the highest SQI was recorded in forest land (0.84) followed by home garden (0.77), bamboo plantation (0.76), rubber plantation (0.70), jhum land (0.61) and lowest in paddy/maize crop land (0.50). WSA contributed 7 highest towards SQI (40.48 to 52.46 %) followed by SOC (26.23 to 39.29 %), MBC (6.67 to 8.57 %), CEC (7.14 to 8.57 %) and lowest (2.67 to 5.33 %) by exc. Ca. In the 15-30 cm soil, the highest SQI was recorded in forest land (0.82) followed by home garden (0.70), rubber plantation (0.69), jhum land (0.60), bamboo plantation (0.58) and lowest in paddy/maize crop land (0.46) where WSA contributed highest towards SQI (29.27 to 39.66 %) followed by SOC (25.7 to 27.49 %), available P (5.52 to 25.61 %), MBC (6.90 to 8.70 %), CEC (6.52 to 7.32 %) and lowest (2.86 to 4.35 %) by exchangeable Mg. In the 30-50 cm soil, the highest SQI was recorded in forest land (0.78) followed by home garden (0.69), rubber plantation (0.68), jhum land (0.62) paddy/maize crop land (0.52) and lowest in bamboo plantation (0.47) where SOC contributed highest towards SQI (29.87 to 33.33 %) followed by exc. Mg (23.8 to 27.14%), MWD (16.67 to 23.38%), MBC (7.14 to 9.80 %), CEC (4.76 to 7.25 %), pH (3.90 to 6.25%), and lowest (1.96 to 3.90 %) by available P. The results of SQI indicated that the soil quality deteriorated due to conversion of natural forest land to other land uses while jhum land and crop land showed highest deterioration of soil quality in the surface soil. Tree based home garden land use with multiple plant species recorded better soil quality both in surface and sub surface soil depths. Therefore reducing intensive cultivation of maize and upland rice and jhum cultivation and integration of multiple tree species and horticultural crops (agroforestry) could arrest further declining of soil quality for sustainable agricultural production and productivity in the Hill Zone of Assam.

# **Morphometry, soil erodibility and productivity potential of a transect of Moridhal River basin in Dhemaji district of Assam**

*Prem Kumar Bharteey*

The present investigation was carried out to study the morphometry, soil erodibility and productivity potential of Moridhal river basin in Dhemaji district of Assam. The Moridhal watershed, encompassing 30,730 ha geographical area, is situated between 94052 E to 94069 E longitude and 27038 N to 27064 N latitude. Based on total variation in satellite data (Resourcesat-2, LISS-4), four distinct physiographic units of the Moridhal watershed were delineated which includes: upper piedmont plain (1,844 ha), lower piedmont plain (2,391 ha), alluvial plain (9,888 ha) and flood plain (16,607 ha). The stream order map of the Moridhal river basin was prepared by on screen digitization using Q GIS software and the morphometric parameters were evaluated through measurement of linear, areal and relief aspects. The drainage streams were delineated up to 4th order with stream numbers of 36, 14, 5 and 1, for I, II, III and IV order, respectively. The mean bifurcation ratio and Rho coefficient for the Moridhal watershed was computed to be 2.22 and 0.41, respectively. The computed value of aerial aspects like elongation ratio, circulatory ratio, form factor ratio and shape factor revealed elongated shape of the watershed area. The studied relief aspects include parameters like basin relief, relief ratio, ruggedness number, and relative relief. The calculated value of ruggedness number (0.03) and relative relief (0.055 per cent) indicated higher infiltration and lower runoff in the studied area.

GPS based surface and core soil samples representing different physiographic units were collected and analyzed for various physico-chemical properties. The texture of the studied soils varied from loamy sand to clay, sandy loam being dominant. There was an increasing trend of very fine sand and silt content from upper piedmont plain to floodplain. The bulk density and particle density of studied soils varied from 1.10 to 1.67 Mg m<sup>-3</sup> and 2.16 to 2.74 Mg m<sup>-3</sup>, respectively. The value of porosity, water holding capacity and hydraulic conductivity of the studied soils ranged from 24.99 to 54.68 per cent, 19.88 to 63.12 per cent, and 0.11 to 6.54 cm hr<sup>-1</sup> respectively. Field capacity and available water content showed significant positive correlation with clay

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content and porosity, while permanent wilting point exhibited significant positive correlation with sand content.

The pH of the soils was extremely acidic (4.2) to slightly acidic (6.3). The electrical conductivity in the studied soils varied from 0.01 to 0.16 dS m<sup>-1</sup> which was almost negligible. The cation exchange capacity of the studied soils varied from 3.88 to 19.40 cmol (p+) kg<sup>-1</sup> with a mean value of 9.69 cmol (p+) kg<sup>-1</sup>. Amongst the exchangeable cations, Ca<sup>++</sup> was found to be the dominant in the studied soils followed by exchangeable Mg<sup>++</sup>, K<sup>+</sup> and Na<sup>+</sup>. The exchange capacity of clay and apparent CEC showed wide variation in the studied area. The base saturation varied from 33 to 83 per cent and the organic matter content was medium to high (range 5.50 to 29.60 g kg<sup>-1</sup>). The available N, available P<sub>2</sub>O<sub>5</sub> and available K<sub>2</sub>O content varied from low to high with a range between 137.98 to 570.75 kg ha<sup>-1</sup>, 18.47 to 67.20 kg ha<sup>-1</sup> and 37.23 to 549.16 kg ha<sup>-1</sup>, respectively. The nutrient index for available N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O were found to be 1.88 (Medium), 2.15 (Medium) and 1.32 (Low). The principal factor analysis, which was carried out using 35 characters, could explain 71.20 per cent of the total variance with the seven number of extracted eigen values.

There was an increasing trend of macroaggregate from upper piedmont plain (mean 24.9 per cent) to flood plain soils (mean 47.4 per cent). The microaggregate in the studied soils varied from 17.8 to 89.8 per cent and the mean weight diameter ranged between 1.00 to 2.74 mm. The erodibility of the studied soils was assessed by computing various erodibility indices like clay ratio, silt clay ratio, modified clay ratio, dispersion ratio, erosion ratio and erosion index. The mean value of clay ratio, silt/clay ratio and modified clay ratio were found to be 4.02, 1.35 and 3.63, respectively. The dispersion ratio of the soils varied from 0.06 to 1.18 with a mean value of 0.19. It was observed that 48.82 per cent of the total studied soil samples had dispersion ratio values above 0.15 which may be considered as erodible. The erosion ratio and erosion index of studied soils varied from varied from 0.01 to 0.55 and 0.03 to 0.71, respectively. It was observed that almost all the studied physico-chemical properties influenced the erodibility indices to a great extent. The soil loss varied from very slight to very severe (range 0.87-67.77 t ha<sup>-1</sup> yr<sup>-1</sup>) with a mean value of 16.19 t ha<sup>-1</sup> yr<sup>-1</sup>. A significant positive correlation of soil loss was noticed with very fine sand ( $r = 0.229^{**}$ ), silt ( $r = 0.212^{**}$ ), microaggregate ( $r = 0.351^{**}$ ) and relief ( $r = 0.711^{**}$ ). The studied soils exhibited a decreasing trend of soil loss from upper piedmont plain towards flood plain. The productivity indexes of the studied soils varied from 12.13 to 62.14 with a mean value of 35.22. The potentiality index and coefficient of improvement values of studied soils varied from 41.04 to 90.25 and 1.11 to 4.69, respectively. Soil site suitability criteria for crops viz., *Sali* rice, *Ahu* rice, *Boro* rice, wheat, mustard/rapeseed, sesame, pea, potato, onion and coconut were evaluated. The study revealed that the soils were permanently unsuitable (N1) to moderately suitable (S2) for *Sali* rice, *Ahu* rice, *Boro* rice, wheat, pea, mustard/rapeseed, sesame, potato, onion and coconut. Major constraints identified in the watershed lies in acidity, organic carbon, texture, flooding, drainage and low precipitation in early growth stage during *rabi* season. GIS based

maps for various themes like pH, organic matter, available N, available P<sub>2</sub>O<sub>5</sub>, available K<sub>2</sub>O along with soil loss, productivity, potentiality, and soil-site suitability for studied crops were also prepared to depict the spatial distribution under different classes.

## **Assessment of potassium use efficiency in transplanted rice**

*Seema Bhagowati*

Potassium (K) the third major essential plant nutrient with diverse roles to play in plant metabolism is required in large amount by crops and is the seventh most abundant element in the earth crust. The total K reserves are generally large in most soils but large portion of soil potassium (90 – 98%) remains chemically bound in the crystal structure of minerals and thus unavailable or slowly available for plant uptake. Based on availability to plants, potassium is categorized into four groups viz., water soluble, exchangeable, non-exchangeable/fixated and lattice K. Potassium supply to crop is a complex phenomenon involving relationships among various K fractions, potassium fixation and release patterns in soil and quantity-intensity relationships. Moreover, the net negative balance for K in current agriculture scenario is 69% which is very high as compared N (19%) and P (12%). This vast difference is partly because of crop removal where 1.5 times more K is removed than N and the application of potassium through fertilizer is considerably lower than that of N or P. Keeping these points in view, a study was carried out on “Assessment of Potassium use efficiency in transplanted rice” in Nagaon district which is famously known as the 'Rice bowl of Assam'. A series of laboratory analysis along with field experiments was carried out to assess the potassium use efficiency in transplanted rice. The soil of the experimental plot was analysed for salient characteristics such as texture including mineralogy of sand, silt and clay, pH, EC, OC, CEC, available NPK contents and various forms of K. An incubation study was conducted upon imposition of ten different treatments for a period of 150 days to know the availability of various forms of potassium in the soils at 20, 40, 60 and 90 days after incubation. After completion of incubation period, soils from various treatments were taken for study the release pattern of step K, constant rate K and cumulative K and fixation of potassium in these soils. Along with the incubation study, a field study was also conducted consecutively for two years with the same ten treatments in rice crop (var. Ranjit) with three replications in RBD design. Post harvested soils were analyzed for various physico-chemical characteristics and different K forms. Crop related data were recorded to study the effect of potassium management on growth and yield of rice.

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**Abstract of Ph.D. thesis**

**Department: Soil Science**

**Major Adviser: Dr. K. N. Das**



The texture of the soil of the experimental plot was clay loam with very strongly acidic pH (= 4.92). Initial status of SOC (0.91%) was high in upper surface (0-15 cm) and medium (0.65%) in lower surface (15-30cm), available N and P medium and K was low in upper surface and low available N and K and medium P was found in lower surface. X-ray diffraction study clearly indicates that clay fraction of this soil contains minerals like clay mica, mixed-layer minerals, vermiculite, smectite and kaolinite. Sand fraction is dominated by resistant minerals like quartz, zircon and weatherable minerals like mica, feldspars and chlorite and silt fraction contains same minerals as that of sand along with kaolinite. Initial water soluble K (WS-K), exchangeable K (Exch. K), non exchangeable K (Non Exch. K), lattice K and total K were 9.20, 41.00, 1020.00 8856.00 and 9480.00 mg kg<sup>-1</sup> respectively in the upper surface (0-15 cm) of the soil. In the lower surface the values were 5.40, 28.40, 1454.00, 10222.00 and 10885.00 mg kg<sup>-1</sup> respectively for WS-K, Exch. K, Non Exch-K, Lattice K and total K. In incubation study, where biofertilizers (T2 and T4) and organic manures (T9 and T10) were applied increase in WS-K was found with progression of the incubation period and in field study, it was highest with 21.35 mg kg<sup>-1</sup> in the plot receiving T10 = INM Package (50% NP + Full K + 5t/ha Vermicompost) and was the lowest 8.17 mg kg<sup>-1</sup> in the control plot. A perceptibly significant increasing trend of Exch-K was found, irrespective of the nutrient source except control treatment in incubated soil. In field condition, Exch. K corresponded to the amount of chemical K fertilizer applied and also to the INM package including microbial consortia and highest amount was observed in INM Package (50% NP + Full K + 5t/ha Vermicompost). Exchangeable K was found to be highly and significantly correlated with available K ( $r= 0.993^{**}$ ), non-exchangeable K ( $r=0.602^*$ ), total K ( $r=0.826^*$ ) and lattice K ( $r=0.769^{**}$ ). With the increase in incubation time the non exch. K decreased in the treatments T2 = Microbial consortia (Azospirillum + PSB + KSB) @ 4 kg/ha, T4 = 100% RDF + KSB @ 4 kg/ha and T6 = Potassium nano-fertilizer @ 100 ml/1.2 L. Lower values of non-exchangeable K were recorded in all the treatments with different levels of potassium as compared to initial (1.020 mg kg<sup>-1</sup>) in the field experiment maximum being found in 100% RDF application. The increase of non exchangeable K in the control treatment with concurrent decrease in exchangeable K indicates the existence of dynamic equilibrium among different forms of potassium. Lattice K content of the treatments varied differently with different treatments but the changes were statistically insignificant in all the treatments in 40 DAI (Days after incubation) to 60 DAI and the changes was statistically at par in 60 to 90 DAI. Maximum amount of lattice was recorded in plot receiving 100% K fertilizer along with N & P fertilizers and INM components while lowest was recorded in plots which did not receive any fertilizer in field condition. The lattice K was significantly and positively correlated with available K ( $r= 0.791^*$ ), water soluble K ( $r=0.801^{**}$ ), exchangeable K ( $r=0.769^*$ ), nonexchangeable K ( $r=0.697^*$ ) and total K ( $r=0.865^{**}$ ). Increased levels of fertilizers brought about significant increase in total K content *i.e.* in the treatments where application of full dose of recommended fertilizers were done the total K tended to increase. In field condition, treatments where

100% K fertilizers were applied alone or in combination with INM components for 2 years continuously observed an increase in total K, highest being observed in T10 = 100% NP + Full K + 5 ton/ha Vermicompost) (11015.50 mg kg<sup>-1</sup>). Highly significant positive correlation values among various forms of K implied the existence of dynamic equilibrium. The amount of K released in successive extraction with boiling 1N HNO<sub>3</sub> decreased step wisely in all treatments and reached to a constant level at 8th number of extraction. Reverse was happened in cumulative K. K release was higher in INM packages than plots received either organic or inorganic fertilizer alone. Cumulative K release was significantly correlated to lattice K ( $r=0.881^{**}$ ) suggesting that 1.0 mol L<sup>-1</sup> HNO<sub>3</sub> chiefly extracted K from nonexchangeable K pool in the soil. The amounts of step K of the treated soils ranged within a limit of 1837.0 to 3529.0 mg kg<sup>-1</sup>, which is high and thereby expected to be nonresponsive to K fertilization for a longer duration to the growing crops. The absolute amount of K fixed in soil progressively increased while percent K fixation decreased with increase in level of added K in all the treatments. Least percent K fixation was observed in T10 and the maximum in control. As this soil contains minerals like mica, vermiculite and smectite in clay fraction so K fixation is also high in this soil. Grain and straw yield was significantly affected by various treatments with the highest yield (= 56.22 q ha<sup>-1</sup>) in T10 which received 100% NP + Full K + 5 ton /ha vermicompost and the lowest in control. Yield was always better in INM package plots. Grain yield exhibited significant positive correlation with NPK uptake ( $r = 0.891^{**}$ ,  $0.946^{**}$  and  $0.970^{**}$ ), water soluble K ( $r = 0.785^{**}$ ) exchangeable K ( $r = 0.897^{**}$ ) and available K ( $0.867^{**}$ ), suggesting their availability to rice crop. The highest potassium use efficiency (PUE) of 51.96% was found in the plot receiving 50% NP + Full K + 5 t/ha Vermicompost (T10) while the lowest of 40.49% in the plot receiving Potassium nanofertilizer @ 100 ml/1.2 L of water (T6) treatment. The information generated in the present study related to the status and distribution of different forms of potassium and its availability, releasing behavior and fixation evaluated through plant utilizable non-exchangeable K *i.e.* step K and constant rate K gave a general idea about the availability of K under the influences of varying doses of applied K and INM packages. Finally it can be concluded that INM Packages were found to be better for maintaining available K status, K release from none available pools and low K fixation in the soil and the resultant crop yield compared to inorganic treatments.

## **Identification of clones suitable for manufacturing green tea from the existing released clones in North East India**

*Bhupen Deka*

India is predominantly a black tea producing country. In recent times, green tea has become gradually popular amongst consumers. Accordingly increasing numbers of producers have started manufacturing green tea. However, there is lack of enough information on cultivation and manufacturing practices of green tea in India. Considering the lack of sufficient knowledge in Assam on suitability of good planting materials for processing of quality green tea the present investigation has been proposed to identify the clones which could be utilized for production of good quality green tea. Ten (10) such clones of tea from the existing tea plantation predominantly been utilized for black tea manufacturing were selected to undertake a detail study. Green tea made from these ten investigated clones were analyzed during three plucking seasons to assess the most important biochemical parameters. The organoleptic quality of the green tea made was also evaluated by tea tasters. From the present investigation, it is seen that the constituents like total catechin, theanine and caffeine content in green tea made from ten different investigated clones ranged from 15.40 percentages to 22.52 percentage, 0.56 percentages to 1.83 percentages, and 3.63 percentages to 6.16 percentages on dry weight basis whereas the chlorophyll content ranged from 1.18 mg/g to 1.92 mg/g. respectively. Among various morphological characteristics studied, characters like leaf size and leaf pubescence density have shown positive impact on the quality of green tea made though these relations could not be established. Polyphenol to amino acid ratio is a good indicator of taste of green tea. The high ratio of polyphenol to amino acid causes a strong and bitter taste, whereas tea clones with low polyphenol to amino acid ratios are expected to yield green tea with good taste. Among the ten investigated clones the total catechin to theanine ratio ranged from 1:9 to 1:29. The clones having low total catechin to theanine ratio were TV 7, TV 17, S3A3 and P126 which were found suitable for manufacturing quality green tea. From the organoleptic evaluation it was observed that the green tea made during second flush showed the best liquor characteristics like

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**Abstract of Ph.D. thesis**

**Department: Tea Husbandry & Technology**

**Major Adviser: Dr. S. C. Barua**

brightness, briskness, mellowness, flavour and quality. In a ten point scale of tea tasters' scores, clones P126, TV 7, TV 17 and S3A3 recorded higher scores compared to other investigated clones. In this study out of 35 TRA released clones and 153 TRA/Garden series clones, only 10 clones were selected, 8 from TRA released clones and 2 from TRA/Garden series clones to carry out the investigations. These 10 clones were selected representing Assam Type, Cambod Type, China Type and Assam x China hybrid. Investigations were limited to only ten popular clones considering the possibilities and limitations of time, manufacturing seasons, analytical facilities and tasting of samples under the study. Some other clones suitable for manufacturing black orthodox tea may also have the potentiality to make good green tea and those clones may also possess scope for future similar investigations considering the growing demand for green tea.

# **Efficacy of nano bioformulation for the management of red spider mite (*Oligonychus coffeae*)**

*Supriya Sonowal*

The present investigation was conducted in the Department of Tea Husbandry and Technology, Nano Lab of Department of Plant Pathology and field experiment were conducted in Experimental Garden for Plantation Crops (EGPC), Assam Agricultural University (AAU), Jorhat, Assam during 2016-2020 to carry out the experiments to obtain nanoparticle and characterization. The nano particles were synthesized from *Fusarium oxysporum*, fish and crab and used as NP-1, NP-2 and NP-3 respectively. The nanoparticle used were characterized by UV-VIS, Zeta Sizer, TEM and DLS. UV-VIS spectroscopy of chitosan nanoparticles was carried out a range of wavelength of 314.00, 340.00, 348.50 nm 200-600 nm and results showed maximum absorption at critical wavelengths for a particular nanoparticle respectively for *F. oxysporum*, fish and crab chitosan nanoparticles. Zeta potential values of the present nanoparticles were recorded positively charged with zeta potential of 3.85, 16.89 and 20.48 respectively for chitosan nanoparticles of *F. oxysporum*, fish and crab. Similarly, TEM study showed the present nanoparticles were smooth surfaced with spherical in shape. On the other hand DLS study showed the size of the nanoparticles as 105.6, 98.0, 285.0 nm respectively for *F. oxysporum*, fish, crab. In vitro evaluation of chitosan NPs synthesized from *F. oxysporum*, fish and crab in combination of *M. anisopliae* and *V. lecanii* against red spider mite was tested at different doses (5 ml/lit, 7 ml/lit and 10 ml/lit) at 100 ppm concentration. At first day after treatment highest per cent mortality recorded from *M. anisopliae* + NP-2 (38.55%) at dose of 7 ml/lit. At third days of spray the highest per cent mortality was recorded from *M. anisopliae* + NP-2 (65.42%) at 7 ml/lit. This was followed by *M. anisopliae* + NP-2 (58.79%) and (58.05%) at 10 ml/lit and 5 ml/lit respectively. At fifth days after treatment *M. anisopliae* + NP-2 showed maximum mortality against *O. coffeae* (81.66%) at 7ml/lit followed by *M. anisopliae* + NP-2 (79.76%) and (76.48%) at dose of 10 ml/ lit and 5 ml/lit respectively and lowest mortality per cent (21.51%) was observed at control.

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**Abstract of Ph.D. thesis**

**Department: Tea Husbandry & Technology**

**Major Adviser: Dr. I. P. Sahewalla**

## **Ph.D (Fishery Science)**

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- **Aquaculture**

# **Effect of Feeding Rate on Growth, Hematological and Biochemical Indices of Indian Majorcarp, *Labeo Rohita* (Hamilton) Fingerling**

*Dharitri Baruah*

The present study was carried out to assess the effect of feeding rate to evaluate the growth performance (Specific growth rate, Feed conversion ratio and Protein efficiency ratio), haematological responses viz. RBC, WBC, Hb, Hct, MCV, MCHC & MCH and biochemical parameters viz. Serum total protein, serum glucose and serum cholesterol of *Labeo rohita*. The experiment was conducted for period of 120 days in cement tanks with water level of  $80 \text{ cm} \pm 5 \text{ cm}$ . Semi-moist feed was prepared using Mustard Oil cake, Rice polish, Fish meal and wheat flour. To assess the effect of feeding rates four different treatments viz. T-0, T-1, T-2 and T-3 in triplicate were considered with the daily feeding rate of 3%, 1%, 6% and 8% per body weight respectively while T-0 (3% BW day<sup>-1</sup>) was taken as reference treatment. Each tank was stocked with 20 numbers of rohu fingerlings and feed accordingly. The average initial weight (g) at the time of stocking were  $58.8 \text{ g} \pm 0.21$  (T-0),  $57.9 \text{ g} \pm 0.19$  (T-1),  $58.9 \text{ g} \pm 0.32$  (T-2) and  $58.9 \text{ g} \pm 0.26$  (T-3). The average weights attained at the end of experiment were  $238.9 \text{ g} \pm 0.75$  (T-0),  $186.83 \text{ g} \pm 0.27$  (T-1),  $353.06 \text{ g} \pm 3.47$  (T-2) and  $165 \text{ g} \pm 0.71$  (T-3), respectively. In the present study, the growth of rohu was significantly ( $p < 0.05$ ) higher in T-2 treatment where fish were fed @ 6% BW day<sup>-1</sup>. The growth of fish was lowest in 8% (T-3) followed by 1% (T-1) feeding rate. The SGR (2.34), FCR (1.42) and PER (3.04) value showed comparatively higher in case of T-2 treatment than the other treatments. The fish also showed better survivability in T-2 treatment. Changes occurring in haematological and bio-chemical parameters in different treatments were analysed after the end of the experiment. The Erythrocyte count (EC) showed highest in T-2 (2.24 million/mm<sup>3</sup>) and significantly different ( $p \leq 0.05$ ) from all other treatments while the significantly lowest count (1.23 million/mm<sup>3</sup>) was recorded in T-3 treatment. The highest value of Leucocytes count (50.77 thousands/mm<sup>3</sup>), hemoglobin level (6.97 g/dl) and Hematocrit (27.99 %), were showed in T-2 treatment where the fish fed with the feeding rate of 6% BW day<sup>-1</sup> and significant ( $p < 0.05$ ) among the treatments. The

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**Abstract of Ph.D. Thesis**

**Department : Aquaculture**

**Major Advisor :**

highest MCH value (38.61 g/dl) in T-0 was recorded in fish fed at 3% BW day-1 and significantly different from other treatments. The highest value of MCHC (24.90 g/dl) was found in T-1 while, the lowest (17.37 g/dl) was recorded in T-2. The MCV value of *Labeo rohita* found to be highest (176.4 g/dl) in T-0 (control). Biochemical indices like serum protein (5.46 mg/dl) and serum glucose (50.21 mg/dl) were significantly highest in the T-2 treatment than other treatments however serum cholesterol was showed highest (145.21 mg/dl) in the treatment T-3. The water quality parameters were not affected by the level of different feeding rate. After 120 days Rohu (*Labeo rohita*) was challenged by *A. hydrophila* (MTCC 7966) at different doses (10<sup>2</sup>-10<sup>8</sup> CFU/ml) for lethal dose concentration (LD<sub>50</sub>) determination and it was calculated as 10<sup>5</sup> CFU/ml. Further, the fish were induced with LD<sub>50</sub> dose of live *A. hydrophila* (2.38 × 10<sup>5</sup> CFU/ml) and RPS (Relative Percent of Survival) was done upto 10 days. The RPS was highest 52% in T-2 treatments. The present findings clearly indicated that feeding rate not only influence the growth of a fish but also interfere with the haematological parameters and immune response. Feeding fish at required rate i.e. 6% BW day-1 helps in maintaining good body physiology together with positive immune response which helps in combating bacterial outbreak and thereby enhance good growth of a fish in intensive farming system.



## **Evaluation of Some Non-Conventional Animal Protein Sources in the Practical Diet Formulation of Fresh Water Cat Fish *Clarias Magur* and Its Effect on Growth and Biochemical Composition**

*Shah Mustahid Hussain*

The present investigation was carried out to evaluate the growth performance of *Clarias magur* in response to different nonconventional diets, in the two locations Raha of Assam and Pasighat of Arunachal Pradesh. Juvenile magur weighing average  $8.49 \pm 1.98$  g and  $15.83 \pm 4.83$  g (Raha and Pasighat) were reared in tanks maintaining water level at  $50 \pm 5$  cm with six inches of soil bed. The fish were stocked @ 4 no./m<sup>2</sup> and fed with four iso-nitrogenous (35% crude protein) experimental diets D-1 (Vermi meal), D-2 (Chicken viscera meal), D-3 (Vermimeal+ Chicken viscera meal) and D-4 (Fish meal) @ 5 to 10 % of body weight in two split doses daily in the morning and evening. The diet D-4 was considered as reference diet. The experimental diets were prepared by using ingredients such as Fish meal, Vermi meal, Chicken viscera meal, Rice polish, Wheat flour & Vitamin and mineral mixture at different combination. The result reflected that the growth performance observed after six months of rearing the fish fed with Fish meal based diet was the best (204.93 g Raha; 194.54 g Pasighat), followed by 100% replacement of Fish Meal with Chicken viscera Meal (200.81 g Raha; 192.61 g Pasighat); Fish meal with mixture of Vermi meal and Chicken viscera meal (190.32 g Raha; 179.69 g Pasighat); and Fish meal with Vermi meal (181.30 g Raha; 174.58 g Pasighat). The present findings reflected that 100 % replacement of Fish meal can be done with Chicken viscera and mixture of Vermi meal and Chicken viscera meal without affecting the growth performance of the fish and flesh quality as differences in growth performance are almost negligible. The feed conversion ratio ranges between 1.50 to 1.75 for the fish grown on Fish meal based diet and 1.54 to 1.77 for Chicken viscera based meal diet and 1.62 and 1.91 for mixture of Chicken viscera meal and Vermi meal diet. All the experimental diets contains almost all the essential amino acids, however glycine and glutamic acid content was higher with all the experimental

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**Abstract of Ph.D. Thesis**

**Department : Aquaculture**

**Major Advisor :**

diets (glycine: 1.71-2.31 g/100g feed; glutamic acid: 5.41-5.95 g/100g feed). The digestibility of protein and lipid in diets D-4 and diet D-2 (Chicken viscera meal based diet) were not significantly different ( $P > 0.05$ ). The protein digestibility was highest ( $78.89 \pm 1.43$  %) with the reference diet D-4; while among the experimental diets, the protein digestibility was better with the diet D-2 ( $76.21 \pm 0.81$  %) followed by diet D-3 ( $75.89 \pm 2.05$  %) and diet D-1 ( $73.72 \pm 1.67$  %). The protein digestibility values did not vary significantly ( $P > 0.05$ ) among the treatments. The Moisture, Dry matter, NFE, Ash, Fibre and Protein percentage in muscles of the fishes grown with four different diets were not significantly ( $P > 0.05$ ) different, but lipid % were significantly ( $P < 0.05$ ) different for different diets for both the location. Significantly high ( $P < 0.05$ ) muscle lipid content was observed in the fish fed with diet D-2 followed by diet D-3 (mixture of Vermi Meal and Chicken Viscera meal based diet), diet D-4 and diet D-1. While assessing the consumer preference by Hedonic scale method it was found that all the fishes grown on different diet treatments was equally preferred. The present study indicated that nonconventional animal protein sources like vermi meal and chicken viscera meal are acceptable ingredients for the replacement of fish meal in practical diets of *Clarias magur*. The magur growers of North Eastern Region of India can use the formulation for preparing of feed for the fish as the ingredients used in the present study are largely available due to higher consumption of chicken in human diet as well as the approaches given for organic farming resulting in wide vermiculture practices in the region. Further, the use of chicken viscera in feed will minimize the environment pollutions converting the waste wealth.

## **Ph.D (Veterinary Science)**

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- **Animal Biotechnology**
- **Animal Genetics and Breeding**
  - **Animal Nutrition**
- **Animal Reproduction, Gynaecology and Obstetrics**
  - **Anatomy and Histology**
    - **Biochemistry**
- **Clinical Medicine, Ethics and Jurisprudence**
  - **Epidemiology and Preventive Medicine**
    - **Extension Education**
      - **Microbiology**
      - **Parasitology**
      - **Pathology**
- **Pharmacology & Toxicology & Jurisprudence**
  - **Physiology**
  - **Public Health**
- **Surgery and Radiology**
- **Livestock Production and Management**
  - **Livestock Products Technology**
    - **Poultry Science**

# **Production and Characterization of Recombinant Beta Toxin of *Clostridium perfringens***

*Arpita Bharali*

*Clostridium perfringens* causes several forms of enteric disease in human and animals. Different toxinotypes of *C. perfringens* produce different combinations of lethal toxins. *C. perfringens* type C produces beta toxin which is a kind of lethal pore-forming toxin that is responsible for necrotic enteritis in animals. Although *C. perfringens* type C infects several livestock species, the juvenile pigs are most susceptible. In India, the north-eastern states have the highest pig population in the country but no indigenous vaccine against *C. perfringens* type C is currently available. Therefore, the present study was conducted with an aim to produce recombinant beta toxin protein in a heterologous host and to evaluate the immunogenicity of the recombinant toxin adjuvanted with calcium phosphate nanoparticles in the mice model. For this, the *cpb* gene of *C. perfringens* type C that encodes the beta toxin was cloned into a prokaryotic expression vector, pET28a(+). Then the recombinant clone was transformed into BL21-CodonPlus<sup>®</sup>(DE3)-RIL *E. coli* cells. Expression of the recombinant beta toxin was induced by 1 mM IPTG for 12 hours at 37°C. The recombinant beta toxin protein was present as inclusion bodies in the insoluble fraction of the cell lysate which was further purified by Ni-NTA column affinity chromatography and confirmed by SDS-PAGE analysis. The specificity and the reactivity of the recombinant beta toxin protein were confirmed by western blotting using anti-sheep *C. perfringens* beta toxin serum. *In-vitro* and *in-vivo* toxicity of the recombinant beta toxin protein was evaluated in MDCK cell line and mice, respectively. The recombinant beta toxin protein did not show cytotoxicity in the concentrations from 3500-6.89 ng/ml as well as failed to produce clinical signs or death in mice when administered intravenously at a 100 µg dose. The recombinant beta toxin protein was loaded into calcium phosphate nanoparticles (CaP-NPs) used as an adjuvant, and a calcium phosphate nanoparticles-recombinant beta toxin protein complex was produced which was characterized using a zetasizer. The immunogenicity of the recombinant beta

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**Abstract of Ph.D. Thesis**

**Department : Animal Biotechnology**

**Major Advisor : Dr. R. K. Sharma**

toxin protein adjuvanted with CaP-NPs was evaluated and compared with the conventional Freund's adjuvant in the mice model. Three groups of six mice each were inoculated separately with 30 µg of the recombinant beta toxin protein with Freund's adjuvant (Group-I), 30 µg of the recombinant beta toxin adjuvanted with CaP-NPs (Group-II), and PBS in the control group (Group-III). The booster doses with corresponding inocula were given in all the groups 3 weeks apart and the level of antibody was estimated in serum samples collected at 7 days interval from day 0 to day 35 post-primary inoculation by indirect ELISA. The specific antibody response against the recombinant toxin protein was significantly higher ( $p < 0.05$ ) in Groups I and II from day 7 to day 35 compared to the control group. The level of antibody was at its peak on day 28 in the experimental groups (Groups I and II) and from day 28 to day 35, the level of antibody was significantly higher ( $p < 0.05$ ) in Group-II compared to Group-I. Hence, in the present study a non-toxic form of recombinant beta toxin of *C. perfringens* could be expressed in *E. coli* and the combination of the recombinant beta toxin protein with CaP-NPs as adjuvant could elicit better antibody response compared to its combination with the conventional oil adjuvant. However, its ability to produce neutralizing antitoxin and the protective efficacy against challenge infection are to be ascertained in future for considering it as a potential vaccine candidate against *C. perfringens* type C infection.

# **Phenotypic and Molecular Characterization of Extended Spectrum B-Lactamase Producing *Escherichia coli* and *Klebsiella* Isolates From Animal Sources**

*Leena Das*

Extended-spectrum beta-lactamase producing Enterobacteriaceae has become a major threat to both animals and human health globally. The present study was undertaken to isolate and identify ESBL producing *Escherichia coli* and *Klebsiella pneumoniae* from various sources, to study their resistant gene profile, to detect insertion sequences, to genogroup the isolates and to compare the efficacy of REP-PCR and PFGE to discriminate ESBL producing *E. coli* and *K. pneumoniae* isolates.

Out of 385 samples from various sources, 31 (8.05%) were positive for ESBL producing *E. coli*. Such isolates could be isolated from 10.05, 8.33, 15.63, 6.67 and 4.35 per cent of cattle milk, curd, chicken, pork and cattle faeces samples, respectively. However, no ESBL producing *E. coli* could be isolated from goat milk, goat faeces and beef samples. A total of 59 (15.32%) samples were positive for ESBL producing *K. pneumoniae*, which could be isolated from 14.35, 6.25, 21.43 and 34.78 per cent samples of cattle milk, chicken, beef and cattle faeces, respectively. No ESBL producing *K. pneumoniae* isolates could, however, be isolated from goat milk and faeces, curd and pork.

*In-vitro* drug susceptibility assay against 3rd and 4th generation cephalosporins showed resistance of all the 90 ESBL isolates to at least one antibiotic. In CDT, 93.55% of *E. coli* and 88.14% *K. pneumoniae* and in ESBL –E test, 96.77% *E. coli* and 88.14% *K. pneumoniae* showed positive results.

Antibiogram of the ESBL producing *E. coli* and *K. pneumoniae* showed resistance of 74.19% and 69.49%, respectively to ceftizoxime, 25.81% and 23.73% to both co-trimoxazole and tetracycline, 19.35% and 25.42% to ciprofloxacin, 9.68% and 16.95% to chloramphenicol, 3.23% and 5.08% to piperacillin-tazobactam, and 3.23% and 3.39% to gentamicin.

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**Abstract of Ph.D. Thesis**

**Department : Animal Biotechnology**

**Major Advisor : Dr. Probodh Borah**

Resistance gene profiling showed *bla*CTX-M gene to be present in all the 90 (100%) ESBL isolates. The *bla*TEM gene was found in 54.84% and 55.93%, *bla*SHV gene in 90.32% and 77.97%, *Sul* 1 gene in 90.32% and 86.44% isolates. The *Int*1 gene was detected in 70.97% and 62.71% isolates, while *qnr*B gene was found in 3.23% and 10.17% of *E. coli* and *K. pneumoniae* isolates, respectively.

Out of the insertion sequences under study, *ISEcp*1 was found to be present in all the 90 (100%) ESBL producing isolates, followed by *IS*26 (100% and 90.32%) and *ISCR*1 (80.65% and 45.76%) in *E. coli* and *K. pneumoniae* isolates, respectively. All the 90 ESBL producing isolates were subjected to PCR for detection of CTX-M genogroups. All the 90 (100%) ESBL producing isolates were found to be positive for group 1 gene. A total of 80.65% and 55.93% *E. coli* and *K. pneumoniae* isolates, respectively showed presence of group 2 genes. The corresponding percentages for group 25 gene were 27.27% and 67.8%. However, group 9 gene could be detected in 5.08% of *K. pneumoniae* isolates only. None of the *E. coli* isolates were found to be positive for group 8 and 9 genes, while no isolate of *K. pneumoniae* was found to be positive for group 8 gene.

The two molecular typing methods, REP-PCR and PFGE were found to show similar discriminatory power and could distinctly differentiate the ESBL producing *E. coli* and *K. pneumoniae* isolates. As both the methods were found equally competent, REP-PCR may be recommended as the preferred method of typing for epidemiological investigations owing to its advantages over PFGE in terms of rapidity, simplicity and ease of performance.

# **Molecular Characterization and Genotyping of Biofilm-Producing Staphylococci Associated with Bovine Mastitis**

*Madhusmita Dutta*

Mastitis is an inflammatory disease of dairy animals and is considered as one of the commonest problems of the dairy industry throughout the world. Though it is a multi-etiological disease, *Staphylococcus aureus* is considered to be a common and potent cause of mastitis due to its wide array of virulence factors and ability of forming biofilm. The present study aimed at isolation and identification of biofilm forming *S. aureus* from mastitic and apparently normal bovine milk samples, and molecular detection of genes related to adhesion and biofilm formation, antibiotic resistance and enterotoxin production. The study also included molecular typing of representative isolates by three methods namely, multilocus sequence typing (MLST), surface protein A typing (spa typing) and accessory gene regulator typing (agr typing). The study was further extended to assessment of antibiofilm efficacy of three compounds- chitosan, EDTA and povidone iodine against selected *S. aureus* isolates in vitro.

The study included a total of 136 milk samples comprising of 26 from mastitic and 110 from apparently healthy cows. In California Mastitis Test for detection of sub-clinical mastitis, 84 (76.40 %) of the 110 apparently normal milk samples tested positive. On bacteriological examination, 18 (69.23%) of 26 milk samples from mastitic cows and 64 (76.19%) of 84 apparently normal milk samples were to be positive for *Staphylococcus* with an overall positivity of 74.55%. Altogether 78 (95.12 %) of the 82 *Staphylococcus* isolates were found to be coagulase positive and confirmed as *S. aureus* based on detection of the species-specific *aroA* gene by polymerase chain reaction (PCR). Among the 78 *S. aureus* isolates, 54 (69.23 %) were identified as biofilm producers based on their characteristic growth on Congo red agar (CRA) plates. However, on PCR amplification, 58 (74.36%) of these isolates were found to carry *icaA* and *icaD* genes. All the isolates were found to have both *fnbA* and *clfB* genes, while 98.71, 61.50 and 11.53 per cent of the isolates were positive for *clfA*, *cna* and *bap* genes,

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respectively. On antimicrobial susceptibility testing, all the 78 isolates were found to be resistant to Oxacillin and Tetracycline. The isolates showed highest (25.64%) susceptibility to.

Cefepime followed by Ceftriaxone (23.08%) and Cefotaxime (20.51%). A very low susceptibility was shown to Gentamicin (10.26%), combination of Tricarillin and Clavulanic acid (3.85%), Chloramphenicol (2.56%) and Co-Trimoxazole (2.56%). Among the 54 biofilm producing isolates, 48 (88.89%) and 45 (83.33%) were found to carry blaZ1 and blaZ2 genes, respectively, while not a single isolate carried the smr gene. On the other hand, among the 24 non-biofilm producing isolates, 22 (91.67%) possessed both blaZ1 and blaZ2 genes, while none carried the smr gene. Of the 78 isolates, 14 (17.94 %) were found to have at least one of the three staphylococcal enterotoxin genes (sea, seb and sed) included in the study. However, none of the isolates were found positive for see genes. Multi Locus Sequence typing (MLST) of 15 representatives biofilm-producing *S. aureus* isolates could detect three sequence types (STs) and one clonal complex (CC). Seven isolates belonged to ST672, five to ST1713 and three to ST2592 with slight variations in the allelic profile. ST672 had no CC while ST1713 and ST2592 belonged to CC1. Spa typing of the same isolates revealed three different spa types, t1309, t1611 and t267. Of the 15 isolates tested, two agr types were identified: agr I (60 %) and agr II (40 %). Strains belonging to agr types III and IV were not detected in this study.

Antibiofilm efficacy of 5% povidone iodine (betadine®), 20 mM EDTA and 5 mg/ml of chitosan was tested in the present study based on determination of MIC of these compounds either alone or in combination against selected biofilm-producing *S. aureus* isolates. It was found that the combined effect of all the three compounds against biofilm-producing *S. aureus* was almost similar to that of the combination of chitosan and povidone iodine. Hence, the later combination was suggested as an alternative to using high concentration of an antiseptic for sanitization of the udder surface of milch cows to get rid of biofilm-producing *S. aureus* frequently associated with subclinical mastitis.

# **Phenotypic Characterization and Polymorphism Study of Prolactin Gene in Native Geese of Assam**

*Ankita Gogoi*

Data pertaining to 1015 native geese of Assam were considered for morphometric characteristics, productive and reproductive performances, egg quality and carcass traits, along with screening of polymorphisms in 5'flanking region of Prolactin gene. Two plumage colours, cinnamon (62.38%) and white (37.62%) were seen. Bill colour was observed to be black (49.08%), orange (35.33%), yellow (13.24%) and mixture of black and orange (2.35%). The skin was 100% white. Shank and feet colour were orange (75.32%), yellow (21.67%) and mixture of black and orange colour (3.01%). Black (60.14%), brown (28.49%) and blue (11.37%) eye colour was seen. The overall LSM  $\pm$  SE for body weights at hatching, 4 week, 8 week, 6 month, 8 month, 12 month of age were 89.85 $\pm$ 0.11, 66.89 $\pm$ 1.21, 1761.90 $\pm$ 2.08, 3305.42 $\pm$ 4.63, 3575.80 $\pm$ 10.61 and 3804.84 $\pm$ 3.91 g, respectively. The overall mean (cm) for bill length, bill width, knob diameter (at 12 months of age), head length, head width, neck length, neck girth, breast length, keel length, body length, body circumference, shank length and wingspan (3 to 6, 8 to 10 and 12 months of age) at the respective ages were 5.31  $\pm$  0.018, 6.24  $\pm$  0.01, 7.24  $\pm$  0.012, 8.42  $\pm$  0.014; 1.46  $\pm$  0.010, 1.95  $\pm$  0.008, 2.19  $\pm$  0.009, 2.45  $\pm$  0.009; 2.34  $\pm$  0.006; 5.42 $\pm$  0.019, 6.70  $\pm$  0.018, 8.31  $\pm$  0.019, 10.26  $\pm$  0.018; 2.44  $\pm$  0.009, 2.80  $\pm$  0.011, 3.03  $\pm$  0.010, 3.26  $\pm$  0.012; 14.13  $\pm$  0.031, 16.00  $\pm$  0.032, 17.80  $\pm$  0.026, 21.74  $\pm$  0.027; 2.17  $\pm$  0.012, 4.12  $\pm$  0.013, 6.28  $\pm$  0.011, 10.19  $\pm$  0.019; 7.95  $\pm$  0.022, 15.73  $\pm$  0.044, 21.42  $\pm$  0.023, 29.93  $\pm$  0.022; 10.93  $\pm$  0.024, 12.62  $\pm$  0.023, 14.34  $\pm$  0.025; 35.89  $\pm$  0.049, 39.82  $\pm$  0.040, 42.36  $\pm$  0.043, 48.21  $\pm$  0.037; 33.03  $\pm$  0.033, 43.74  $\pm$  0.06, 45.59  $\pm$  0.033, 49.92  $\pm$  0.029; 5.23  $\pm$  0.015, 6.10  $\pm$  0.016, 7.30  $\pm$  0.015, 8.36  $\pm$  0.015 and 89.89  $\pm$  0.038, 101.54  $\pm$  0.038 and 114.12  $\pm$  0.037, respectively. Significant effects (P<0.01) of district and sex of bird on body weight and morphometric traits were observed. Age at first lay, annual egg production, clutch size and clutch interval were 323.02 $\pm$ 0.302 days, 21.51 $\pm$ 0.180 numbers, 9.87 $\pm$ 0.098 numbers and 64.48 $\pm$ 0.655 days, respectively. Two laying cycles, viz., September to October and December to February were observed. Egg weight, shell weight, shell thickness, shape

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index and specific gravity were  $117.00 \pm 1.395$  g,  $14.19 \pm 0.225$  g,  $0.54 \pm 0.006$  mm,  $72.22 \pm 0.283$  % and  $1.09 \pm 0.001$ , respectively. Albumen Index, Haugh Unit, Yolk Index and yolk weight were  $0.06 \pm 0.001$ ,  $59.79 \pm 0.726$ ,  $0.34 \pm 0.007$  and  $61.98 \pm 1.045$ , respectively. Age at slaughter (days), pre-slaughter weight (g), shrinkage (%), dressing percentage (%), evisceration loss (%) and ready to cook yield (%) in gander were  $411.40 \pm 4.26$ ,  $4192.80 \pm 69.87$ ,  $4.36 \pm 0.05$ ,  $67.10 \pm 1.14$ ,  $7.58 \pm 0.58$  and  $70.43 \pm 1.05$ , respectively. The corresponding values in geese were  $338.00 \pm 21.48$ ,  $3878.40 \pm 36.06$ ,  $4.76 \pm 0.32$ ,  $66.11 \pm 1.01$ ,  $7.02 \pm 0.73$  and  $70.28 \pm 1.24$ . In gander, yield of cut up parts on live weight (%) were  $17.62 \pm 0.19$ ,  $7.68 \pm 0.14$ ,  $6.58 \pm 0.10$ ,  $13.56 \pm 1.29$ ,  $4.62 \pm 0.12$  and  $8.05 \pm 0.21$  for breast, drumstick, thigh, back, neck and wings respectively. The corresponding values on dressed weight (%) were  $27.49 \pm 0.56$ ,  $11.98 \pm 0.29$ ,  $10.26 \pm 0.13$ ,  $21.01 \pm 1.66$ ,  $7.21 \pm 0.23$  and  $12.55 \pm 0.25$ , respectively. In geese, cut up parts yield to live weight (%) were  $17.58 \pm 0.28$ ,  $6.74 \pm 0.14$ ,  $6.71 \pm 0.10$ ,  $12.40 \pm 0.50$ ,  $4.35 \pm 0.16$  and  $7.87 \pm 0.33$  for breast, drumstick, thigh, back, neck and wings, respectively. The corresponding values as per dressed weight (%) were  $27.94 \pm 0.42$ ,  $10.71 \pm 0.19$ ,  $10.67 \pm 0.16$ ,  $19.67 \pm 0.43$ ,  $6.93 \pm 0.33$  and  $12.48 \pm 0.41$ , respectively. Meat to bone ratio of  $2.05 \pm 0.01$  was found in both the sexes. 100 percent broody behavior observed. Fertility and hatchability (TES) were  $91.38 \pm 6.83$  and  $86.50 \pm 7.59\%$ . Mortality rate were 22.58, 15.24 and 11.72 at 0 to 1, 1 to 8 and 8 to 20 weeks. Screening for polymorphism in 5'-flanking region of *PRL* revealed transversion of G to C at location 117 and transition of C to T at location 182. The native geese attained much higher body weight at 6 months and 12 months of age compared to other poultry species. Various studies may be undertaken to genetically characterize the goose populations and association studies of genes with production traits may be conducted. Geese have promising role as alternate species for backyard poultry meat production. The detailed study would help in development of breed descriptors and baseline reference for future studies.

## **Genetic Studies on the Performance of HD-K75 Pigs**

*Jyotishree Bayan*

Pig farming in India is primarily a small scale unorganized rural activity and is an integral part of diversified agriculture particularly in the tribal belt of the country and have been contributing to improve the livelihood of poor and socially weaker section of the society including the tribal people of India. Pig farming in Assam is rapidly gaining momentum in recent years as the farmers are finding it a profitable enterprise.

The present investigation was carried out on HD-K75 pigs (75% Hampshire inheritance and 25 % indigenous inheritance) that are bred and maintained in the All India Coordinated Research Project (AICRP) on pigs, ICAR, located at College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati-781022. The data were collected and compiled from the progenies of 44 sires and 114 dams maintained over a period of 6 years from 2012 to 2018.

The objective of the investigation were to study some important traits of growth and reproduction and the effect of various non-genetic factors influencing these traits, determine heritability, genetic correlation and phenotypic correlation of some important growth and reproduction traits, to construct linear, partial and multiple regression equations and to predict adult body weights based on early body weights.

Traits included in the study were body weights at birth, weaning, 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, 6<sup>th</sup> and 8<sup>th</sup> months of ages, and daily body weight gains during pre-weaning (birth to weaning) and post-weaning periods (from weaning to 4<sup>th</sup>, 6<sup>th</sup> and 8<sup>th</sup> month of ages), age at sexual maturity, gestation period, farrowing interval, litter size at birth, litter weight at birth, litter size at weaning and litter weight at weaning.

The overall mean body weight in HD-K75 pigs at birth, 1 month, weaning, 2 months, 3 months, 4 months, 6 months and 8 months of age were  $1.001 \pm 0.001$  kg,  $6.912 \pm 0.011$  kg,  $9.666 \pm 0.013$  kg,  $12.207 \pm 0.007$  kg,  $18.324 \pm 0.001$  kg,  $28.349 \pm 0.052$  kg,  $51.177 \pm 0.091$  kg and  $71.229 \pm 0.110$  kg respectively. The average daily body weight gains (ADG) in g during birth to weaning, weaning to 4<sup>th</sup> month, weaning to 6<sup>th</sup> month and weaning to 8<sup>th</sup> month of ages were  $206.299 \pm 0.311$ ,  $237.294 \pm 0.773$ ,  $299541 \pm 0.700$  and  $311.206 \pm 0.557$  respectively. Least-squares analysis of variance

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revealed highly significant effect of season of birth, parity and sex on body weight at all ages and daily body weight gains at various stages of growth. Piglets born during winter season had higher body weight at birth, 1 month, 42 days, whereas piglets born during post-monsoon season had higher body weight at 2 months, 3 months, 4 months and 6 months of age and piglets born during monsoon season had higher body weight at 8 months of age. Pre-weaning ADG was higher in piglets born during monsoon season and lowest in animals born during pre-monsoon season. The ADG during 42 days to 4<sup>th</sup> month and 42 days to 6<sup>th</sup> month were found to be higher in piglets born during post-monsoon season and lowest in piglets born during pre-monsoon season. Piglets born in second parity had higher body weight at 3 months, 4 months, 6 months and 8 months whereas piglets born in third parity had higher body weight at birth and 1 month and piglets born in first parity had higher body weight at weaning and 2 months of age. Significantly higher ADG was found during pre-weaning period of growth in animals born in first parity. Further, the ADG from 42 days to 4<sup>th</sup> month, 42 days to 6<sup>th</sup> month and 42 days to 8<sup>th</sup> months of age were found to be higher in animals born in second parity and revealed significant difference with the animals of first and third parities. Males showed higher body weight and higher ADG than females in all stages of growth.

The  $h^2$  estimates for body weight and ADG at various stages of growth in the present study were moderate to high in most of the cases which indicated that the population under study possess good amount of additive genetic variance and there is scope of genetic improvement of the herd in terms of growth traits and ADG at various stages using adequate methods of selection by incorporating these estimates. The phenotypic correlations among body weights at various ages were moderate and positive in some cases and negative in some cases. The phenotypic correlations among ADG at various stages of growth were moderate and positive in some cases and negative in some cases. The genetic correlations among body weights at various ages of growth were low to high and positive in some cases and negative in some cases. The genetic correlations among ADG at various stages of growth were moderate and positive in some cases and negative in some cases.

The overall means for age at sexual maturity, gestation length and farrowing interval were found to be  $205.294 \pm 1.054$ ,  $112.70 \pm 0.119$  and  $216.781 \pm 2.565$  days respectively.

Effect of season of birth on age at sexual maturity was found to be non-significant as indicated by least square analysis of variance. Non-significant effect of season of birth and parity on gestation period was observed in the present study in HD-K75 pigs. Least-squares analysis of variance revealed significant difference between the various seasons under study in respect of farrowing interval. Sows that farrowed during post-monsoon season had significantly longer farrowing interval and differed significantly with other seasons and the shortest farrowing interval was observed in sows that farrowed during monsoon season. Least square analysis of variance revealed that the effect of parity on farrowing interval in the present study was non-significant.

The  $h^2$  estimates of age at sexual maturity, gestation length and farrowing interval for HD-K75 pigs was low to moderate in magnitude. The phenotypic correlation among the reproduction traits were found to be low and positive in most cases. The genetic correlation among the reproduction traits were found to be moderate and positive in most cases.

The overall means for litter size at birth, litter size at weaning, litter weight at birth and litter weight at weaning were found to be  $7.747 \pm 0.088$ ,  $7.556 \pm 0.093$  numbers and  $7.804 \pm 0.084$  and  $74.644 \pm 0.0886$  kg respectively.

Least-squares analysis of variance revealed significant effect of season of birth on litter size at birth, litter size at weaning, litter weight at birth and litter weight at weaning. Piglets born during pre-monsoon season showed highest litter size at birth and weaning. Piglets born during post-monsoon season and winter season showed highest litter weight at birth and litter weight at weaning. Further, litter size at birth, litter size at weaning, litter weight at birth and litter weight at weaning were found lowest during monsoon season. Least-squares analysis of variance revealed that parity had significant effect on litter size at birth, litter size at weaning, litter weight at birth and litter weight at weaning. Piglets born in third parity showed highest and piglets born in first parity showed lowest litter size at birth, litter size at weaning, litter weight at birth and litter weight at weaning respectively.

The  $h^2$  estimates of litter size at birth and litter size at weaning in HD-K75 pigs in the present study were found to be low in magnitude. The  $h^2$  estimates of litter weight at birth and litter weight at weaning were found to be medium in magnitude. The phenotypic correlations among the litter traits were found to be high and positive in most cases. The genetic correlations among the litter traits were found to be moderate to high and positive in most cases.

Prediction equations were developed using post-weaning body weights at 6 months ( $Y_1$ ) and 8 months ( $Y_2$ ) of ages as dependent variables based on pre-weaning body weights at birth ( $X_1$ ), 1 month ( $X_2$ ), 42 days ( $X_3$ ), 2 months ( $X_4$ ) and 3 months ( $X_5$ ) of age as independent variables in various combinations. For prediction of adult body weights on the basis of body weights at early ages in HD-K75 pigs, linear, partial and multiple regression equations were developed.

The linear regression equations for predicting body weights at 6 months of age had comparatively higher  $R^2$  values than 8 months of age in HD-K75 pigs, but were not found to be reliable as the  $R^2$  values were less than 60 %. The partial regression equations for predicting body weights at 8 months of age had comparatively higher  $R^2$  values than 6 months of age and were found to be more reliable. All the multiple regression equations developed to predict the adult body weight at 8 months of age can be reliably used when 3-5 independent variables are considered. Multiple regression equations developed to predict 8 month body weight showed highest reliability with  $R^2$  values ranging from 70.87 to 90.56 %. High  $R^2$  values indicates that the 8 month body weight can be predicted more efficiently than 6 month body weight. The multiple regression equations for predicting body weight at 8 months using 3 independent

variables viz. body weight at birth, 1 month and weaning showed high  $R^2$  value of 90.21 % which was found to be highly reliable and the best combination, though higher  $R^2$  values were obtained in multiple regression equations using 4 and 5 independent variables.

## **Studies on Swamp Buffaloes of Assam under Farm and Field Condition**

*Momi Sarma*

The present investigation was conducted to study some of the morphometric, production & reproduction and milk constituent traits of swamp buffaloes of Assam under farm and field condition. Accordingly, the required data for farm animals were collected from the records maintained at the buffalo farm under Network project on swamp buffaloes of Assam, College of Veterinary Science, A.A.U. Khanapara and Government Livestock Farm, Department of A.H. & Vety., Govt. of Assam, Barhampur, Nagaon. The data for field animals were collected from different buffalo *khutis* located at Dhemaji, North Lakhimpur and Sivasagar districts of Assam through field survey by providing questionnaire as well as through personal interviews with the farmers. For morphometric traits, the measurements were made on adult buffaloes using standard measuring tape at farm as well as at field. For milk constituents milk samples of swamp buffaloes were collected randomly from farm as well as from field and were tested using Milk Analyzer, LAKTAN 1-4 (Model: 220). For morphometric traits 62 numbers of swamp buffaloes from Khanapara buffalo farm, 21 numbers from Barhampur buffalo farm and 224 numbers from field were considered. Out of 224 animals, 146 from Dhemaji and North Lakhimpur districts (north bank) and 78 from Sivasagar district (south bank) were measured. For production and reproduction traits 1056 lactation records, of which 208 lactation records pertaining to 52 no. of animals from Khanapara buffalo farm and 848 lactation records pertaining to 212 no. of animals from field (buffalo *khutis*) covering all the three districts were considered. A total of 172 milk samples, out of which 46 samples from Khanapara farm and 126 from Dhemaji, North Lakhimpur and Sivasagar districts of Assam were tested for various milk constituents. The body measurement traits include body length, height at withers, heart girth and the pouch girth. The overall least-squares means ( $\mu$ ) for the body length, height at withers, heart girth and pouch girth were found to be  $108.881 \pm 1.448$  cm,  $126.793 \pm 1.378$  cm,  $172.630 \pm 2.608$  cm and  $174.760 \pm 2.422$  cm, respectively. Significant ( $P < 0.05$ ) effect of the two locations under study was observed in case of all

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the body measurement traits viz., body length, heights at withers, heart girth and pouch girth. Significant ( $P < 0.05$ ) effect of sex was seen for all the body measurement traits viz., body length, heights at withers, heart girth and pouch girth. Male buffaloes were observed to show higher values for all the traits of body measurements than the females. The head measurement traits include head length and eye to eye space. The overall least-squares means ( $\mu$ ) for the head length and eye to eye space was found to be  $43.746 \pm 0.772$  cm and  $15.125 \pm 0.314$  cm, respectively. Significant ( $P < 0.05$ ) effect of the two locations under study was observed in case of head length. Significant ( $P < 0.05$ ) effect of sex was seen on both the traits of head measurements viz., head length and eye to eye space. Male animals have shown higher values for both the traits of head measurements than the females. The least-squares means ( $\mu$ ) for the ear length was found to be  $21.498 \pm 0.287$  cm. The horn measurement traits include circumference of horns at base, horn length, space between two horns at base and space between two horns at tips. The overall least-squares means ( $\mu$ ) for the circumference of horns at base and horn length was found to be  $18.975 \pm 0.491$  cm and  $43.312 \pm 0.934$  cm, respectively. While the overall least-squares means ( $\mu$ ) for the space between two horns at base and space between two horns at tips were found to be  $16.293 \pm 0.316$  cm and  $37.118 \pm 0.807$  cm. Significant ( $P < 0.05$ ) effect of sex was observed in case of horn length and space between two horns at base. Male buffaloes have shown higher values for the horn measurement traits. The tail measurement traits include length of tail and length of switch of tail. The overall least-squares means ( $\mu$ ) for the length of tail and length of switch of tail were found to be  $69.956 \pm 0.913$  cm and  $13.625 \pm 0.298$  cm. Significant ( $P < 0.05$ ) effect of sex was observed in case of length of tail. Male buffaloes have shown higher value for the length of tail than the female buffaloes. For colour characteristics, coat colour, horn colour and tail switch colour was included. Coat colour was predominantly grey (98.58%) with few white (albino) (1.52 %) was observed. For horn colour, black colour was observed in all the observations. For tail switch colour two variants were observed viz., black in 86.65 % observation and brown in 13.35% observation. The least-squares means ( $\mu$ ) for first lactation milk yield and for first lactation length was found to be  $449.379 \pm 5.517$  kg and  $239.443 \pm 5.845$  days, respectively. Highly significant effect ( $P < 0.01$ ) of location on first lactation milk yield was observed. The least-squares means ( $\mu$ ) for first peak yield and for days to attain first peak yield was found to be  $2.810 \pm 0.016$  kg and  $59.204 \pm 3.167$  days, respectively. Significant influence ( $P < 0.05$ ) of season of calving was observed on days to attain peak yield. The least-squares means ( $\mu$ ) for the age at first calving was found to be  $53.714 \pm 2.269$  months. The least-squares means ( $\mu$ ) for first gestation length and first dry period were found to be  $308.549 \pm 1.444$  days and  $246.913 \pm 6.452$  days, respectively. Significant influence ( $P < 0.05$ ) of sex of calf was observed on first gestation length. Highly significant influence ( $P < 0.01$ ) of location was observed on first dry period. Significant influence ( $P < 0.05$ ) of season of calving and sex of calf was observed on first dry period. The overall least-squares means ( $\mu$ ) for first service period and first calving interval were found to be  $178.042 \pm 5.852$  days and  $486.533 \pm 6.879$  days,

respectively. Highly significant influence ( $P < 0.01$ ) of location was observed on service period. Significant influence ( $P < 0.05$ ) of season of calving and sex of calf was observed on first service period. Significant influence ( $P < 0.05$ ) of location was observed on first calving interval. The least-squares means ( $\mu$ ) for birth weight was found to be  $29.441 \pm 2.446$  kg. The least-squares means ( $\mu$ ) for lactation milk yield and lactation length was found to be  $453.654 \pm 6.715$  kg and  $243.847 \pm 6.394$  days, respectively. Highly significant influence ( $P < 0.01$ ) of location and order of lactation were observed on both lactation milk yield and lactation length. The overall least-squares means ( $\mu$ ) for peak yield was found to be  $2.951 \pm 0.035$  kg and days to attain peak yield was found to be  $59.626 \pm 4.591$  days. Highly significant influence ( $P < 0.01$ ) of location was observed on days to attain peak yield. Highly significant influence ( $P < 0.01$ ) of order of lactation was observed on peak yield as well as on days to attain peak yield. The least-squares means ( $\mu$ ) for gestation length and dry period was found to be  $309.079 \pm 1.387$  days and  $238.396 \pm 5.664$  days, respectively. Highly significant ( $P < 0.01$ ) influence of sex of calf was observed on gestation length. Highly significant ( $P < 0.01$ ) influence of order of lactation was seen on dry period. The overall least-squares means ( $\mu$ ) for service period and calving interval was found to be  $177.709 \pm 5.555$  days and  $486.700 \pm 5.503$  days, respectively. Highly significant ( $P < 0.01$ ) influence of order of lactation was observed on calving interval. The overall least-squares means ( $\mu$ ) for milk fat %, solid-not fat %, milk protein % and total solids % were found to be  $7.591 \pm 1.148$ ,  $9.047 \pm 0.052$ ,  $3.032 \pm 1.126$  and  $16.638 \pm 1.125$  % respectively. Significant ( $P < 0.05$ ) influence of location was observed on milk fat % and milk protein %.

## **Characterization of Ghumusari and Raighar Goats of Odisha**

*Subhashree Panigrahi*

The present study was conducted to characterize two indigenous goat population of Odisha viz. the Ghumusari and the Raighar. Data were collected through field survey from the breeding tracts of these two varieties. Objectives of the investigation were to study some of the important morphometric traits, certain important traits of growth and reproduction and polymorphism of *IGF1* gene. Records were obtained from 859 animals for coat colour, 216 animals for ear length and horn measurements, 375 animals for body measurements and growth traits and 272 animals for reproductive traits in Ghumusari goat. For Raighar goat, the corresponding number of animals for these traits were 667, 314, 394 and 338. Polymorphism of *IGF1* gene was investigated on 50 animals from each of these two goat populations of Odisha. Coat colour was found to be predominantly black (66.13 per cent) in Ghumusari and deep brown (74.52 per cent) in Raighar. The overall least-squares means for ear length, horn length, horn circumference at base, space between two horns at base and the space between two horns at tip were  $12.570 \pm 0.06$ ,  $5.111 \pm 0.03$ ,  $6.584 \pm 0.03$ ,  $4.598 \pm 0.03$  and  $9.778 \pm 0.03$  cm respectively in Ghumusari. In Raighar goat, the respective values for these traits were  $13.004 \pm 0.02$ ,  $5.243 \pm 0.02$ ,  $6.337 \pm 0.02$ ,  $2.986 \pm 0.02$  and  $10.440 \pm 0.03$  cm. The LSM for body length at birth, 3, 6, 9 and 12 months of age were  $27.069 \pm 0.10$ ,  $40.755 \pm 0.09$ ,  $46.282 \pm 0.11$ ,  $51.084 \pm 0.13$  and  $54.842 \pm 0.15$  cm respectively in Ghumusari. The corresponding values for these traits were found to be  $26.027 \pm 0.10$ ,  $45.545 \pm 0.13$ ,  $50.066 \pm 0.12$ ,  $53.852 \pm 0.15$  and  $55.887 \pm 0.14$  cm in Raighar. Location had significant effect on body length at 9 months, season of birth at 12 months, and parity at 6 months of age in Raighar goat. Body length was significantly higher in males than in females at birth, 3 and 6 months of age in Ghumusari, and at 3 and 9 months of age in Raighar. Among the birth types, singlets had significantly higher body length at 3 months in Ghumusari, and at 6, 9 and 12 months of age in Raighar. The overall LSM for height at withers at birth, 3, 6, 9 and 12 months of age were  $27.648 \pm 0.12$ ,  $42.048 \pm 0.09$ ,  $47.929 \pm 0.14$ ,  $52.380 \pm 0.15$  and  $54.678 \pm 0.18$  cm respectively in Ghumusari; and  $27.591 \pm 0.13$ ,  $46.548 \pm 0.12$ ,  $52.882 \pm$

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0.15, 53.628±0.14 and 54.858±0.19 cm respectively in Raighar. Significant effect of parity at birth, sex at 3, 6, 9 months and type of birth at all the age groups was observed in both the populations. Raighar goat of Nuapada district showed significantly higher height at withers at birth, 6 and 9 months of age compared to those of Kalahandi and Nabarangpur districts. The overall LSM for heart girth at birth, 3, 6, 9 and 12 months of age were 25.346±0.09, 41.606±0.09, 47.701±0.15, 51.397±0.15 and 54.105±0.17 cm respectively in Ghumusari. The respective values were found to be 26.713±0.12, 46.273±0.17, 51.061±0.15, 54.612±0.15 and 58.540±0.16 cm in Raighar. Location (district) exhibited significant effect on heart girth at 6 and 9 months in Ghumusari and at 6 months of age in Raighar. Significant effect of parity at birth and birth type was found in Raighar goat at 3 months of age. The overall LSM for paunch girth at birth, 3, 6, 9 and 12 months of age were 26.866±0.09, 44.747±0.14, 49.333±0.16, 55.748±0.17 and 57.105±0.17cm respectively in Ghumusari. In Raighar goat, the corresponding values were found to be 28.101±0.09, 52.097±0.16, 53.791±0.16, 58.457±0.17 and 59.938±0.15 cm. The effect of parity and birth type at 3 months and sex at birth, 3, 12 months of age were observed in Ghumusari. Location influenced paunch girth significantly at 3 months, birth type at 12 months and sex at 12 months of age in Raighar goat. The overall LSM for body weight at birth, 3, 6, 9 and 12 months were found to be 1.294±0.02, 6.376±0.04, 11.491±0.06, 14.597±0.06 and 16.630±0.09 kg respectively in Ghumusari goat, the respective values being 1.485±0.02, 6.432±0.04, 11.520±0.06, 14.739±0.06 and 16.668±0.09 kg in Raighar goat. In Ghumusari goat, with regard to body weight at all the ages, location and season of kidding showed non-significant effect. Parity at 3 months, sex and birth type at all the ages exerted significant effect on this trait. In Raighar goat, significant effect of location and sex at 3, 6, 9, 12 months of age; parity and birth type at all the ages; and season of kidding at 12 months of age for this trait was noted. The overall LSM for age at sexual maturity, weight at sexual maturity, age at first kidding, weight at first kidding, kid size at birth, kidding interval, gestation period and service period in Ghumusari were found to be 204.52±1.02 days, 11.64±0.05 kg, 375.49±1.18 days, 16.68±0.06 kg, 1.51 ± 0.03, 241.79±1.72 days, 148.09±0.13 days and 93.78±1.71 days respectively. For Raighar goat, these values were respectively 292.32±1.07 days, 14.63±0.05 kg, 456.66±1.22 days, 17.01±0.06 kg, 1.45 ± 0.03, 234.15±1.61 days, 147.67 ± 0.12 days and 86.65±1.60 days. In Ghumusari goat, kid size at birth was significantly affected by season of kidding. Parity had significant influence on age at sexual maturity, weight at sexual maturity, age at first kidding, weight at first kidding and kid size at birth. In Raighar goat, location had significant effect on age at sexual maturity, kidding interval and service period. Season of kidding exerted significant effect on age at sexual maturity, weight at sexual maturity, age at first kidding, weight at first kidding, kid size at birth, gestation period, and parity on weight at sexual maturity, kid size at birth, kidding interval and service period in this goat variety. The PCR-RFLP analysis was used to identify the variants in *IGF1* gene based on the variants produced by digestion of 505 bp amplified product with *HaeIII* restriction enzyme. On restriction digestion, the 505 bp

amplicon produced 4 fragments of 333, 234, 172 and 99 bp. The PCR-RFLP studies on *IGF1* gene in both Ghumusari and Raighar goats of Odisha using *HaeIII* restriction enzyme revealed three banding patterns, arbitrarily designated as AA, AB and BB genotypes. Out of these, AA genotype yielded two fragments ( 333, 172 bp ), AB genotype yielded four fragments ( 333, 234, 172, 99 bp ), and BB genotype yielded three fragments ( 234, 172, 99 bp ). In Ghumusari goats, the frequencies of AA, AB and BB genotypes were 0.28, 0.32 and 0.4 respectively, and the frequencies of 'A' and 'B' alleles were 0.44 and 0.56 respectively. In Raighar goat, the frequencies of AA, AB and BB genotypes were 0.1, 0.5 and 0.4 respectively, and the frequencies of 'A' and 'B' alleles were 0.35 and 0.65 respectively. In the present study, the results showed polymorphic banding patterns in both the goat populations with respect to *IGF1* gene. Chi-Square ( $\chi^2$ ) test revealed that the population under study was in Hardy-Weinberg equilibrium. *HaeIII* restriction site was detected at 171<sup>th</sup> position of a total 505 bp by partial sequencing. The sequence alignment of the samples detected an SNP at 405<sup>th</sup> position with nucleotide transversion from G to C. Based on the uniformity in their productive and reproductive performances both the population are potent to be recognized as breed.

# **Isolation, Characterization and Morpho-Biometric Evaluation of Pre-Pubertal Porcine Spermatogonial Stem Cells in Different Culture Media**

*Timothy Lalmalsawma*

Testes samples were collected from 7-15 days old pre-pubertal male crossbred piglets (Local × Hampshire) for isolation, enrichment and *in vitro* culture of porcine spermatogonial stem cells (SSCs). Isolation of spermatogonial stem cells like cells was performed by double enzymatic digestion using four enzymes viz., collagenase, DNase I, hyaluronidase type II and trypsin-EDTA. Isolated cells were further enriched by differential plating and percoll density gradient centrifugation method. Enriched cells were cultured on Sertoli cell feeder layer in three different culture media. All the three media consisted of same concentration of DMEM, NEEA, L-glutamine, FBS, EGF and FGF, however in addition to these, LIF was added to media I, GDNF was added to media II and both LIF and GDNF were added to media III. Characterization of SSCs was done by alkaline phosphatase and immunofluorescence staining. Expression of SSC specific pluripotent marker genes by putative SSCs was also studied by RT-PCR study. Porcine SSCs were observed as dome shaped round or oval bodies on 5<sup>th</sup> -6<sup>th</sup> day of culture in all the three media. Clustering of cell was observed from 4<sup>th</sup> -5<sup>th</sup> day of culture and single, paired or multiple colonies were observed from 8-10<sup>th</sup> day of culture. The SSCs colonies appeared as mulberry, grape or rosette shaped with irregular distinct boundary from feeder layer on 15<sup>th</sup> - 19<sup>th</sup> day of culture in all the three media. However, the shape of the SSCs was found to be distorted with increase in the days of culture. The morphology of the SSC colonies was maintained best up to 30<sup>th</sup> day of culture in media III. The SSC colony number was recorded as  $82.14 \pm 2.91$ ,  $60.07 \pm 2.78$  and  $48.43 \pm 1.96$  on 5<sup>th</sup>, 15<sup>th</sup> and 30<sup>th</sup> day of culture respectively in media I. The corresponding numbers were  $91.71 \pm 2.62$ ,  $67.00 \pm 2.05$  and  $57.29 \pm 2.17$  in media II and  $105.93 \pm 2.82$ ,  $80.21 \pm 2.45$  and  $62.50 \pm 2.09$  in media III respectively. The SSC colony diameter was found to be  $64.26 \pm 0.85$ ,  $125.30 \pm 1.88$  and  $123.01 \pm 5.49$   $\mu\text{m}$  on 5<sup>th</sup>, 15<sup>th</sup> and 30<sup>th</sup> day of culture respectively in media I. The corresponding values were  $69.67 \pm 1.12$ ,

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139.58 ± 3.93 and 142.08 ± 5.72µm in media II and 76.49 ± 1.61, 152.55 ± 4.07 and 172.08 ± 4.96µm in media III respectively. The day of culture and culture media had significant effect ( $P \geq 0.01$ ) on SSC colony number and significantly higher number of SSC colony was observed on day 5 and lower was on day 30 of culture in all the three media. The SSC colony number was significantly higher in media III containing both GDNF and LIF. The diameter of SSC colony differed significantly ( $P \geq 0.05$ ) due to day of culture and culture media. The interaction between day of culture and culture media was also significant ( $P \geq 0.01$ ). The colony diameter recorded on day 30 of culture was significantly higher, whereas lower number was recorded on day 5 of culture in all the culture media. Diameter of SSC colony obtained in media III was found to be significantly higher and the lower diameter was obtained in media I on all the day of culture. It was observed that the SSC colony number decreased and colony diameter increased with the day of culture from day 5<sup>th</sup> to 30<sup>th</sup> day of culture in all the media. The putative SSCs in all the three media showed positive result for alkaline phosphatase and immunofluorescence staining. The putative SSCs in all the three media were also found to express SSC specific pluripotent marker genes viz., *OCT4*, *SOX2*, *NANOG* and maximum expression was observed in media III, however, no expression was recorded for *c-KIT* and *PPAR $\gamma$*  which were known to be the markers for differentiated SSCs. *BAX4*, an apoptotic marker gene was also expressed by putative SSCs in all the three media. Based on the findings of the present study, it may be concluded that a pure population of porcine spermatogonial stem cells (SSCs) could be obtained and successfully maintained *in vitro* up to 30<sup>th</sup> day of culture. Media III containing DMEM, FBS, NEAA, L-glutamin, FGF, EGF, LIF and GDNF was found to be the best for *in vitro* culture of porcine SSCs.

## **Effect of Feeding Distillers Dried Grain with Soluble (DDGS) with or without Multi-Enzymes on the Growth Performance of Indigenous Chicken**

*Ashim Kumar Saikia*

The present study was undertaken to investigate the effect of dietary incorporation of distillers dried grains with solubles (DDGS) with or without multi-enzyme supplementation on the growth performance of indigenous chicken. A total of one hundred and eighty (180) day-old indigenous chicks were procured from a few villages of Dhemaji district. The chicks were reared together for a period of 21 days, up to the point when the sex of the chicks could be identified, by feeding standard chick feed. On 22nd day, after knowing the numbers of male and female chicks, they were weighed and randomly divided into six groups viz. T1, T2, T3, T4, T5 and T6 containing 30 chicks with 3 replicates of 10 chicks in each group. The chicks were wing banded and reared under deep litter system of management throughout the experimental period following standard and uniform managerial practices. The birds of T1 group (control) were offered the standard chick, grower & layer feeds as per BIS, 2007. The birds of T2 group were fed with the same standard chick, grower and layer feeds as per BIS, 2007 with supplementation of multienzyme (Xzyme). Maize DDGS was incorporated at 10% level in all the rations for T3 and T4 groups and the rations for T4 group was supplemented with multi-enzymes. In the same way, the birds of T5 and T6 groups were fed with rations containing 20% DDGS without and with enzymes, respectively. The maize DDGS used in the rations was procured from Brahmaputra Biochem Pvt. Ltd., Jambari, Guwahati.

The feeding trial was conducted for a period of 182 days (13 fortnights) using chick feeds for first 3 fortnights (0-42 days), grower feeds for next 7 fortnights (43-140 days) and layer feeds for last 3 fortnights (141-182 days). A metabolic trial was conducted for a period of 8 days after the completion of feeding trial. During the experiment, average fortnightly and total feed consumption, fortnightly and total body weight and body weight gain, feed conversion ratio (FCR), various blood bio-chemicals

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constituents, balance of nutrients, survivability rate, carcass characteristics like dressing percentage, relative organ and giblets weight, organoleptic evaluation, egg quality parameters and economics of production were studied and recorded.

The average final body weight of indigenous chicken was highest in T2 group (1643.93±25.22 g) followed by T1 (1607.86±16.29 g), T4 (1603.21±13.88 g), T6 (1596.07±11.78 g), T3 (1589.26±13.83 g) and T5 (1580.00±14.50 g) groups. The average total feed consumption per bird for different experimental groups was highest in T6 group (11748 g) and lowest in T1 group (11653 g). The overall FCR of the birds for entire period was least in T2 group (7.37) followed by T1 (7.51), T4 (7.51), T3 (7.62), T6 (7.64) and T5 (7.69) groups. The per cent survivability of birds was 93.33 in T1, T2, T4 and T6 groups and 90.00 in T3 and T5 groups. No significant difference ( $P>0.05$ ) was observed in respect of final body weight, total and mean daily gain in body weight among the groups and total feed consumption as well as overall FCRs were found to be comparable among the treatment groups. Positive balances were observed in N, Ca and P utilization and significant difference ( $P<0.05$ ) was recorded between T1 and T4 and T6 groups, between T3 and T6 and between T5 and T6 groups in percent phosphorus retention. No significant differences ( $P>0.05$ ) were observed among the groups in respect of the blood constituents viz. Hb., blood glucose, total serum protein, blood lipids, blood cholesterol, AST and ALT levels and serum calcium and significant difference ( $P<0.05$ ) was found in serum inorganic phosphorus between T1 and all other groups. All the carcass characteristics like dressing percentage, relative organ and giblets weight showed non-significant ( $P>0.05$ ) differences among the experimental groups. The average proximate principles (%) of breast meat of experimental birds of different groups for moisture, protein, fat and total ash contents were estimated and no significant difference ( $P>0.05$ ) was found among the groups in respect of these proximate principles. Non-significant ( $P>0.05$ ) difference was found in colour, tenderness, flavor, juiciness and overall acceptance of the breast meat among the treatment groups. Comparable values were also observed among the experimental groups in respect of both the external as well as internal egg quality parameters of the eggs laid by the birds of different groups. The costs of feeding and production were highest in group- T2 i.e. ₹284.48 & 405.67 and lowest in group- T5 i.e. ₹ 245.28 & 366.47, respectively.

## **Understanding the Physio-Biochemical Status of Anoestrus Crossbred Cows and Comparative Evaluation of Certain Treatment Regimes**

*Biren Kumar Das*

A study was conducted on Large White Yorkshire (LWY) pigs to assess the effect of feeding banana pseudo-stem silage and mixed silage of banana pseudo-stem and Taro (*Colocasia esculenta*) fermented, anaerobically, with *Lactobacillus acidophilus* and *Enterococcus faecium*. Eighteen LWY piglets, average body weight  $15.097 \pm 0.71$  kg, were randomly divided into three groups (T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub>) in a completely randomised block design with 6 piglets in each group. Three experimental iso-nitrogenous and iso-caloric diets were prepared and fed in two phase feeding programme i.e. growing phase (up to 35 kg body weight) and finishing phase (above 35 kg body weight) as per BIS, 2001 where T<sub>1</sub> (control) group was fed basal diet without silage while T<sub>2</sub> and T<sub>3</sub> group received diet with 25 % replacement of cereal (maize) grain of the basal diet with banana pseudo-stem silage and mixed silage of banana pseudo-stem and Taro. During 180 days of feeding trial, the body weight changes of the LWY pigs in growing phase as well as finishing phase varied significantly ( $P < 0.01$ ) among the treatment groups. There was significant difference ( $P < 0.05$ ) in fortnightly dry matter intake of the experimental pigs in the growing phase. ADG (g/h/d) and FCE of the growing-finishing pigs in the growing phase were also found to be significant ( $P < 0.05$ ) among the experimental pigs. Digestibility of dry matter and other nutrients were studied by conducting digestibility trial in growing and finishing phase of the experimental pigs. In the growing phase digestibility coefficient of DM, CP, CF & EE differed significantly ( $P < 0.05$  &  $P < 0.01$ ) among the treatment groups, but digestibility coefficient of OM and NFE did not differ ( $P > 0.05$ ) among the treatment groups. In the finishing phase digestibility coefficient of DM, OM, CP, CF, EE and NFE did not differ ( $P > 0.05$ ) among the experimental groups. There was no significant ( $P > 0.05$ ) difference in biochemical parameters of SGPT, SGOT, glucose, total protein, cholesterol, HDL and LDL among the groups. The carcass traits like dressing percentage, back fat thickness,

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loin eye area, per cent weight of whole sale cuts of pork, edible and inedible offal were not affected ( $P>0.05$ ) by the partial replacement of cereal (maize) grain in the basal diet with silages. Drip loss (%), water holding capacity and pH of *Longissimus dorsi* muscle did not differ ( $P>0.05$ ) among the treatment groups. Per cent moisture, protein, fat and ash of the *Longissimus dorsi* muscle were also not affected ( $P>0.05$ ) by the partial replacement of cereal (maize) grain in the basal diet with silages. Analysis of variance of histo-morphological measures of villus height, crypt depth, villus height: crypt depth and average villus surface area of duodenum and jejunum showed that 25% replacement of cereal (maize) grain of the basal diet with silages did not have adverse effect ( $P>0.05$ ) in the experimental pigs. In economic analysis, the cost of feed per kg weight gain was found to be reduced ( $P<0.05$ ) in  $T_3$  group pigs compared to  $T_1$  (control) and  $T_2$  group pigs. It was concluded that 25 % substitution of cereal (maize) grain from the basal diet by mixed silage of banana pseudo-stem and Taro in growing-finishing LWY pigs had no adverse effect on growth performance, serum biochemical profile and carcass characteristics, and had reduced the cost of pig production.

**Key words:** Growing-finishing pigs, silage, serum bio-chemical parameters, carcass traits, histo-morphology of intestine

## **Nutritional and Feeding Management Strategies on Performance, Nutrient Utilization and Gut Health in Weaned Crossbred Pigs**

*Ekramul Hoque*

An experiment was conducted to investigate the effects of prebiotic, probiotic, lysine and methionine supplementation in diets with two level of protein on growth performance, nutrient utilization, feed conversion efficiency, biochemical parameters and gut health in weaned growing pig in a 90 day trail.

A total of 30 piglets of crossed bred pig of average  $18.38 \pm 0.93$  kg body weight of about three months of age irrespective of sex were selected from KVK, Darrang, AAU, Mangaldai-784125 which were bred, born and raised at the farm maintained under KVK, Darrang. The piglets were randomly allotted to five treatments of six piglets in each group on the basis of body weight. Hence, five experimental treatment groups were the T<sub>0</sub> (Basal Diets), T<sub>1</sub> (Basal Diets, commercial MOS 0.3%, Probiotic 40 g/100kg feed,  $2.5 \times 10^9$  CFU/ gm), T<sub>2</sub> (Basal Diets, extracted MOS 0.3% and Probiotic 40 g/100kg feed, CFU/ gm  $2.5 \times 10^9$ ), T<sub>3</sub> (Basal Diets, commercial MOS 0.3%, Probiotic 40 g/100kg feed, CFU/ gm  $2.5 \times 10^9$ , lysine 0.3% and methionine 0.1%) and T<sub>4</sub> (Basal Diets, extracted MOS 0.3%, Probiotic 40 g/100kg feed, CFU/ gm  $2.5 \times 10^9$ , lysine 0.3% and methionine 0.1%) in a randomized complete block design. The basal diet was prepared as per the recommendation of ICAR-2013.

The average DM intake (kg/100kg BW) was  $4.57 \pm 0.02$ ,  $4.14 \pm 0.01$ ,  $4.31 \pm 0.02$ ,  $4.02 \pm 0.01$  and  $4.38 \pm 0.01$  for T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub>, respectively. The difference of average DM intake (kg/100kg BW) was statistically significant  $P < 0.001$  among control and treatment group. Average daily body weight gain (gm/day) were  $217.67 \pm 5.10$ ,  $249.11 \pm 4.52$ ,  $244.26 \pm 3.52$ ,  $258.59 \pm 3.21$  and  $255.78 \pm 5.55$  for T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub>, respectively. Average daily body weight gain (gm/day) showed significant difference ( $P < 0.05$ ). The average feed conversion ratio were  $5.53 \pm 0.28$ ,  $4.65 \pm 0.35$ ,  $4.79 \pm 0.26$ ,  $4.40 \pm 0.28$  and  $4.81 \pm 0.29$  for T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> respectively where significant difference ( $P < 0.05$ ) existed among the groups.

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The digestibility coefficient of DM, OM, EE, Total carbohydrate, NDF and ADF did not differ ( $P > 0.05$ ) significantly among the treatment groups but digestibility coefficient of CP differed ( $P < 0.05$ ) significantly among groups. N-retention (%) of different groups were  $76.33 \pm 0.78$ ,  $80.93 \pm 0.05$ ,  $82.39 \pm 0.54$ ,  $79.38 \pm 0.63$  and  $80.51 \pm 0.48$  for T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> groups, respectively; there was significant difference ( $P < 0.01$ ) among groups. There was no significant difference ( $P < 0.05$ ) in Ca and P retention (%) in different groups but there was significant difference ( $P < 0.01$ ) in fecal ammonia nitrogen (NH<sub>3</sub>-N) concentration. In respect of fecal microbial count, *E. coli* count (log<sub>10</sub>cfu/g) was significantly different ( $P < 0.05$ ) among groups and minimum was recorded in T<sub>4</sub> and T<sub>3</sub> group. The fecal TVC (log<sub>10</sub>cfu/g) count was highest in T<sub>4</sub> group followed by T<sub>3</sub> and T<sub>2</sub> group. The concentrations of total serum protein and blood cholesterol were found within normal physiological range in all experimental groups. There was significant difference ( $P < 0.05$ ) in respect of blood glucose, blood albumin, blood globulin and blood Albumin: Globulin ratio.

Feed cost (Rs.) per kg gain was 102.85, 97.30, 101.91, 91.90 and 96.35 for control group (T<sub>0</sub>) and treatment groups (T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub>), respectively. Highest profit (in terms of feed cost/kg gain) was observed in T<sub>3</sub> group followed by T<sub>2</sub> group of crossbred pig in comparison to other groups. Thus it can be concluded that supplementation of prebiotic, probiotic, lysine and methionine in diet in growing pig @ 0.3%, 40 g/100kg feed ( $2.5 \times 10^9$  CFU/ gm), 0.3% and 0.1% may be recommended in terms of growth and economic of production.

**Keywords:** Probiotic, Prebiotic, Growth performance, Gut health, Pigs.

## **Effect of Feeding Pineapple Waste with Probiotic Supplementation on the Performance of Growing Pigs**

*Nirmali Das*

A 5 month feeding trial was conducted on 24 weaned pigs (11.53±1.08 to 11.75±1.03 kg body weight) to investigate the effect of feeding pineapple waste with probiotic supplementation on the growth performance, feed conversion ratio, nutrient utilization, blood biochemical, faecal microbial count, carcass characteristics and cost of feeding. Basal rations (BIS, 2001) were assigned as C, T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub>. The pineapple waste were sundried, chaffed into small pieces and then mixed with the basal diet at 10, 20 and 30% level for T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> respectively. Probiotic (lactobacillus) was added at the level of 0.35g in all the ration including control. Two digestion trials were carried out – once in the growing phase (18<sup>th</sup> week) and another one in the finishing phase (22<sup>nd</sup> week). Faeces and blood samples were collected from each treatment group at three stages i.e., initial, grower and finisher stages of the feeding trial for estimation of total bacterial count and for evaluation of blood haemato-biochemical parameters. For carcass characteristics study, three pigs from each treatment were sacrificed at the end of the feeding trial. Study revealed improvement in feed consumption in the growing and finishing phase and also found that T<sub>2</sub> was significantly higher (P<0.05). Apparent digestibility co-efficient (ADC) of all the nutrients was comparatively higher in T<sub>2</sub> followed by C, T<sub>1</sub> and T<sub>3</sub>. Significant difference was found among the groups (P<0.05) in apparent digestibility co-efficient (ADC) of CP, EE and NFE in grower phase; whereas in finisher stage significant difference (P<0.05) was observed in apparent digestibility co-efficient (ADC) of DM, CP, EE, NFE and OM among the groups. The average daily body weight gain (ADG) was significantly higher in T<sub>2</sub> groups and resulted significantly higher total gain and final body weights than C, T<sub>1</sub> and T<sub>3</sub>. Significant difference was found in both phases among treatment group on nitrogen balance where T<sub>2</sub> was found significantly different from C, T<sub>1</sub> and T<sub>3</sub> (P<0.05), whereas C, T<sub>1</sub> and T<sub>2</sub> was found significantly similar (P<0.05). Significant difference was not found in ca balance for both the phases (P<0.05); whereas significant difference was

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found in p balance in finisher phase ( $P < 0.05$ ). The FCR at the end of feeding trial was calculated as  $4.264 \pm 0.085$ ,  $4.211 \pm 0.041$ ,  $4.200 \pm 0.060$  and  $4.415 \pm 0.042$  respectively for C, T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> respectively and indicating significantly better FCR in T<sub>2</sub> groups. The feeding cost (Rs./kg body weight gain) in the growing phase was Rs.124.87, Rs. 117.12, Rs 113.28 and Rs.113.38; whereas for finisher phase the feeding cost (Rs./kg body weight gain ) was calculated as Rs. 126.77, Rs. 117.77, Rs.113.31 and Rs.114.35 for C, T<sub>1</sub>,T<sub>2</sub> and T<sub>3</sub> groups, respectively, which indicated significantly reduced feeding cost/kg body weight gain in T<sub>2</sub> group compared to C, T<sub>1</sub> and T<sub>3</sub>. All blood haemato-biochemical parameters were within the normal range in all the treatment groups. Significant difference ( $P < 0.01$ ) was observed among the groups for faecal microbial load. Also significant difference was observed for slaughter weight, carcass weight, dressing percentage, carcass length, back fat thickness and loin eye area where C, T<sub>1</sub> and T<sub>2</sub> was found significantly different from T<sub>3</sub>( $P < 0.01$ ). Findings of the study revealed that feeding pineapple waste upto 20% level significantly improved growth performance, digestibility of nutrients, faecal microbial load and feed: gain ratio of pigs. Thus, feeding of pineapple waste upto 20% level may be recommended to crossbred pigs for remunerative and sustainable profit.

**Key words:** Pineapple waste, Probiotic, grower-finisher pigs, growth, economics.

# **Effect of Fermented Liquid Feed on the Performance and Gut Health of Grower-Finisher Large White Yorkshire Pigs**

*Rajat Buragohain*

A 180-days feeding trial was conducted on 24 weaned Large White Yorkshire pigs (11.45±2.42 to 11.46±2.37 kg body weight, 42-days of age) to investigate the effect of feeding fermented liquid feed on growth performance, nutrient digestibility, gut health and immunity, carcass characteristics, blood haemato-biochemical parameters and economics under intensive management. Basal rations (NRC, 2012) were assigned as dry feed (DF), non-fermented liquid feed (NFLF), fermented liquid feed prepared with *Lactobacillus acidophilus* (FLF-LA) and fermented liquid feed prepared with *Enterococcus faecium* (FLF-EF) to 4 homogenous groups of pigs (3 males and 3 females in each group). NFLF was prepared by mixing basal ration with drinking water at 1:2 (w/w) immediately before feeding. For preparation of FLF-LA, from stock culture of *Lactobacillus acidophilus*, a loop full of culture was transferred aseptically to 100 ml of De Man, Rogosa and Sharpe (MRS) broth and was incubated for 24 hours at 37°C in an automatic incubator shaker. Ground yellow maize mixed with water (1:1, w/w) was fermented with 24 hr. old culture of *Lactobacillus acidophilus* at 37°C for 24 hr. The fermented maize was then mixed with basal ration mixed with water at 1:2 (w/w) and fermented for 48 hrs. to prepare FLF-LA (1-2 10<sup>9</sup> cfu/g). 50% of the fermented feed was utilized for feeding and rest was used for backslopping for another 7 days after which the process was started from the beginning. The same procedure of preparation was followed for FLF-EF, except Brain Heart Infusion broth was used instead of MRS. The feeding trial was conducted for 180 days. Two digestibility trials were conducted 1st at the end of 17th week of age (growing phase) and 2nd at the end of 29th week (finishing phase). Faeces and blood samples were collected from three randomly selected pigs from each treatment on day 0, 60, 120 and 180 for estimation for faecal metabolites and faecal microbial counts, and evaluation of haemato-biochemical parameters. For carcass characteristics study, three pigs from each treatment were slaughtered at the end of the feeding trial. The cell-mediated immune response was

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assessed through *in vivo* sub-cutaneous delayed-type hypersensitivity (DTH) reaction against phytohaemagglutinin-p and humoral immune response by micro-hemagglutination assay. Study revealed improvement in feed consumption in the growing phase and significantly ( $P < 0.05$ ) higher feed consumption in the finishing phase in pigs fed FLF than pigs fed NFLF than DF. Apparent digestibility co-efficient (ADC) of all the nutrients was comparatively higher in FLF fed-groups than DF and NFLF in growing phase. ADC of CP was significantly ( $P < 0.05$ ) higher in FLF-LA and FLF-EF with improved digestibility of other nutrients than DF and NFLF in the finishing phase. The average daily body weight gain (ADG) was significantly higher in FLF fed-groups and resulted significantly ( $P < 0.05$ ) higher total gain and final body weights than pigs fed DF and NFLF. Diarrhoea score and incidence was significantly reduced on feeding of FLF. Higher faecal lactic acid bacteria count with low faecal counts of *E. coli* and *Salmonella*; and high faecal pH, less faecal lactic acid and  $\text{NH}_3\text{-N}$  level were recorded in FLF fed-pigs compared to DF and NFLF. Significantly higher villi height, crypt depth and apparent villi surface area were found in FLF fed-groups than DF and NFLF. More numbers of mononuclear and glandular epithelial cells and presence of lymphoid follicles were observed in the duodenal and jejunal sections of small intestine of FLF fed-groups. No such infiltration and lymphoid follicles were observed in duodenal and jejunal sections of DF and NFLF groups. Pigs of FLF-LA & FLFEF showed more skin indurations and high antibody titre post-inoculation to phytohaemagglutinin-p and 20% sheep RBC, respectively as the measure of cell-mediated and humoral immune response. No significant difference was observed for carcass traits, physico-chemical and nutritional properties of meat and sensory attributes on feeding of FLF compared to DF and NFLF. All blood haemato-biochemical parameters were within the normal range in all the treatment groups. No pathological lesions were found in the liver and spleen on feeding of FLF. The FCR at the end of feeding trial was calculated as  $3.82 \pm 0.07$ ,  $3.64 \pm 0.05$ ,  $3.36 \pm 0.04$  and  $3.46 \pm 0.07$ , respectively for DF, NFLF, FLF-LA and FLF-EF indicating significantly better FCR in FLF fed-groups. The feed cost/kg gain in body weight (Rs./kg) was calculated as  $128.36 \pm 2.82$ ,  $120.43 \pm 1.67$ ,  $112.87 \pm 2.26$  and  $115.51 \pm 1.96$ , respectively for DF, NFLF, FLF-LA and FLF-EF, respectively, which indicated significantly reduced feeding cost/kg body weight gain in FLF fed-pigs compared to DF and NFLF. Findings of the study revealed that feeding of FLF-LA and FLF-EF significantly improved growth performance, digestibility of nutrients, gut health and immunity and gain: feed ratio of the grower-finisher LWY pigs than the DF and NFLF. Thus, feeding of FLF prepared with either *Lactobacillus acidophilus* or *Enterococcus faecium* may be recommended to LWY grower-finisher pigs for remunerative and sustainable profit.

**Key words:** Liquid feed, fermented liquid feed, *Lactobacillus acidophilus*, *Enterococcus faecium*, grower-finisher LYW pigs, growth, gut health, economics.

## **Effect of Feeding Protected Proteins on Milk Yield and Nutrient Utilization in Crossbred Cows**

*Sikhamoni Haloi*

An experiment was conducted to assess the effect of feeding protected proteins on milk yield, milk quality, nutrient utilization and cost of production in crossbred cows. Eighteen lactating crossbred cows of almost similar milk yield and parity were randomly divided into three groups of six animals each. Randomized block design (RBD) technique was followed for the study. Experimental cows were allotted to three dietary treatments (T0, T1 and T2). T0 was considered as control group and T1 and T2 as treatment groups. Feeding of roughage and concentrate mixture having soybean meal (untreated) was offered in T0 group; while concentrate mixture with heat treated and formaldehyde treated soybean meal was offered to T1 and T2 group, respectively. The feeding trial was conducted for a period of 120 days followed by digestibility trial of 5 days.

The average dry matter (DM) intake (kg/Day) was  $10.98 \pm 0.04$ ,  $11.05 \pm 0.05$  and  $11.02 \pm 0.05$  for T0, T1 and T2 groups, respectively and did not differ significantly among groups. The DM intake (kg) per 100 kg body weight was  $3.34 \pm 0.07$ ,  $3.40 \pm 0.07$  and  $3.35 \pm 0.05$  for T0, T1 and T2 group, respectively. The DM intakes (g) per kg W<sup>0.75</sup> body size was  $141.92 \pm 2.21$ ,  $144.44 \pm 2.22$  and  $142.32 \pm 1.31$  for the corresponding groups. The DM intake per 100 kg body weight and per kg W<sup>0.75</sup> body size did not differ significantly among groups. The percent digestibility of DM, CP were significantly higher in T1 and T2 group over T0 group, however digestibility of EE, CF, NFE, NDF and ADF did not differ significantly among groups. The average daily milk yield (kg/Day) was  $7.70 \pm 0.98$ ,  $9.01 \pm 0.14$  and  $8.93 \pm 0.14$  for the T0, T1 and T2 group, respectively which was significantly higher ( $P < 0.01$ ) in T1 and T2 group compared to T0 group. The average FCM yield (kg/Day) was  $8.12 \pm 0.16$ ,  $9.42 \pm 0.17$  and  $9.30 \pm 0.18$  in T0, T1 and T2 respectively which was significantly higher ( $P < 0.01$ ) in T1 and T2 group in comparison to T0 group. The milk parameters like fat, protein, lactose, total solid, solid not fat did not differ significantly among groups. The total

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serum protein (g/dl), albumin (g/dl) and albumin globulin ratio was significantly higher ( $P<0.01$ ) in T1 and T2 group compare to T0 group. The creatinine (mg/dl) and globulin (g/dl) concentration of blood were significantly lower in ( $P<0.01$ ) in T1 and T2 group compared to T0 group. The gamma glutamyl transferase (U/L) concentration of blood was comparable among the groups. Rumen degradable protein (RDP) percentages were  $26.47 \pm 0.02$ ,  $22.52 \pm 0.01$  and  $22.53 \pm 0.02$  for untreated, heat treated and formaldehyde treated soybean meal, respectively. Undegradable dietary protein (UDP) percentages were  $18.55 \pm 0.01$ ,  $22.51 \pm 0.01$  and  $22.52 \pm 0.01$  for the corresponding feeds. RDP percentages were lower in ( $P<0.01$ ) in heat treated and formaldehyde treated soybean meal than untreated soybean meal whereas UDP percentages were significantly higher ( $P<0.01$ ) in heat treated and formaldehyde treated soybean meal compared to untreated soybean meal. The feed cost per kg of milk was lower in T1 and T2 groups (Rs.28.77 and Rs.29.60) compared to T0 (Rs.32.83) group.

It was observed that feeding of heat treated soybean meal (T1) and formaldehyde treated soybean meal (T2) showed better results in terms of milk yield, FCM yield and digestibility of nutrients like dry matter and crude protein over untreated soybean meal (T0). Hence, it can be concluded that treatment of soybean meal has a significant effect on milk yield due to enhancement of nutrient bioavailability caused by lowering of rumen degradable protein (RDP). Comparing the heat treatment and formaldehyde treatment of soybean meal, heat treatment could be recommended from practical and economic point of view as there is no risk of chemicals.

## **Effect of Vitamin E and Selenium Feed Supplements on Performance, Oxidative Stress, Immunity and Heat Shock Protein Expression in Broiler Chicken**

*Subhalakshmi Bora*

The present study was undertaken to investigate the effect of dietary supplementation of vitamin E and Selenium on the growth performance, oxidative stress, immunity and heat shock protein expression in Broiler chicken. Two hundred and forty (240) day-old commercial Vencobb 400 broiler chicks were randomly divided into four experimental groups viz. T0 (unsupplemented control), T1 (Vitamin E @ 100 mg/kg and Selenium @ 0.2 mg/kg), T2 (Vitamin E @ 125 mg/kg and Selenium @ 0.25 mg/kg) and T3 (Vitamin E @ 150 mg/kg and Selenium @ 0.3 mg/kg) groups of 60 chicks each subdivided into 3 equal replicates. The experimental birds were offered *ad libitum* quantities of four experimental rations either without supplementation or with supplementation of different levels of vitamin E and selenium from 0 to 7 days, 8 to 21 days, and 22 to 42 days of age.

During the experiment, weekly body weight and daily feed intake, total body weight gain, total feed intake, feed conversion ratio (FCR), survivability rate, BPEI, various blood haematological and bio-chemicals constituents, antioxidant enzymes, heat shock protein, immunity, cortisol, carcass characteristics like dressing percentage, cut up parts percentage, relative organ and giblets weight, physicochemical properties of breast meat were studied and recorded.

The mean total body weight (g) was 2120.0±33.5, 2292.9±14.7, 2219.0±16.4 and 2179.9±9.08 and mean total weight gain (g) was 2077.7±14.5, 2250.6±14.7, 2176.6±14.3 and 2137.6±9.08 for T0, T1, T2 and T3 groups, respectively. The mean total feed intake (g) was 4062.75±0.08, 4156.53±0.77, 4151.91±0.35 and 4117.85±11.67 and the average feed conversion ratios was 1.92±0.04, 1.81±0.01, 1.88±0.04 and 1.87±0.04 for T0, T1, T2 and T3 groups, respectively. T1 group attained significantly higher ( $P<0.05$ ) final body weight and body weight gain compared to all the other groups. T2 group did not differ significantly ( $P>0.05$ ) with T3 group; but, had

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a significantly higher ( $P < 0.05$ ) final body weight over T0 group. Total feed intake (g) in T1 group was significantly higher ( $P < 0.05$ ) than the rest of the groups. The other groups did not differ significantly ( $P > 0.05$ ) in mean total Feed Conversion ratio.

BPEI was found to be significantly ( $P < 0.05$ ) higher in T1 ( $126.67 \pm 1.764$ ) group than the other groups; however, no significant ( $P > 0.05$ ) difference was observed among T0 ( $110.67 \pm 4.67$ ), T2 ( $118.00 \pm 0.58$ ) and T3 ( $116.33 \pm 0.33$ ) groups.

Economics of production showed that difference in the total feed cost (Rs.) and the total cost involved per bird (Rs.) were highly significant ( $P < 0.05$ ) among the all the groups. Average profit per bird and per kg body weight did not differ significantly ( $P > 0.05$ ) among the experimental groups.

Overall mean haematological values was, for Hb (%)  $9.75 \pm 0.50$ ,  $11.22 \pm 1.56$ ,  $10.56 \pm 1.11$  and  $10.50 \pm 1.19$ ; for PCV (%)  $25.7 \pm 0.60$ ,  $28.22 \pm 1.67$ ,  $27.20 \pm 1.01$  and  $27.23 \pm 0.86$  and for WBC (thousand  $\text{mm}^3$ )  $28.03 \pm 2.95$ ,  $24.13 \pm 0.47$ ,  $25.13 \pm 0.75$  and  $25.14 \pm 0.83$  for T0, T1, T2 and T3 groups respectively. Hb (%), PCV (%), WBC (thousand  $\text{mm}^3$ ) level in T1 treatment group was significantly higher ( $P < 0.05$ ) than the rest of the groups. However, T2 and T3 groups did not differ significantly ( $P > 0.05$ ) but, were significantly higher ( $P < 0.05$ ) than T0 group.

Overall mean of blood biochemical were, for serum glucose (mg/dl)  $213.3 \pm 27.9$ ,  $186.7 \pm 7.90$ ,  $202.9 \pm 1.36$  and  $201.9 \pm 21.5$ ; for serum total protein (g/dl)  $2.40 \pm 0.37$ ,  $3.21 \pm 0.85$ ,  $2.91 \pm 0.54$  and  $2.94 \pm 0.60$ ; for Albumin (g/dl)  $1.16a \pm 0.14$ ,  $1.44c \pm 0.27$ ,  $1.27b \pm 0.13$  and  $1.31b \pm 0.18$  and for Globulin (g/dl)  $1.25 \pm 0.25$ ,  $1.77b \pm 0.60$ ,  $1.64b \pm 0.44$  and  $1.63b \pm 0.44$  in T0, T1, T2 and T3 groups respectively. Serum glucose (mg/dl) level in T1 treatment group was significantly lower ( $P < 0.05$ ) than the rest of the groups. Total protein (g/dl), Albumin (g/dl) level in T1 treatment group was significantly higher ( $P < 0.05$ ) than the rest of the groups. However, T2 and T3 groups did not differ significantly ( $P > 0.05$ ) but, were significantly higher ( $P < 0.05$ ) than T0 group. Globulin (g/dl) level in all the treatment group was significantly higher ( $P < 0.05$ ) than the unsupplemented group.

The overall mean of AST (U/L) level was  $202.4 \pm 19.4$ ,  $180.2 \pm 8.67$ ,  $194.6 \pm 16.1$  and  $188.4 \pm 5.58$  and of ALT (U/L) level was  $8.73 \pm 2.80$ ,  $7.05 \pm 1.56$ ,  $7.76 \pm 1.96$  and  $7.94 \pm 1.92$  in T0, T1, T2 and T3 groups respectively. AST (U/L) and ALT (U/L) levels in T1 treatment group was significantly lower ( $P < 0.001$ ) than the rest of the groups. T0 group had significantly higher ( $P > 0.05$ ) AST (U/L) and ALT (U/L) level than rest of the groups. The overall mean values of serum superoxide dismutase (SOD, unit/mg protein) was  $2.03 \pm 0.39$ ,  $3.46 \pm 0.64$ ,  $2.94 \pm 0.68$  and  $2.69 \pm 0.45$ ; serum GPx (microgram/mg protein) was  $2.37 \pm 0.27$ ,  $3.61 \pm 0.18$ ,  $2.99 \pm 0.27$  and  $2.83 \pm 0.30$  and serum GSH (mg/g protein) was  $0.90 \pm 0.07$ ,  $1.36 \pm 0.53$ ,  $1.21 \pm 0.41$  and  $1.17 \pm 0.36$ , respectively in T0, T1, T2 and T3 groups, respectively. SOD, GPx and GSH levels in T1 group were significantly higher ( $P < 0.05$ ) than the rest of the groups.

The overall mean of serum Cortisol (ng/ml) in T1 ( $1.26\pm 0.01$ ) group was significantly lower ( $P<0.05$ ) than T0 ( $2.65\pm 0.28$ ), T2 ( $1.71\pm 0.04$ ) and T3 ( $1.77\pm 0.05$ ) groups, respectively.

The HSP70 in T1 ( $2.28\pm 0.05$ ) group was significantly lower ( $P<0.001$ ) than T0 ( $6.20\pm 0.08$ ), T2 ( $2.81\pm 0.07$ ) and T3 ( $2.65\pm 0.0$ ) groups, respectively. T2 and T3 groups did not differ significantly ( $P>0.05$ ); but, were significantly lower ( $P<0.05$ ) than T0 group. The overall mean of humoral immune response against NDV was  $1.51\pm 0.33$ ,  $2.13\pm 0.36$ ,  $1.91\pm 0.34$  and  $2.01\pm 0.35$ , respectively and the overall mean of humoral immune response against IBDV was  $1.85\pm 0.17$ ,  $2.65\pm 0.23$ ,  $2.25\pm 0.26$  and  $2.35\pm 0.25$  in T0, T1, T2 and T3 groups, respectively. Both the immune responses were significantly higher ( $P<0.05$ ) in T1 group than T0, T2 and T3 groups. However, T2 and T3 groups did not differ significantly ( $P>0.05$ ).

The carcass parameters like dressing percentage with giblet in T0, T1, T2, T3 group was  $77.42\pm 0.21$ ,  $80.13\pm 0.59$ ,  $78.64\pm 0.09$  and  $78.54\pm 0.21$ , respectively. The dressing percentage without giblet in T0, T1, T2, and T3 groups was  $71.86\pm 0.25$ ,  $74.79\pm 0.53$ ,  $73.12\pm 0.05$  and  $72.87\pm 0.24$ , respectively. Dressing percentages were significantly higher ( $P<0.05$ ) in T1 group than rest of the groups.

Among the cut up parts, thigh, neck, drumstick and breast as percentage of dressed weight were significantly higher ( $P<0.05$ ) in T1 group ( $15.07\pm 0.19$ ,  $4.64\pm 0.43$ ,  $13.05\pm 0.49$ ,  $32.46\pm 0.32$ ) than T0 ( $13.61\pm 0.34$ ,  $5.86\pm 0.32$ ,  $11.65\pm 0.39$  and  $29.64\pm 1.08$ ), T2 ( $14.27\pm 0.17$ ,  $5.38\pm 0.38$ ,  $12.59\pm 0.62$ ,  $31.25\pm 0.53$ ) and T3 ( $14.16\pm 0.72$ ,  $5.54\pm 0.18$ ,  $12.56\pm 0.15$ ,  $31.03\pm 0.14$ ) groups.

The giblet yield as percentage of dressed weight was significantly lower ( $P<0.05$ ) in the unsupplemented T0 group ( $5.34\pm 0.07$ ) compared to antioxidant supplemented T1 ( $5.56\pm 0.11$ ), T2 ( $5.52\pm 0.04$ ) and T3 ( $5.68\pm 0.04$ ) groups.

Among the lymphoid organs, spleen (as percentage of dressed weight) in T1 ( $0.12\pm 0.01$ ) group was found to be significantly bigger ( $P<0.05$ ) than that of T0 ( $0.10\pm 0.01$ ) group but not that of T2 ( $0.11\pm 0.00$ ) and T3 ( $0.11\pm 0.00$ ) group. Thymus and bursa sizes of all the experimental groups did not differ significantly ( $P>0.05$ ).

The abdominal fat % in T1 ( $2.09\pm 0.50$ ) group was significantly lower ( $P<0.05$ ) than T0 ( $3.49\pm 0.16$ ), T2 ( $2.89\pm 0.29$ ) and T3 ( $2.72\pm 0.12$ ) group, however T2 and T3 groups did not differ significantly ( $P>0.05$ ).

In breast meat the pH was  $5.47\pm 0.19$ ,  $6.14\pm 0.09$ ,  $5.79\pm 0.06$  and  $5.74\pm 0.19$ ; WHC(%) was  $58.17\pm 1.83$ ,  $72.38\pm 1.25$ ,  $65.08\pm 1.70$  and  $67.95\pm 1.45$ ; drip loss (%) was  $6.96\pm 0.48$ ,  $4.71\pm 0.45$ ,  $6.08\pm 0.46$  and  $5.70\pm 0.39$ ; SFV (Kg/cm<sup>2</sup>) was  $3.80\pm 0.10$ ,  $2.77\pm 0.38$ ,  $3.23\pm 0.15$  and  $3.30\pm 0.10$  and TBARS (mg MDA/Kg) was  $3.30\pm 0.10$ ,  $1.18\pm 0.04$ ,  $3.23\pm 0.15$  and  $2.77\pm 0.38$  in T0, T1, T2 and T3 groups, respectively. PH and WHC (%) level in T1 group was significantly higher ( $P<0.05$ ) than the rest of the groups. However, T2 and T3 groups did not differ significantly ( $P>0.05$ ) but, were significantly higher ( $P<0.05$ ) than T0 group. The drip loss (%), SFV (Kg/cm<sup>2</sup>) and

TBARS (mg MDA/Kg) in T1 group was significantly lower ( $P<0.05$ ) than the rest of the groups.

Proximate composition (per cent dry matter) of the breast meat of broiler chickens of different experimental groups i.e. moisture, crude protein, ether extract and total ash did not differ significantly ( $P>0.05$ ).

# **Morphological and Functional Characterization of Boar Spermatozoa on Incubation in Capacitating Media and Preservation**

*Arunima Das*

A total of 24 ejaculates comprising 6 ejaculates from each of four HD-K75 boars of 10-12 months age maintained at ICAR - All India Coordinated Research Project (AICRP) on Pig C.V.Sc, A.A.U., Khanapara, Guwahati are being selected for the present study. The semen was collected by simple fist method twice weekly to study the morphological and functional characterization of *in-vitro* capacitated and preserved boar spermatozoa. After initial evaluation (volume, concentration and initial motility), the fresh semen was split into three parts. One part of the semen was used for fresh semen evaluation, second for capacitation and the other for preservation. For capacitation, the semen was incubated in TALP and m-KRB media at 37°C for 5 hours. For preservation semen was extended (1:4) in BTS and GEPS extenders and held at 22°C for 4 hours. The extended semen was then preserved at 15°C in BOD incubator upto 120 hours.

The overall mean of strained volume of semen, initial motility, hyperactivated spermatozoa, sperm concentration, live spermatozoa, live acrosome reacted spermatozoa and per cent hypo-osmotic swelling test (HOST) was 220.65±5.34 ml, 83.29±0.92 per cent, 92.21±0.54 per cent, 270.87±2.94 million per ml, 90.82±0.83 per cent, 82.76±0.36 per cent and 65.06±0.27 per cent and the overall range being 150-265 ml, 78 to 95 per cent, 88 to 95 per cent, 245- 298 million per ml, 86 to 95, 79-86 and 62 to 78 per cent respectively. Sperms were suspended in TALP media and m-KRB media and incubated for 5 hours at 37°C for *in-vitro* capacitation and evaluation was carried out at 0, 3 and 5 hours of incubation. In the present study, the highest hyperactivated motility was observed at 3 hours of incubation, from 18.51% at 0 hour to 57.32% in TALP and 17.96% at 0 hour to 43.25% at 3 hour in m-KRB, the hyperactivated motility of spermatozoa increased significantly upto 3 hours then it decreased upto 44.72 in TALP and 43.25 at 5 hours of incubation. The overall mean live acrosome reacted spermatozoa

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**Department : Animal Reproduction, Gynaecology and Obstetrics**

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per cent declined from 85.31% to 35.52 % in TALP and 84.95% to 34.04% in m-KRB media, HOST reacted spermatozoa decreased from 68.49% to 53.37% in TALP and 67.54% to 51.41% in m-KRB, FITC-PSA(-ve) spermatozoa percentage increased from 0.17% to 13.92% in TALP and 0.17 % to 12.58% in m-KRB, total protein increased from 0.41mg/ml to 1.21 mg/ml in TALP and 0.44 mg/ml to 1.25 mg/ml in m-KRB, total cholesterol decreased from 31.58 mg/dL to 11.28 mg/dL in TALP and 32.24 mg/dL to 10.61 mg/dL in m-KRB, total phospholipid 61.90 mg/dL to 59.24 mg/dL in TALP and 62.15 mg/dL to 59.40 mg/dL in m-KRB. The overall mean values were found to be differed significantly ( $P<0.01$ ) between periods, while between media no significant difference was observed except in live acrosome reacted spermatozoa ( $P<0.05$ ) and HOST ( $P<0.01$ ). In preserved group, Semen was extended with BTS and GEPS extender (1:4), held at 22oC for 4 hours and preserved upto 120 hours at 15oC. The semen samples were evaluated at 0 (i.e. immediately after extension), 24, 48, 72, 96 and 120 hours of preservation. In the present investigation, the overall mean sperm motility showed a decline from 82.63% to 30.21% in BTS and 83.04% to 31.75% in GEPS, hyperactivated motility percentage decreased from 84.64% to 32.70% in BTS and 83.95% to 34.24% in GEPS and live spermatozoa decreased from 84.92% to 45.08% in BTS and 85.75% to 46.92 % in GEPS, live acrosome reacted decreased from 80.79% to 44.79% in BTS and 82.29% to 44.79% in GEPS, host reacted spermatozoa decreased from 61.64% to 36.09% in BTS and 60.62% to 34.20% in GEPS, FITC-PSA(-ve) spermatozoa increased from 0 to 13.17% in BTS and 0 to 12.58% in GEPS, total protein (g/dL) level increased from 1.39% to 2.01% in BTS and 1.32% to 2.02% in GEPS, total cholesterol (mg/dL) level decreased from 32.82 to 15.54 in BTS and 32.82 to 15.21 in GEPS and total phospholipid (mg/dL) level decreased from 62.03 to 60.90 in BTS and 62.31 to 60.24 in GEPS. The overall mean values were found to be differed significantly ( $P<0.01$ ) between periods, while between media significant difference ( $P<0.05$ ) was observed in sperm motility and HOST while, hyperactivated motility, live spermatozoa and live acrosome reacted spermatozoa were differed significantly higher ( $P<0.05$ ). The aim of the present study was to determine the nature of capacitation like changes during preservation by studying the morphological and functional characteristics of *in-vitro* capacitated and preserved boar spermatozoa. In the present study, the maximum *in-vitro* capacitation was observed at 3 hours of incubation at 37oC. While, changes of the boar spermatozoa after 72 hours of preservation in respect of acrosomal status, plasma membrane integrity, total protein, total cholesterol and FITC-PSA (-ve ) spermatozoa resembled with the changes of spermatozoa of *in-vitro* capacitated for 3 hours of incubation.

# **Management of Postpartum Anoestrus and Repeat Breeding in Crossbred Cattle Through Nutritional and Therapeutic Interventions**

*Arunoday Das*

The relationship of managemental condition with infertility, reproductive status and incidence of different reproductive problems of crossbred cattle were studied in a few parts of Lower Brahmaputra Valley Agro-Climatic Zone of Assam. A total of seven nutritional and hormonal interventions and six nutritional and therapeutic interventions were used for addressing postpartum anoestricity and repeat breeding in crossbred cattle respectively. The incidence of infertility was significantly ( $P < 0.01$ ) higher under poor as compared to good housing and feeding conditions. The mean age at puberty, age at first service, age at first calving, postpartum interval of oestrus and calving interval were significantly ( $P < 0.05$ ) higher in poor managemental condition as compared to good one. Among the reproductive disorders, post-partum anoestrus (19.75%) and repeat breeding with or without infection (17.73%) were most predominant in crossbred cattle.

The response to different treatments was studied based on oestrus response, interval from treatment to onset of oestrus and conception rate in postpartum anoestrous cows. The response to treatment in case of repeat breeder cow was estimated on the basis of conception rate. The blood biochemical constituents, *viz.* IGF-1, oestrogen, progesterone, cortisol, T3, T4, calcium, inorganic phosphorus, zinc, magnesium, total protein and albumin were estimated before treatment, on day of oestrus and day 20 of oestrus in postpartum noestrous cattle, and on day of oestrus, day of subsequent oestrus and day 20 of subsequent oestrus in repeat breeding crossbred cows for different interventions.

The conception rate at induced oestrus of postpartum anoestrous cows in groups treated with Bypass fat, Probiotics, Injectable phosphorus, Area specific mineral mixture+ Bypass fat + Probiotics + Injectable phosphorus, Progesterone + eCG and Area specific mineral mixture + Bypass fat + Progesterone + eCG was 83.33, 66.67, 60.00, 83.33, 83.33 and 100.00 per cent respectively. Out of five nutritional interventions,

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**Major Advisor : Dr. R. K. Biswas**

Area specific mineral mixture + Bypass fat + Probiotics + Injectable phosphorus regime brought about the highest rate of oestrus induction and conception rate in postpartum crossbred cattle. Progesterone + eCG supplemented with Area specific mineral mixture + Bypass fat resulted in higher rate of oestrus induction, lower interval from the end of treatment to onset of oestrus and higher conception rate in postpartum anoestrous cows as compared to without supplementation.

The conception rate in infectious and non-infectious repeat breeder crossbred cows following different treatment regimes was 60.00, 71.43, 85.71, 42.86, 83.33, 57.14, and 16.67 per cent in Intrauterine antibiotic, *E. coli* Lipopolysaccharide, Selenium + Vitamin E orally + *E. coli* Lipopolysaccharide i.u., Area specific mineral mixture + Bypass fat + Probiotics, GnRH + Injectable Progesterone + COX-2 inhibitor, AI+ hCG on day 0 and on day 10 of the oestrous cycle treatment regime and control group respectively. *E. coli* LPS intrauterine fortified with oral selenium + vitamin E, and GnRH + Injectable progesterone + COX-2 inhibitor were superior for treatment of infectious and non-infectious repeat breeder cows respectively.

# **Understanding the Physio-Biochemical Status of Anoestrus Crossbred Cows and Comparative Evaluation of Certain Treatment Regimes**

*Chiranjeev Archarya*

The genital status, certain hormonal and blood biochemical profiles of anoestrus and normal cyclic crossbred cows and the efficacy of certain hormonal, nutritional and herbal treatment regimes fortified with bypass fat was carried out. The cows were subjected to 7 different treatment regimes viz, T1 (hormonal treatment like heat synchrony protocol), T2 (heat synchrony protocol+ Bypass fat), T3 (feeding of HMTBa minerals vitamins and herbs bolus), T4 (HMTBa minerals vitamins herbs bolus+bypass fat), T5 (feeding of herbal medicine AV/OIP/22), T6 (Bypass fat fortified with AV/OIP/22) and T7 (Bypass fat). The genital status, percent of estrus response, estrus intervals, conception rate and blood biochemical profiles of anoestrus crossbred cows was studied. The blood biochemical constituents, viz. oestrogen, progesterone, cortisol, IGF-I, calcium, inorganic phosphorus, zinc, total protein and cholesterol were estimated on day 0 (before treatment) and day of estrus. The study revealed that overall incidence of infertility was 14.7%. The incidence of silent oestrus and anoestrus were 4.58 and 2.69% respectively. The average ovarian follicle diameter (mm) was found to be  $9.62 \pm 0.3$  and  $8.40 \pm 0.4$  mm in normal and true anoestrus cows respectively. Highly significant difference in the mean serum levels of cortisol and cholesterol on the day of examination between normal cyclic and true anoestrus cows was seen. However, no significant difference was recorded in the serum oestrogen, progesterone, IGF I, Phosphorus and Zinc. But significant difference was seen in serum calcium and total protein levels.

The oestrus response was found to be improved in T2 and T6 groups. Further, the oestrus interval from end of treatment to onset of 1<sup>st</sup> oestrus was found to be shortest in T1 and highest in T6. The overall conception rate in different treatment groups showed no improvement in conception rate when compared with known treatment groups. The mean levels of oestrogen before and after treatment were significantly

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higher in all the treatment groups. Highly Significant differences in serum progesterone was seen in T1,T2, T4 and T6 group whereas group T3 and T5 showed significance difference. The serum IGF-I showed highly significant difference in all the groups except in T7. Serum calcium level showed highly significant difference in T1, T4, T5, T6 group whereas in T3 group it there was significant difference. On further studies, the serum profile revealed highly significant differences in phosphorus values in T6 group. The serum zinc in T5 and T6 groups were highly significant. The serum cholesterol levels in group T6 showed highly significant difference. From the results of the present study following conclusions could be drawn.

The overall incidence of anoestrus and silent oestrus was found to be 2.69% and 4.58% respectively. The mean progesterone, cholesterol and total protein was significantly higher and cortisol and calcium levels was significantly lower in true anoestrus cows compared to normal cows. The oestrous response rate (%) was found to be highest when treated with Bypass fat fortified with heat synch protocol and interval from end of treatment to onset of 1<sup>st</sup> oestrus was found to be highest in heat synch protocol. The conception rate was found to be highest 80% in animals treated with heat synch and Bypass fat fortified with heat synch.

## **Optimizing Cryopreservation of Semen and Artificial Insemination in Pigs**

*Manoj Kumar Kalita*

A total of forty-two ejaculates from six Lumsniang crossbred boars, maintained at Livestock Research Farm, DAFS, ICAR Research complex for NEH Region, Umiam, Meghalaya were used in the present study. Semen was collected twice weekly by gloved hand method using dummy sow in a sterilized semen collection bag fitted inside the insulated collection cup. The sperm rich fraction of 42 ejaculates showing more than 70 per cent initial motility was considered for further processing and freezing. The semen parameters were assessed in fresh ejaculates, 1 hour after equilibration and during post thawed period. The extended semen with different nanoparticles, packaging systems and thawing temperatures and times were assessed for optimizing of cryopreservation. A total of 5 semen samples, including one fresh and rest four frozen with BTSLEYG extender, out of which three with ZnO-NPs, Se-NPs, Fe<sub>3</sub>O<sub>4</sub>-NPs nanoparticles and one Control (without nanoparticles) were assessed to study the ultrastructural changes of spermatozoa by scanning electron microscope and transmission electron microscope, respectively. The optimized frozen thawed boar semen with best nanoparticles, packaging methods and thawing temperatures and times was used to assess conception rate following artificial insemination in oestrus pig.

The overall mean percentages of fresh boar semen evaluated for volume, pH, sperm concentration, total sperm per ejaculate, initial motility, live sperm, intact-acrosomal membrane (by Giemsa), intact plasma membrane integrity, sperm viability, acrosomal intact (by FITC-PSA), mitochondrial membrane potentiality (MMP) of spermatozoa and sperm DNA integrity revealed no significant difference between boars.

The boar semen after 1 hour of equilibration in BTSLEYG extender with ZnO-NPs (10 $\mu$ M), Se-NPs (1.0  $\mu$ g), Fe<sub>3</sub>O<sub>4</sub>-NPs (0.192 mg/ml) and without nanoparticles (Control) group showed non-significant ( $P < 0.05$ ) difference for sperm motility, live sperm, intact-acrosomal membrane (FITC-PSA), mitochondrial membrane potentiality and sperm DNA integrity. However, intact plasma membrane integrity and sperm viability live and moribund population showed significant difference ( $P < 0.01$ ) between

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different nanoparticles. The boar semen with ZnO-NPs (10  $\mu$ M) showed significantly ( $P < 0.05$ ) highest per cent of intact plasma membrane integrity than Se-NPs (1.0  $\mu$ g), Fe<sub>3</sub>O<sub>4</sub>-NPs (0.192 mg) and control (without nanoparticles). Similarly, for sperm viability- live exhibit no significant difference amongst ZnO-NPs (10  $\mu$ M), Se-NPs (1.0  $\mu$ g) and control (without nanoparticles). The sperm viability- moribund showed no significant difference amongst Se-NPs (1.0  $\mu$ g), Fe<sub>3</sub>O<sub>4</sub>-NPs (0.192 mg/ml) and control (without nanoparticles) group.

Assessment of quality of frozen boar semen with different nanoparticles (NPs) irrespective of packaging system and thawing temperatures and times revealed that sperm motility, live sperm, intact acrosomal membrane and intact-PMI and sperm viability-live, Intact-acrosomal membrane (FITC-PSA), mitochondrial membrane potentiality-high and sperm DNA normal showed significantly higher ( $P < 0.05$ ) in ZnO-NPs (10 $\mu$ M) than Se-NPs (1.0  $\mu$ g), Fe<sub>3</sub>O<sub>4</sub>-NPs (0.192 mg/ml) and Control (without nanoparticles). However, per cent of sperm viability-dead, non-intact-acrosomal membrane (FITC-PSA), mitochondrial membrane potentiality-low and sperm DNA damage showed significantly higher ( $P < 0.05$ ) in Fe<sub>3</sub>O<sub>4</sub>-NPs (0.192 mg/ml) than ZnO-NPs (10 $\mu$ M), Se-NPs (1.0  $\mu$ g), and Control (without nanoparticles). There was no significant difference observed between Se-NPs (1.0  $\mu$ g), and Control (without nanoparticles) for sperm motility, live sperm, intact acrosome membrane,

Mitochondrial membrane potential-high and Intact acrosome (FITC-PSA).

Assessment of quality of frozen boar semen of different packaging systems irrespective of nanoparticle and thawing temperatures and times revealed that per cent of sperm motility, live sperm, intact acrosomal membrane and intact-PMI and sperm viability-live, intact-acrosomal membrane (FITC-PSA), mitochondrial membrane potential-high and sperm DNA integrity significantly ( $P < 0.05$ ) higher in straws than sachets and cryovials,. The ANOVA indicated significant ( $P < 0.01$ ) difference between straws, sachets and cryovials.

Assessment of quality of frozen boar semen of different thawing temperatures and times irrespective of nanoparticles and packaging systems revealed that per cent of sperm motility, live sperm, intact acrosomal membrane and intact-PMI, sperm viability-live, intact-acrosomal membrane (FITC-PSA), mitochondrial membrane potential-high showed significantly ( $P < 0.05$ ) higher in 720 C for 9 sec and 500 C for 20 sec. than 370 C for 1 min. However, per cent of non-intact acrosome (FITC-PSA), sperm DNA normal and damage showed no significant difference between semen thawed at 370 C for 1 min, 500 C for 20 sec and 720 C for 9 sec.

In Scanning electron microscope the fresh ejaculates spermatozoa were having normal structure of head, middle piece, principal piece and terminal piece with intact plasma membrane. However, after thawing with different nanoparticles in 0.5 ml straw at 500 C for 20 sec, majority of the spermatozoa showed detached head, rupture plasma membrane, bent tail, stump tail, coiled tail and middle piece defects. The maximum and

worst damage was recorded with the semen extended with Fe<sub>3</sub>O<sub>4</sub>-NPs (0.192 mg/ml) followed by Se-NPs (1.0µg), and Control and least ultrastructure changes was found in ZnO-NPs (10µM).

In Transmission electron microscope the fresh spermatozoa were having intact plasma membrane over head and middle piece, Acrosome and acrosomal apical ridge were normal and intact, nucleus was electron opaque. However after thawing with different nanoparticles in 0.5 ml straw at 500 C for 20 sec, majority of the spermatozoa showed swollen, separating and rupture plasma membrane over the head region. Fusion of plasma membrane with outer acrosomal membrane and formation of large spaces between plasma membrane and outer acrosomal membrane were commonly seen. Most of the cells showed ruptured of plasma membrane over the middle piece and thinned mitochondrial matrix was also seen after thawing. The extreme and worst damage was recorded with the semen extended with Fe<sub>3</sub>O<sub>4</sub>-NPs (0.192 mg/ml) followed by Se-NPs (1.0µg), and Control and least ultrastructure damage was observed in ZnO-NPs (10µM).

A total of 37 numbers of sows were inseminated with optimized frozen boar semen with ZnO-NPs (10µM), packaged in straws (0.5ml) and thawed at 500 C for 20 seconds obtained 40.00 per cent non-return rate, while 29.41 per cent obtained in control. Sows were inseminated twice at 30 and 42 hours following onset of oestrus @ 4-5 x 10<sup>9</sup> sperm in 5 ml thawed semen diluted with 60 ml of BTS.



## **Differential Cytokine Gene Expression in Postpartum Endometritic Crossbred Cows**

*Maradona Nath*

The present research work was conducted to find out the incidence of postpartum (PP) endometritis and to study the differential cytokine gene expression during early postpartum period and its variation following treatment in endometritic crossbred cows. The incidence of postpartum endometritis was 25.19 per cent on examination of 258 postpartum crossbred cows based on white side test and cytological examination of uterine endometrial discharge obtained by cytobrush technique adopting the threshold level of 4.00 per cent PMN. Out of 18 postpartum stalled cows that were selected on the basis of white side test, cytological, haematological examination and liver function test, six apparently healthy animals were kept as control (Group- A) and 12 animals (Group-B) without history of abnormal parturition but found to be endometritic on cytological examination of uterine sample at first PP oestrus were subjected to study cytokine gene expression. Blood samples were collected by jugular venipuncture from all the cows of group-A and B on the day of parturition i.e., Day 0, Day 7 PP, Day 14 PP, on day of first PP oestrus and on day of second PP oestrus for the study of different haematological parameters viz. Hb, TLC, DLC, TEC and PCV. Uterine biopsy samples were collected by cytobrush technique on the said days for study of cytokine gene expression of IL-10, IL-6 and IL-2. Oestrogen, Progesterone and cytokines IL-10, IL-6, IL-2 were estimated in serum samples. Uterine discharge was collected on first and second PP oestrus for bacteriological study and antibiotic sensitivity test. It was revealed that the level of TLC ( $20.18 \pm 1.85$  m/mm<sup>3</sup>), Neutrophil ( $26.32 \pm 1.68$  %) and Lymphocyte ( $68.40 \pm 2.38$  %) count were significantly ( $P < 0.01$ ) higher on first PP oestrus in postpartum endometritic cows than the healthy cows. Other haematological parameters did not vary significantly between the groups of animals on the days of observation. Oestrogen and progesterone concentrations did not differ significantly between the two groups. Significantly ( $P < 0.05$ ) higher expression of cytokine gene IL-10 (4.85 fold), IL-6 (3.95 fold) and IL-2 (2.98 fold) was observed on

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first PP oestrus in postpartum endometritic cows in comparison with that in non-endometritic control cows. The serum IL-10, IL-6 and IL-2 concentrations were significantly ( $P < 0.01$ ) higher in endometritic cows on first PP oestrus ( $71.47 \pm 1.60$ ,  $1210.91 \pm 3.40$  and  $477.63 \pm 3.81$  pg/ml respectively) than the control cows. Uterine samples from all the endometritic cows in Group-B (12/12) i.e. 100.00 per cent were found to be positive for presence of bacteria on first PP oestrus before treatment. Two out of twelve cows i.e. 16.67 per cent exhibited bacterial presence on second PP oestrus following treatment. Two types of bacterial isolates were identified, Staphylococcus spp. and E. coli. The Staphylococcus spp. was predominant with percentage frequency of occurrence of 58.33 on first PP oestrus (pretreatment) in group-B cows. The percentage frequency of occurrence for E. coli on first PP oestrus was 41.66 in Group-B. Uterine discharge was free from E. coli infection on second PP oestrus (posttreatment). The presence of Staphylococcus spp. in uterine samples of endometritic cows after treatment with sensitive antibiotic reduced to 16.67 per cent on second PP oestrus. A total of seven (7) Staphylococcus spp. and five (5) E. coli isolates were isolated from the cultured uterine samples. Out of the total seven (7) Staphylococcus spp. isolated 5 isolates were found to be sensitive to ciprofloxacin (71.43 %). Three (3) out of total five (5) E. coli isolates were found to be sensitive to ciprofloxacin (60.00 %). The overall sensitivity of both the bacterial isolates was higher for ciprofloxacin (65.72 %) and hence intrauterine infusion of ciprofloxacin was selected for intrauterine antibiotic for treatment of endometritis in group B crossbred cows. The frequency of occurrence of bacteria decreased substantially in endometritic cows after intrauterine antibiotic infusion based on sensitivity test indicating the efficacy of the antibiotic used. The first A.I. conception rate in endometritic crossbred cows after intrauterine antibiotic treatment was 58.33 per cent which was higher than that in control cows. The present findings indicated that intrauterine treatment with most sensitive antibiotic was effective in postpartum endometritis of crossbred cows. It was concluded that upregulated cytokine gene expression and higher concentration of serum cytokines at first postpartum oestrus could serve as an indicator of endometritis which could be effectively addressed by intra-uterine antibiotic based on antibiotic sensitivity test for the enhancement of fertility in crossbred dairy cows.

# **Comparative Cytomorphological, Cytochemical, Cytoenzymic and Ultrastructural Studies on the Blood Cells of Adult Rhode Island Red, Aseel and Non Descript Indigenous Chicken of Mizoram**

*Mitali Dutta*

Thirty six pooled ejaculates from nine Assam Hill Goat bucks aged 2 to 2.5 years collected by artificial vagina method were used to study the fresh and frozen semen characteristics, characterization of seminal plasma proteins, characterization of sperm membrane proteins in fresh and frozen semen and to study the effect of supplementation of three membrane stabilizers, each at two different concentrations viz. 50 and 80 mM sucrose, 50 and 100 mM trehalose, and 100 and 150ng/ml IGF-1 to tris-citric acid fructose egg yolk glycerol extender (TCFEYG) on post-thaw semen characteristics and on sperm membrane proteins of frozen semen. Characterization of two fertility related membrane proteins viz. ADAM1 and ADAM2 were also done in fresh and frozen spermatozoa of Assam Hill goat by western blotting and immunolocalization using anti ADAM1 and anti ADAM2 antibodies raised in rabbit respectively. The mean per cent progressive sperm motility, HOST-reacted sperm and intact acrosome was significantly ( $p<0.01$ ) higher in fresh semen than in semen frozen in different extenders. The mean per cent post-thaw progressive motility, HOST-reacted sperm and intact acrosome differed significantly ( $p<0.01$ ) between the different extenders. However, no significant difference was observed in the mean per cent HOST-reacted sperm between TCFEYG supplemented with 100mM trehalose and TCFEYG supplemented with 100ng/ml IGF-1 and no significant difference was observed in the mean per cent intact acrosome between TCFEYG supplemented with 100mM trehalose and TCFEYG supplemented with 100ng/ml IGF-1 and between TCFEYG supplemented with 50mM sucrose and TCFEYG supplemented with 50mM trehalose. The mean per cent post-thaw progressive sperm motility, HOST-reacted sperm and intact acrosome in frozen semen was found to be the highest in TCFEYG supplemented with 150ng/ml IGF-1.

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SDS- PAGE of seminal plasma and sperm membrane extract of fresh semen revealed the presence of 20 and 24 protein bands respectively with molecular weights ranging from 10 kDa to 240 kDa. The SDS-PAGE electrophoretogram of sperm membrane proteins of semen frozen using TCFEYG and TCFEYG supplemented with 50mM sucrose (TCFEYG + 50mM S) and, 80mM sucrose (TCFEYG + 80mM S) revealed 21 protein bands with molecular weights ranging from 10 kDa to 240 kDa. The 21 protein bands were same with that observed in the sperm membrane of fresh spermatozoa, except three protein bands. These three proteins of molecular weights 23 kDa (~Phosphatidyl-ethanolamine-binding protein), 29 kDa (~Proacrosin binding protein) and 42 kDa (~tyrosine- phosphorylated SPACA1) were absent in TCFEYG and TCFEYG supplemented with 50mM, and 80mM sucrose. The SDS-PAGE electrophoretogram of sperm membrane proteins of semen frozen using TCFEYG supplemented with 50mM trehalose (TCFEYG + 50mM T), and 100mM trehalose (TCFEYG + 100mM T) revealed 22 protein bands with molecular weights ranging from 10 kDa to 240 kDa. The 22 protein bands were same with that observed in the sperm membrane of fresh spermatozoa, except two protein bands. These two proteins of molecular weights 29 kDa (~Proacrosin binding protein) and 42 kDa (~tyrosine-phosphorylated SPACA1) were absent in TCFEYG supplemented with 50mM, and 100mM trehalose. The supplementation of trehalose to the basic TCFEYG extender at 50mM and 100mM concentrations, however, had a protective effect on the sperm membrane protein of 23kDa when compared to the basic TCFEYG extender and TCFEYG supplemented with 50 and 80mM sucrose. The SDS-PAGE electrophoretogram of sperm membrane proteins of semen frozen using TCFEYG supplemented with 100ng/ml IGF-1 (TCFEYG + 100ng/ml IGF-1), and 150ng/ml IGF-1 (TCFEYG + 150ng/ml IGF-1) revealed 21 protein bands with molecular weights ranging from 10 kDa to 240 kDa. The 21 protein bands were same with that observed in the sperm membrane of fresh spermatozoa, except three protein bands. These three proteins of molecular weights 29 kDa (~Proacrosin binding protein), 130 kDa (~lipoprotein binding protein) and 240 kDa (~golgi-associated retrograde protein) were absent in TCFEYG supplemented with 100ng/ml, and 150ng/ml IGF-1. Supplementation of the basic tris extender with IGF1 at concentrations of 100ng/ml and 150ng/ml resulted in protection of sperm membrane proteins of molecular weights 23kDa (~Phosphatidyl-ethanolamine-binding protein) and 42 kDa (~tyrosine-phosphorylated SPACA1) during the freeze-thaw process when compared to the basic tris extender and tris extender supplemented with sucrose. The 23 kDa protein was however, also found to be protected in the tris extender supplemented with trehalose.

ADAM1 was detected as three bands of ~ 25kDa, 66kDa and ~ 90kDa in the sperm membrane extract of fresh sperm. However, in the sperm membrane extract of semen frozen using TCFEYG, TCFEYG + 80mM S, TCFEYG + 50mM S, TCFEYG + 50mM T, TCFEYG + 100mM T, TCFEYG + 100ng/ml IGF-1 and TCFEYG + 150ng/ml IGF-1 extenders it was detected as ~25kDa, 66kDa and ~90kDa; ~25kDa,

66kDa and ~90kDa; ~25kDa, ~49kDa,~66kDa, ~90kDa and ~110kDa; ~25kDa,66kDa and ~90kDa; ~25kDa, 66kDa and ~90kDa; ~25kDa, ~49kDa,~66kDa, ~90kDa and ~110kDa ; and ~25kDa, ~49kDa,~66kDa, ~90kDa and ~110kDa respectively. In the present study, freeze-thaw process and supplementation of tris extender used for freezing of semen with membrane stabilizers such as sucrose, trehalose and IGF-1 has been found to result in certain variations in the molecular weight of ADAM1. However, reactive protein bands of 25kDa, 66kDa and 90kDa were found to be consistently present in the fresh sperm as well as sperm frozen in different extenders. ADAM2 was detected as two bands of ~ 80kDa and~ 130kDa in the sperm membrane extract of fresh sperm. However, in the sperm membrane extract of sperm frozen using TCFEYG, TCFEYG + 80mM S, TCFEYG + 50mM S, TCFEYG + 50mM T, TCFEYG + 100mM T, TCFEYG + 100ng/ml IGF-1 and TCFEYG + 150ng/ml IGF-1 extenders it was detected as ~70kDa, ~80kDa, ~100kDa and ~130kDa; ~70kDa, 80 kDa and ~130kDa; ~70kDa, ~80kDa,~90kDa, ~100kDa and ~130kDa; ~70kDa, ~80kDa, and ~100kDa; ~70kDa, ~80kDa, and ~100kDa; ~70kDa, ~80kDa, and ~100kDa; and ~70kDa, ~80kDa, and ~100kDa respectively. In the present study, freeze-thaw process and supplementation of tris extender used for freezing of semen with membrane stabilizers such as sucrose, trehalose and IGF1 has been found to result in certain variations in the molecular weight of ADAM2. However, a protein band of 80 kDa was found to be consistently present in the fresh sperm as well as sperm frozen in different extenders. Immunolocalization of the ADAM1 and ADAM2 proteins revealed the presence of the proteins in the acrosomal region of sperm cells in both fresh and frozen semen. Present study revealed no change in the localization of ADAM1 and ADAM2 post freezing thereby indicating that there is no effect of freezing on the distribution of these two proteins.

It was concluded that cryopreservation of Assam Hill Goat semen resulted in alterations in sperm membrane proteins, however, supplementation of membrane stabilizers exerted protective effects. Based on post-thaw semen characteristics and study on membrane proteins it was found that IGF-1 @ 150ng/ml was superior to other membrane stabilizers in maintaining post-thaw semen quality.

# **Differential Expression of Certain Fertility Marker Genes in Yak Semen and Their Association with Yak Embryo Production**

*Mokhtar Hussain*

Six healthy yak bulls of 3-5 years age and twenty four healthy cyclic female yaks, in their first to second lactation stage, aged 3 to 4.5 years, maintained at ICAR-NRC on Yak, Dirang were used to study the effect of seasons and additive in semen qualities, the expression pattern of certain fertility associated genes in yak semen, and their association with semen characteristics and embryo production. A total of 216 ejaculates collected by standard artificial vagina method were evaluated for volume, initial sperm motility, sperm concentration, live sperm, sperm abnormality, HOST-reacted sperm, acrosomal abnormality and intake acrosome in fresh semen in different seasons. Each ejaculates were split into two equal parts for fresh and frozen semen study, and the fresh semen part was divided into two parts for studying semen characteristics and mRNA gene expression, while the frozen part was divided into two parts to study the effect of additives in different stages of processing and freezing, and for mRNA gene expression studies.

All the parameters for fresh semen characteristics varied significantly ( $P<0.01$ ) between seasons and between animals, while live sperm (%) varied significantly ( $P<0.05$ ) between seasons. The interaction between season and animals was found to be non-significant except in live sperm (%) that varied significantly ( $P<0.05$ ), and acrosomal abnormality (%) and intake acrosome (%) that varied significantly ( $P<0.01$ ). The percentage of sperm motility, live sperm, HOST-reacted sperm and total acrosomal changes of yak semen differed significantly ( $P<0.01$ ) between additives and between the seasons, but no difference was observed in their interaction. The total acrosomal changes of yak semen showed interaction between additives and seasons after equilibration and thawing during processing and freezing. Better quality of fresh yak semen was obtained in the autumn season.

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**Abstract of Ph.D. Thesis**

**Department : Animal Reproduction, Gynaecology and Obstetrics**

**Major Advisor : Dr. K. Ahmed**

Freezing did not seem to have any effect on *YWHAZ* gene expression but had significantly negative effect on the expression of *CATSPER2* gene during premonsoon, and a positive influence on *PRMI* gene expression in all the seasons. Autumn season appeared to have no influence on the expression of *YWHAZ* gene, but had a positive and negative influence on the expression of *CATSPER2* and *PRMI* gene, respectively. Winter season had a positive influence on the expression of *CATSPER2* and *YWHAZ* genes, and a negative influence in the expression of *PRMI* gene. All the three genes showed highly significant positive correlation with most of the characteristics of fresh semen viz. ejaculate volume, sperm motility, sperm concentration, live sperm count, HOST-reacted sperm and intact acrosome, and negative correlation with sperm abnormalities and total acrosomal changes in all the seasons.

Twenty four female yaks were synchronized by ovsynch protocol and following superovulatory treatment with Stimufol (@400 $\mu$ g and @200  $\mu$ g per animal) and Folligon (@1500 IU and @1000IU per animal) in two different doses, a hundred per cent oestrus response was observed in all the groups. The oestrus response, duration of estrus, number of CL and embryo recovered in yaks did not differ significantly between the different treatment groups and animals, but differed significantly ( $P < 0.01$ ) between the treatment and the onset of estrus. The highest number ( $3.50 \pm 0.65$ ) of excellent grade embryos were recovered from the animals treated with Folligon @ 1500 IU per animal. The progesterone concentrations differed significantly between treatment and between different days of observation in all animals of the group. The minimum concentration of progesterone of  $0.19 \pm 0.43$  ng/ml on the day of induced oestrus increased to maximum level of  $25.11 \pm 2.67$  ng/ml on the day 7th of induced oestrus.

# **Biochemical Profile with Special Reference to Acute Phase Protein and Energy Balance in Crossbred Cows During Post-Partum Uterine Infection**

*Pranjal Borah*

The present research work was conducted to evaluate the haematobiochemical status on supplementation or without supplementation of bypass fat in periparturient cows that developed or not developed uterine infection subsequently following calving. Study was also carried out to find the haemato-biochemical changes on different days of cycle in post partum cyclic cows with uterine infection along with treatment response. A total of 48 crossbred cows comprising 24 peri-partum and 24 post-partum cyclic cows at their third to fifth lactation were used as experimental animals in the study.

Haemato-biochemical investigation carried out in four groups comprising six peri-partum cows in each, viz., non-supplemented with uterine infection (Group-I), nonsupplemented without uterine infection (Group-II), supplemented with uterine infection (Group-III) and supplemented without uterine infection (Group-IV) on day -14, 2, 7 and 14 of peri-parturition revealed that the mean lymphocyte and neutrophil count varied significantly between groups and between days, while monocyte, eosinophil and basophil counts and haemoglobin levels differed significantly between days of observation. WBC and RBC counts and PCV level showed no significant variations. The mean level of serum Hp, total protein, GGT, ALT, AST and ghrelin differed significantly between groups and between days while SAA varied significantly between days of sampling. No significant variations could be observed in serum albumin, IGF-I and Leptin levels. In non-supplemented and supplemented groups, 66.67 and 69.44 per cent uterine samples were positive for presence of bacteria. The frequency percentage of occurrence of bacterial isolates on day 2, 7 and 14 postpartum was 75.00, 66.67 and 58.33 and, 66.67, 75.00 and 66.67 in non-supplemented and supplemented group respectively. *Staphylococcus spp.* and *E. coli* were isolated from both the groups, *Staphylococcus spp.* being predominant.

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**Major Advisor : Dr. Ranjan Kumar Biswas**



Serum ghrelin level had significant negative correlation with WBC count and serum total protein level while IGF-I had significant positive correlation with serum albumin and negative correlation with serum AST activity when assessed in nonsupplemented crossbred cows with uterine infection during day 2, 7 and 14 post-partum. The mean first post-partum oestrus in Group I, II, III and IV peri-parturient cows was found to be  $118.29 \pm 12.33$ ,  $104.00 \pm 18.05$ ,  $86.50 \pm 9.97$  and  $82.75 \pm 8.27$  days respectively with first A.I conception rates of 57.14, 60.00, 62.50 and 75.00 per cent in corresponding groups.

Haemato-biochemical study done in four groups, comprising six post-partum cows in each, viz., normal cyclic (Group-I), antibiotic (Levofloxacin Hemihydrate, Ornidazole and Alpha Tocopherol Acetate)-treated (Group-II), *E. Coli* LPS (100 µg single dose at oestrus)- treated (Group-III) and *E. coli* LPS + bypass fat supplementation for 21 days (Group-IV) indicated that among the haematological parameters (estimated on day 0, 7 and 21 of oestrus) the mean haemoglobin level, PCV per cent, WBC, lymphocyte and eosinophil counts varied significantly between groups, the mean RBC and monocyte counts differed significantly between groups and between days of observation, neutrophil count varied significantly between days while basophil count did not vary significantly. Among the biochemical parameters (estimated on day 0 and 21) the levels of mean SAA, GGT, ALT, IGF-I, leptin and ghrelin differed significantly between groups, that of Hp and AST varied significantly between groups and between days while there was no significant variation in the level of mean serum total protein and albumin. Bacteriological study revealed that in uterine infected cows cent per cent uterine samples were positive for bacterial growth; while post-treatment it reduced to 33.33, 16.67 and 16.67 per cent in Group II, III and IV cows respectively. Two types of bacteria isolated were *Staphylococcus* spp. and *E. coli*; *Staphylococcus* spp. being predominant. First A.I conception rate was higher in group of cows treated with *E. coli* LPS 100µg I.U + bypass fat supplementation (83.33 %) in cyclic uterine infected crossbred cows followed by *E. coli* LPS 100µg I.U (66.67 %) and antibiotic (50.00 %). SDS- PAGE analysis of pooled samples for different days in different groups of peri-parturient and normal cyclic and post-partum infected and treated cows revealed 10 protein bands with molecular weight of 157.65, 90.41, 72.73, 59.94, 55.74, 51.84, 47.07, 39.74, 34.37 and 33.55 kDa. No difference in band profile was observed among groups and days indicating no expression of new protein.

## **Effect of Cryopreservation on Semen Biochemical Parameters Including Lipid Profile in Beetal and Assam Hill Goat**

*Prasanta Kumar Das*

A total of 72 ejaculates comprising six ejaculates from each of 12 bucks (six Beetal and six Assam Hill Goat) were used to study the effect of cryopreservation on the physical and biochemical characteristics of semen including sperm ultrastructure. The physical characteristics of fresh semen *viz.*, ejaculate volume, mass activity, initial sperm motility, live sperm, sperm concentration, cold shock resistance index, acrosomal integrity, HOST-reacted sperm and sperm abnormalities were studied by conventional methods. The biochemical characteristics *viz.*, sodium, potassium, calcium, total cholesterol, total lipid, AST, ALT and lipid profile were studied in seminal plasma, and total cholesterol, total lipid and lipid profile were also studied in spermatozoa of fresh and frozen semen. Semen was extended in Optixcell extender and frozen in 0.25 ml straws using liquid nitrogen vapour and stored in liquid nitrogen. Each sample was evaluated on the following day for sperm motility, live sperm, acrosomal integrity and HOST-reacted sperm. The biochemical characteristics studied after freezing in extracellular medium were the same as in case of seminal plasma. Sperm ultrastructure was studied both in fresh and frozen-thawed spermatozoa.

Physical and biochemical characteristics of semen of Beetal and Assam Hill Goats were within normal range and differed significantly between breed for ejaculate volume ( $P<0.001$ ), sperm concentration ( $P<0.001$ ), cold shock resistance ( $P<0.05$ ), Host-reacted sperm ( $P<0.01$ ), sodium ( $P<0.001$ ), potassium ( $P<0.001$ ) and total lipid ( $P<0.001$ ). Post-thaw sperm parameters *viz.* sperm motility, live sperm, acrosomal integrity and HOST-reacted sperm, and content of biochemical constituents *viz.* sodium, potassium, calcium, total cholesterol and total lipid decreased after freezing in semen of both the breeds, while AST and ALT increased. Thirteen and fourteen fatty acids were identified in the seminal plasma of Beetal and Assam Hill Goat bucks, respectively. Pentanedioic acid was identified only in seminal plasma of Assam Hill Goat. In the extracellular medium of frozen Beetal semen, all the fatty acids of seminal plasma of

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fresh semen were present, however, in Assam Hill Goat bucks both Dodecadienoic acid and Pentanedioic acid which were present in seminal plasma of fresh semen were found to be absent in frozen semen. Breed variation was observed in respect of Pentanedioic acid of fresh semen. Freezing had significant effect in alteration of membrane stabilizing fatty acids *viz.* Erucic acid, carboceric acid, linoleic acid, tricontanoic acid, arachidic acid, eicosadienoic acid, margaric acid, mentanic acid, tetradecadienoate, tridecanoic acid, heneicosylic acid, cerotic acid and tricosanoic acid. Major ultrastructural changes in spermatozoa after freezing were separating and ruptured plasma membrane, fusion of plasma membrane with outer acrosomal membrane, swelling of acrosome and loss of acrosomal content.

Based on the physical and biochemical parameters studied it could be concluded that cryopreservation of goat semen has deleterious effects on fatty acid profile of seminal plasma and sperm plasma membrane, and also on sperm ultrastructure in both Beetal and Assam Hill Goat. The proportion of loss of plasma membrane fatty acids after freezing was lower in Assam Hill Goat as compared to that of Beetal goat. Post-thaw semen quality in Assam Hill Goat was superior to that of Beetal goat.

## **Effect of Antioxidants on Quality and Relative Expression of Fertility Related Genes of Cryopreserved Beetal Buck Semen**

*W. Lomen Singh*

A total of 120 ejaculates from six Beetal bucks, collected by artificial vagina were used in the study. Immediately after collection each ejaculate was evaluated for volume, mass activity and initial sperm motility and the ejaculates having volume 0.8 ml or more, mass activity (0 to 4+ scale) 3+ or more and initial sperm motility 70 per cent or more were pooled. A total of 48 pooled ejaculates comprising 12 pooled ejaculates for each experiment were evaluated for sperm motility, live sperm, intact acrosome, sperm concentration, HOST-reacted sperm and sperm abnormalities. Each pooled ejaculate was split into two parts and one part was used for assessment of glutathione-S-transferase (GST), superoxide dismutase (SOD), catalase (CAT), glutathione reductase (GR), glutathione peroxidase (GPx), alanine aminotransferase (ALT), aspartate aminotransferase (AST), lactate dehydrogenase (LDH), and malondialdehyde (MDA) level in the seminal plasma. The other part of pooled semen was split into four parts, then centrifuged and the seminal plasma was discarded. The centrifugate of the first three parts was extended separately in Tris extender containing vitamin E @ 1, 2 and 3 mM in experiment I; IGF-1 @ 100, 125 and 150 ng/ml in experiment II; crocin @ 1, 2 and 3 mM in experiment III; and vitamin E @ 2 mM (best of expt. I), IGF-1 @ 125 ng/ml (best of expt. II) or crocin @ 1 mM (best of expt. III) in experiment IV while the fourth part was kept as control in each experiment. Semen was frozen in 0.25 ml French straws using static horizontal vapour freezing. Frozen semen was thawed in warm water at 37°C for 30 seconds for evaluation. Each semen sample was evaluated after freezing in experiment I, II and III for sperm motility, intact acrosome (Giemsa stain), HOST-reacted sperm and intact DNA (AO stain) and in experiment IV for sperm motility, intact acrosome (FITC-PSA stain), HOST-reacted sperm, viability (CFDA + PI stain), high mitochondrial potential (JC-1 stain) and intact DNA. Semen after freezing in all the experiments was evaluated for GST, SOD, CAT, GR, GPx, ALT, AST, LDH and MDA

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levels in the extracellular fluid by standard methods. In experiment IV, the relative expression of certain fertility related genes and their correlation with seminal attributes in frozen-thawed Beetal buck spermatozoa as well as fertility rate of frozen semen was also studied.

In Beetal bucks all the seminal attributes studied immediately after collection and pooling were within normal ranges. Semen samples extended with Tris extender containing vitamin E @ 1, 2 and 3 mM or no additive (control) and with Tris extender containing IGF-1 @ 100, 125 and 150 ng/ml or no additive differed significantly ( $P < 0.001$ ) in respect of sperm motility, intact acrosome, HOST-reacted sperm, intact DNA, GST, SOD, CAT, GR, GPx, ALT, AST, LDH and MDA after freezing. Semen samples extended with Tris extender containing crocin @ 1, 2 and 3 mM or no additive differed significantly ( $P < 0.05$ ) in respect of sperm motility and intact acrosome after freezing. While HOST-reacted sperm, intact DNA, GST, SOD, CAT, GR, GPx, ALT, AST, LDH and MDA differed significantly ( $P < 0.001$ ) after freezing in Tris extender containing crocin @ 1, 2 and 3 mM or no additive. In semen extended using Tris extender containing best concentration of vitamin E (2 mM), IGF-1 (125 ng/ml) and crocin (1 mM) or no additive differed significantly ( $P < 0.001$ ) in respect of sperm motility, intact acrosome, HOST-reacted sperm, viability, MMP+, intact DNA, GST, SOD, CAT, GR, GPx, ALT, AST, LDH and MDA after freezing.

*NFE2L2*, *GPx4*, *CAT* and *SOD2* gene expression was significantly ( $P < 0.05$ ) higher in IGF-1 group compared to that in vitamin E and crocin groups, however, no significant ( $P > 0.05$ ) differences were recorded between vitamin E and crocin groups.

Correlation study revealed that sperm motility showed a significant ( $P < 0.05$ ) positive correlation with all the four target genes, irrespective of the antioxidant treatment. The target genes also showed a positive correlation with all the seminal attributes in different antioxidant groups. Although the kidding rate (doe kidded per inseminated doe) did not differ significantly ( $P > 0.05$ ) between groups, the values were found to be the highest in the IGF-1 @ 125 ng/ml group.

Based on the semen parameters studied it was concluded that IGF-1 @ 125 ng/ml, was found to be superior to other additives studied in maintaining post-thaw semen quality.

# **Effect of Probiotic and Zinc In Gut Integrity of Pre and Post Weaned Piglets: An Immunomorphological and Biomolecular Analysis**

*Arup Kalita*

Present study was undertaken to elaborate alteration of histomorphological, histochemical, ultrastructural, immunofluorescence, gut microbiota, cytokine gene profile and brush border enzyme activity of histocompartments of small intestine in control (basal diet) and treatment (basal diet + probiotic + zinc) group piglets during pre and post-weaned period. This study was assumed to understand the effect of probiotic and zinc on gut digestibility and immunity compared to the control piglets so that the productivity of this important species of farm animal could be enhanced. Besides, this information was assumed to help to control the post-weaning diarrhoea in piglets that causes significant economic losses in pig production. Eighteen (18) numbers of apparently healthy Large White Yorkshire piglets, irrespective of their sex were utilized in the present study. These piglets were selected from three litters (6 piglets from one litter) and were divided into control (basal diet) and treatment (basal diet + probiotic + zinc) groups, consisting of 3 animals in each group.

The probiotic (dosed daily with  $1.25 \times 10^9$  CFU/gm) and zinc (ZnO dosed daily with 2000 ppm) was supplemented orally to the treated piglets from birth to 10 days of age. The weaning of the piglets was done at 28 days. The animals were sacrificed at day 20, day 30 and day 60 from both the groups. The histomorphological, ultrastructural, histoenzymatic, immunofluorescence and cytokine gene expression were performed to study the alteration in treatment group of piglets. Besides, examination of brush border enzyme activity was done to evaluate the conversion of disaccharide into monosaccharide in these two groups of piglets.

The villus and crypt morphometry revealed higher villus height, villus width, crypt depth, crypt width, villus enlargement factor and crypt enlargement factor, and lower villus crypt ratio in treatment group of piglets. This might indicate greater absorptive capacity of available nutrients and higher epithelial turn-over rate to

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**Major Advisor : Dr. Manmath Talukdar**

compensate losses in height of villi in treated piglets especially during early postweaning period.

In the mucosa of villus and crypt, the number of goblet cells, argentaffin cells and tuft cells were increased in treatment group of piglets. These findings might be concluded with better enhancement of epithelial barrier, higher production of gastrointestinal hormones, better microenvironment of gut and defense mechanism which resulted in effective immunity and digestibility in this group of piglets. In the lining epithelium of small intestine, the number of intraepithelial lymphocytes (IEL) was higher in treatment group piglets that could be the result of a nonspecific stimulation of the local immune system possibly by certain antigens of probiotic bacteria. The increased number of IEL might be an indicative of more mature and efficient adaptive immune response in piglets fed with probiotic and zinc than the control animal.

In the histotopographic areas, the CD4+ cells, CD8+ cells, IgA+ cells and IgM+ cells were increased in treatment group of piglets. These findings might be interpreted with more production and secretion of secretory IgA, enhancing defense against pathogens, maintenance and enhancement of epithelial cell integrity and production of more immunoglobulin to ensure a fast reaction against potential pathogens. These might led to better mucosal immunity in the probiotic and zinc treated piglets. In the treatment group of piglets, the brush border enzyme activity was higher to convert their respective substrates into glucose that might be indicative of more absorption of glucose from the available carbohydrate present in the intestine, and resulted with better growth and development in this group of piglets. The increased activity of acid and alkaline phosphatase in treated piglets might be correlated with higher secretion of glands and greater absorptive capacity of enterocytes. Similarly, higher ATPase and non-specific esterase activities might be indicative of more concentration of B and T cells in follicular and interfollicular areas of PP in treatment group of piglets, respectively.

The cultivable cell counts of lactic acid bacteria were higher in treatment group of piglets. These more number of beneficial microbiota might reduce the pathogenic bacterial load in the small intestine and provide a healthy environment for better digestion and immunity in treatment group of piglets especially in early post-weaning period.

The marginal up-regulation of cytokine expression of TNF- $\alpha$ , IL-1 $\beta$  and IL-6 transcripts in treatment group of piglets might have resulted in the stimulation of innate immune cells to eradicate microbes and enhancement of IgA B-cell population in the young ones and increased epithelial cell turn-over. The down-regulation of cytokine expression of IL-8, IL-12 and IL-18 transcripts in treatment group of piglets possibly lead to decreased activity of NK cells and CD8+ cytotoxic T lymphocytes which was an indicative of lesser infections associated with intracellular pathogens and presence of healthy intestinal epithelial cells in the gut.

# **Anatomical Study of The Post-Natal Development of Male Genital System of Pati Duck (*Anas platyrhynchos*) of Assam**

*Elizabeth VI Hmangaihzuai*

The present study was undertaken to elaborate certain gross anatomical, histomorphological, histochemical, ultrastructural, haematological and serum biochemical aspect of male genital organs of Pati duck (*Anas platyrhynchos*) of Assam during the postnatal development. Total 30 (thirty) numbers of apparently healthy Pati ducks (*Anas platyrhynchos*) were utilized for present study. The testis of Pati duck (*Anas platyrhynchos*) was located within the abdominal cavity. The organ was elongated rice-grain like in 1 month which changed to oval shaped in 20 weeks and bean shaped in 30 and 40 weeks. The epididymis was found on the dorso-medial aspect of testis. The epididymal duct of the testis continued as Vas deferens. The convoluted vas deferens tightly coiled in a zingzag pattern till 20 weeks and the convolutions loosened in 30 and 40 weeks. The vas deferens was translucent in 1 month and 6-8 weeks whereas in 30 and 40 weeks they were opaque white with presence of spermatozoa in the lumen. The phallus coiled in anti-clockwise direction from the base to the apex. The ejaculatory groove and sulcus divide the shaft into two lateral bodies. The length increased with age.

The testis of Pati duck (*Anas platyrhynchos*) had a capsule which had three parts viz., tunica serosa, tunica albugenia and tunica vasculosa. The thickness of the capsule of the testis gradually increased along the advancement of the age i.e. from 1 month to 40 week age group. The collagen, reticular, elastic and nerve fibers were observed within the capsule and as well the peritubular area of the seminiferous tubules. The thickness of the capsule and distribution of all the fibers increased along with the advancement of the age i.e. from 1 month to 40 week age group.

The parenchyma of the testis of the Pati duck (*Anas platyrhynchos*) consisted of complex and convoluted seminiferous tubules separated by interstitial connective tissue. No lobulation and mediastinum testis. The diameter as wells as layers of cell of the ST increased with age. One month and 6-8 weeks birds semiferous tubules were mainly composed of Sertoli cells, spermatogonium cells and vacuolated cells. In 20 weeks the

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cells were 3 to 5 layers consisting of spermatocyte along with other cells. The ST of 30 and 40 weeks age groups had 8 to 17 layers of cells formed by different stages of spermatogenesis. The interstitial connective tissue decreased with increased in age. The epididymal region consisted of rete testis which was intracapsular and extracapsular, efferent duct with smooth and folded epithelium, collecting duct and epididymal duct having the same epithelial lining. The vas deferens diameter increased with age. Smooth epithelium at the cranial part and folded epithelium at caudal part. The phallus has a narrow lumen which was surrounded by a very large lymphatic space and vascular body. In the present histochemical study of male genital organ of Pati duck, the reaction of Alkaline Phosphatase enzyme decreased with age in the testis, moderate in the vas deferens and intense in the phallus. The reaction of the Acid Phosphatase moderate in the testis and vas deferens of all age group, while phallus had intense and moderate activity area. The Adenosine Tri Phosphatase (ATPase) activity increased with increased in age in the testis, weak activity in the vas deferens and phallus with intense and weak activity area.

Under TEM two types of leydig cells *viz.*, elongated and polygonal shaped was found, they contain numerous lipid droplets along with mitochondria and endoplasmic reticulum. Sertoli cell had large and irregularly shaped nucleus which had intranuclear cleft. The prominent nucleoli of sertoli cell nucleus had a very dense and moderately dense area. In the peritubular space layers of overlapping myoid cells was found. Within seminiferous tubules cellular detailed of spermatogenic cells were observed. Age related change observed with Testosterone hormone which increased with increased in age. T3 and T4 hormones were higher in younger age while Cortisol was higher in older groups. Among the haematological parameters significant changes was found in PCV, WBC, monocyte and neutrophils. ALP was the only serum enzyme which showed significant changes between age groups. Serum metabolites *viz.*, total protein, albumin and creatinine showed significant changes among the different age group.

# **Histological, Ultrastructural and Molecular Studies on Guard Hair for Species Difference of Hoolock Gibbons (*Hoolockhoolock*) Found in Assam, Arunachal Pradesh and Meghalaya**

*Jahan Ahmed*

Hoolock gibbons are the only ape species found in India and its population is confined to the north eastern states of India. The Hoolock gibbons are tailless and have distinctive call pattern. The gibbons have strong hook shaped hands for grasping branches, brachiating arms and long and strong legs to help them in jumping and propelling across branches of trees. Gibbons found in India has been identified based on their phenotypic characters as Western Hoolock gibbons found in Assam, Meghalaya, Nagaland, Tripura and Mizoram while the ones found in Arunachal Pradesh were classified as Eastern hoolock gibbon. These classification is purely based on the external observation and phenotypic characters. There has been a debate regarding the species found in India, initially it was believed to be one single species but later on it was found that there are two species namely the Western Hoolock gibbon and Eastern Hoolock gibbon. Recently, a new sub species has been added from Mishmi hills in Arunachal Pradesh called as Mishmi gibbons (*Hoolockhoolockmishmiensis*). All the classifications are based on morphological characteristics.

In Western Hoolock gibbons, the newborns are milky white and turn to black in both sexes by the age of 2 years. Males remain black and the scrotum appears distinct by seven months. In females when they reach adult stage, the hairs turn into golden blond colour with white brows and a white frame in the face. The white brows are found in males as well. These are distinctive characteristics of Western Hoolock gibbons. Eastern Hoolock gibbons are similar to the Western Hoolock gibbons except that the adult female is pale colour with more distinct paler arms. The male has a white genital tufts and spaced out white eyebrows.

The length of the hairs varied in different body regions being shortest hairs in the forehead region of male hoolock gibbons from Assam and longest in the shoulder

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**Major Advisor : Dr. Munmun Sharma**

region in both sexes of gibbons from Arunachal Pradesh, Assam and Meghalaya. The hairs were curly and twisted. The hairs were observed to have a fine lustrous texture. In male eastern hoolock gibbon it was observed that the hair diameter in the forehead region was  $43.43 \pm 0.19 \mu\text{m}$  and in female it was  $46.55 \pm 0.21 \mu\text{m}$ . In western hoolock gibbon from Assam the hair shaft diameter was  $43.22 \pm 0.59 \mu\text{m}$  in male and in female it was recorded as  $44.55 \pm 0.23 \mu\text{m}$ . In western hoolock gibbon from Meghalaya it was observed that the hair shaft diameter in male was  $41.88 \pm 0.26 \mu\text{m}$  while in female it was  $39.74 \pm 0.61 \mu\text{m}$ . Hair medulla was present only in the male gibbons from Arunachal Pradesh. The medulla pattern was continuous and elongated in shape. Hair medulla was observed in gibbons of all the three states. The hair medulla was elliptical and fragmented in structure. The cortico medullary index was maximum in female hoolock gibbons from Arunachal Pradesh i.e.  $34.66 \pm 0.04 \mu\text{m}$  and minimum was recorded from hoolock gibbons in Meghalaya gibbons i.e.  $30.06 \pm 0.2 \mu\text{m}$ . 2D electrophoresis revealed two protein bands in the range of 61.98 KDal and 44.3 KDal. Highest value was recorded from male Eastern hoolock gibbon at  $172.7 \pm 0.28 \text{Kdal}$  while lowest was recorded from Western hoolock gibbon from Assam at  $5.04 \pm 0.14$ . Molecular analysis indicates that hoolock gibbon from NE are Hoolockhoolock or western hoolock gibbon.

# **Postnatal Development of The Harderian Gland of *Pati Duck (Anas platyrhynchos domesticus)* of Assam**

*Jiten Rajkhowa*

The present study was undertaken to elaborate certain gross anatomical, histomorphological, histochemical, ultrastructural and biochemical aspect of Harderian gland of *Pati* ducks (*Anas platyrhynchos domesticus*) of Assam during the postnatal development. Total 45 (forty five) numbers of apparently healthy *Pati* ducks (*Anas platyrhynchos domesticus*) were utilized for present study. The Harderian gland of *Pati* duck (*Anas platyrhynchos domesticus*) was located within the orbit. The gland was flat, oval and coma shaped with irregular border. The gland had two surfaces i.e. the parietal and the visceral surfaces, two borders and two blunt poles. The parietal surface was found convex and attached to fascia covered by the nasal bones and interorbital septa of the orbit. The visceral surface was concave and it was attached loosely to the eye ball with fascia. The lobes of the Harderian gland became more prominent with the advancement of the age. The gland was light pink while freshly collected. The arterial blood supplied and the venus drainage was by the ophthalmic artery and vein. The slender branch of oculomotor nerve innervated the Harderian gland. The result reflected an ascending trend from 0 week age group to 42 weeks age group in all the gross parameters. There were slight difference between left and right gland in all the gross parameter but statistically not significant (p value > 0.05). A short single duct was observed in the Harderian Gland of *Pati* duck (*Anas platyrhynchos domesticus*). The duct opened into the conjunctival sac at the base of the 3rd eyelid. The Harderian gland of *Pati* duck (*Anas platyrhynchos domesticus*) had a capsule which was consisted of connective tissue, blood vessels, nerves and lymphatics. The thickness of the capsule of the Harderian gland was increased slightly along the advancement of the age i.e. from 0 week to 42 weeks age group. The capsular connective tissue penetrated the parenchyma

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of the Harderian gland in the form of septa or trabeculae. The collagen, reticular, elastic and nerve fibers were observed along with the capsule and as well as in the septa and trabeculae. The thickness of the capsule and distribution of all the fibers increased along with the advancement of the age i.e. from 0 week to 42 weeks age group. The Harderian gland of the *Pati* duck (*Anas platyrhynchos domesticus*) was compound tubular gland. The columnar epithelial cells lined the tubules. There was no cortex and medulla in the gland and the tubular structures were uniformly distributed within the lobules. A central canal was present in the gland which converged to the duct of the gland. The lymphocytes and plasma cells were found in the intertubular connective tissue. The numbers or population of plasma cell and lymphocytes were accelerated by the advancement of age. The myoepithelial cells with spindle shaped nuclei were present near the basement membrane close to the secretory cells. The histology of the duct of the Harderian gland of *Pati* duck (*Anas platyrhynchos domesticus*) was like typical hollow tubular organs. There were few lymphatic nodules very distinctly present and extended from the lamina propria to the muscle layer. In the present histochemical study of the Harderian gland of *Pati* duck, the reaction of Alkaline phosphatase enzyme was mild. The reaction of the Acid phosphatase was absent. The Adenosine triphosphatase (ATPase) activity was observed moderate in all the age groups of birds. The activity of non specific Esterase was observed strong in all the age groups. The periodic acid-Schiff (PAS - Alcian Blue 2.5 pH) stain revealed positive reaction in all the age groups which indicated the presence of acid sulfated mucosubstances in the cells. In the Scanning Electron Microscopic studies of the Harderian gland of *Pati* duck (*Anas platyrhynchos domesticus*) the tubular structures were looked like hole having some secretion inside it. In higher magnification the lining epithelium cells were found with some secretion at the tip of the cells. In Transmission Electron Microscopic study it was found that the secretory mucous vesicles pushed the nucleus of the cell towards the basal border. The nucleus was oval in shape and rough endoplasmic reticulum, mitochondria, golgi apparatus were observed around the nucleus. The quantity of total protein of the Harderian gland reflected a descending trend in advancement of the age of the birds. The quantity of the total lipids in the Harderian gland of *Pati* duck increased from 0 week age to 42 weeks age. The total lipid and total protein content of the Harderian gland of *Pati* duck were inversely proportional to each other.

# **Comparative Cytomorphological, Cytochemical, Cytoenzymic and Ultrastructural Studies on the Blood Cells of Adult Rhode Island Red, Aseel and Non Descript Indigenous Chicken of Mizoram**

*Probal Jyoti Doley*

Matured erythrocytes were elliptical in shape and their mean length was measured to be  $12.65 \pm 0.12 \mu$ ,  $12.62 \pm 0.19 \mu$  and  $12.52 \pm 0.10 \mu$  and their mean width was measured to be  $6.83 \pm 0.09 \mu$ ,  $6.81 \pm 0.11 \mu$  and  $6.07 \pm 0.07 \mu$  in Rhode Island Red, Aseel and Zoar respectively. The heterophils were the largest granulocyte and had a mean diameter of  $10.01 \pm 0.16 \mu$ ,  $10.23 \pm 0.12 \mu$  and  $9.98 \pm 0.23 \mu$  while the basophils were the smallest granulocyte and had a mean diameter of  $8.41 \pm 0.17 \mu$ ,  $8.37 \pm 0.14 \mu$  and  $8.24 \pm 0.18 \mu$  in Rhode Island Red, Assel and Zoar respectively. The eosinophils were almost equal to the heterophils and measured  $9.53 \pm 0.10 \mu$  in Rhode Island Red,  $9.61 \pm 0.10 \mu$  in Aseel and  $9.82 \pm 0.24 \mu$  Zoar. The monocytes were the largest leukocyte and had a mean diameter of  $11.35 \pm 0.15 \mu$  in Rhode Island Red,  $11.97 \pm 0.27 \mu$  in Assel and  $11.43 \pm 0.10 \mu$  in Zoar. The lymphocytes were of variable sizes and their mean diameter ranged from  $5.96 \pm 0.13 \mu$ ,  $6.09 \pm 0.11 \mu$  and  $5.67 \pm 0.13 \mu$  to  $9.35 \pm 0.48 \mu$ ,  $9.88 \pm 0.20 \mu$  and  $9.13 \pm 0.04 \mu$  in Rhode Island Red, Assel and Zoar respectively. The thrombocytes were the smallest blood cell and had a mean diameter of  $4.85 \pm 0.10 \mu$ ,  $4.93 \pm 0.15 \mu$  and  $4.47 \pm 0.08 \mu$  in Rhode Island Red, Aseel and Zoar respectively. Reticulocytes and siderocytes were rare in the blood of Rhode Island Red, Aseel and Zoar. The heterophils of Rhode Island Red, Aseel and Zoar were positive for SBB, PAS, acid phosphatase, alkaline phosphatase and arylsulphatase while the eosinophils were positive for SBB, PAS, alkaline phosphatase, cytochrome oxidase and peroxidase. The basophils of Rhode Island Red, Aseel and Zoar were positive for toluidine blue while the thrombocytes were positive for PAS. Under Scanning Electron Microscopy the erythrocytes appeared elliptical in shape while the leukocytes and thrombocytes

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## **Abstract of Ph.D. Thesis**

**Department : Veterinary Anatomy and Histology**

**Major Advisor : Dr. (Mrs.) Kabita Sarma**

appeared round in shape with variable surface modifications. Under Transmission Electron Microscopy the granules of the heterophils of Rhode Island Red, Aseel and Zoar appeared predominantly fusiform in shape, the granules of the eosinophils appeared round in shape and that of the basophils appeared pleomorphic in shape. The cytoplasm of the monocytes, medium to large lymphocytes and thrombocytes of Rhode Island Red, Aseel and Zoar under Transmission Electron Microscopy appeared to be vacuolated and granular while that of the small lymphocytes appeared to be non vacuolated and granular.

# **Toxicological Analysis of Nanoparticles and Microparticles Used as Oral Vaccine Delivery Systems for Poultry**

*Dipankar Hazarika*

Nanoparticles and microparticles offer great applications in the field of biological sciences in terms of oral drug and vaccine delivery systems. The present study was carried out to evaluate *in-vitro* and *in-vivo* toxicity associated with chitosan nanoparticles, Gantrez® nanoparticles and poly-lactide co-glycolide (PLG) microparticle in Vero cell line and poultry bird model. The Gantrez® nanoparticles, PLG microparticles and chitosan nanoparticles were administered orally to the week old poultry birds at the limit dose of 2 g per kg body weight for assessment of oral acute toxicity and were found to be safe as the birds did not show any mortality in 24 hours post administration and the birds did not show any clinical signs till 14 days post administration. For assessment of subacute toxicity, the chitosan nanoparticles, PLG microparticles and Gantrez® nanoparticles were administered at the dose rate used in vaccine delivery that is 3 mg/kg, 15 mg/kg and 1.5 mg/kg respectively and in the dose rate 10 times of the former. The second dose was administered after 14 days. No significant elevation of serum AST, ALT, ALP, BUN and creatinine were observed in the treated groups. In addition, the significant influence of the chitosan nanoparticles, PLG microparticles, and Gantrez® nanoparticles on elevation of blood SOD, GPx and catalase were not observed. The significant upregulation of HSP70 gene expression was observed in the spleen of the group treated with PLG microparticle at the dose rate of 150 mg/kg and in the liver of the group treated with Gantrez® nanoparticle at the dose rate of 15 mg/kg. On histopathological investigation, mild changes of congestion and haemorrhage was observed in kidney of the group treated with PLG microparticles at the dose rate of 150 mg/kg body wt. while in case of liver focal aggregation of mononuclear cell was observed in Gantrez® nanoparticles at the dose rate of 15 mg/kg

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**Abstract of Ph.D. Thesis**

**Department : Veterinary Biochemistry**

**Major Advisor : Dr. Shantanu Tamuly**



body weight treated group. The congested capillaries in spleen were observed in the group treated PLG microparticles at the dose rate of 150 mg/kg body weight. The groups treated with vaccine dose of chitosan nanoparticles, Gantrez® nanoparticles and PLG microparticles have shown normal cellular architecture.

In *in vitro* study in Vero cell line, the concentration of chitosan nanoparticles and Gantrez® nanoparticles up to 1000 µg/ml did not have any influence in cellular metabolic activities and viability. However, a reduction in the cellular viability and metabolic activities were observed when PLG microparticles were used at 1000 µg/ml. At lower concentrations, all the nanoparticles/microparticles were found to be safe in terms of cytotoxicity.

# **Development of Mucosal Vaccine Against *Riemerella anatipestifer* Based on Membrane Antigen Conjugated with Nanoparticle**

*Naba Jyoti Deka*

Duck plays a significant role to mitigate the poverty by upgrading the socio-economic condition of farmers. *Riemerella anatipestifer* infection is a contagious bacterial disease of ducks and causes a significant economic loss to duck rearers. The present study was carried out to develop a mucosal vaccine against *Riemerella anatipestifer* based on membrane antigen which was conjugated calcium phosphate nanoparticle. The outer membrane vesicle (OMVs) was extracted and conjugated with calcium phosphate nanoparticle. The average OMVs yield in terms of protein concentration was found to be  $122.33 \pm 3.48$  mg per litre of BHI broth. In SDS-PAGE analysis, isolated OMVs exhibited presence of 16 distinct protein bands with molecular weight ranging from 142.1 to 12.1 kDa in SDS-PAGE. Among them, seven protein bands of 74.1, 69.3, 55.5, 50.6, 45.6, 25.1 and 13.1 kDa were found relatively more distinct. The major bands detected in our findings were 42 kDa, 37 kDa and 16 kDa that corresponds to OmpA, OmpH, P6 respectively. The mean size ( $\pm$  SD) of nanoparticle was found to be  $246.20 \pm 0.53$  nm and the mean zeta potential ( $\pm$  SD) was found to be  $-25.60 \pm 5.97$ . The mean size of the nanoparticles was found to be  $129.80 \pm 11.10$  nm in size and spherical morphologies in transmission electron microscopy analysis. The optimum conditions for conjugation of OMV and calcium phosphate nanoparticles were found to be pH=6.00, amount of OMV=1.5 mg, conjugation temperature=10°C and period of conjugation=1 hour. The PD50 or the median protective dose of CAP-OMV nanoparticle was found to be 1881.10  $\mu$ g of protein. For the bacterin vaccine, the concentration of the vaccine dose was taken as  $2 \times 10^9$  cfu/ml. The immunization trial was carried out in ducks. Group I birds received 3762  $\mu$ g of protein (entrapped protein in CAP-OMV nanoparticle) preparation *via* intra nasal route and it showed the highest serum IgG and secretory IgA level than the other immunized group. Group V which was administered 0.5 ml of inactivated bacterin vaccine by subcutaneous (s/c) route elicited

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**Abstract of Ph.D. Thesis**

**Department : Veterinary Biochemistry**

**Major Advisor : Dr. Dhruba Jyoti Kalita**

strong immune response after Group I. All the experimental birds were challenged with  $10\times$  LD50 ( $\sim 2.1\times 10^{10}$  CFU per bird) on 35 days of post primary immunization. Group I and group V showed 100 % survivability, while other vaccine groups showed 0 % survivability. From the present study it can be concluded that CAP-OMV nanoparticle can act as suitable mucosal vaccine delivery system for *Riemerella anatipestifer*.

# **Biochemical Profile and Innate Immune Response of Indigenous Ducks to Duck Plague Virus Infection**

*Prasanta Chabukdhara*

The present study was carried out to explore the innate immune response of indigenous ducks of Assam namely, Pati, Nageswari and Cinahanh to duck plague virus (DPV) infection reared in different agro-climatic zones of Assam *viz.* North Bank plains, Upper Brahmaputra, Lower Brahmaputra and Barrak Valley zones. A total of 397 ducks of indigenous breed/varieties were screened for the detection of DPV in the suspected ducks by PCR amplification of DPV specific DNA polymerase (UL 30) gene (446 bp). Positivity and mortality rate were recorded to be 45.84% and 50.55%, respectively.

Three experimental groups of ducks were formed *viz.* healthy, duck plague infected and recovered. The ducks under respective groups were analyzed for different hematological and serum biochemical parameters including inflammatory indices (acute phase proteins- Positive APP C-reactive protein and Negative APP Albumin) and liver specific biomarkers (GGT, ALT, AST, ALP, Total bilirubin, Direct bilirubin and Indirect bilirubin). Serum cytokines *viz.* IL-1, TNF- $\alpha$ , IL-4 and IL-10 were assessed in the birds under study. Innate immune response in different group of indigenous ducks was evaluated by studying mRNA expression profiles of certain innate immune genes (TLR 2, TLR 3, TLR 21 and RIG-I) in different tissues of birds *viz.* liver, spleen, intestine, brain and Peripheral Blood Mononuclear Cells (PBMC).

The infected birds revealed to have significantly decreased ( $P \leq 0.05$ ) PCV%, Hb, TEC, MCV, MCHC, TLC, Heterophil, Lymphocyte and Monocyte. MCV and MCH were significantly increased ( $P \leq 0.05$ ) in infected ducks. Infected birds had significantly increased ( $P \leq 0.05$ ) mean values of Glucose, Globulin and Creatinine in contrast to healthy and recovered ducks. However, significant higher values ( $P \leq 0.05$ ) of total protein, creatinine and insignificant higher values of uric acid were recorded in the diseased birds. Eosinophil, basophil, uric acid and BUN did not reveal any significant alteration in the studied birds. Serum C reactive protein (positive APP) was significantly increased while serum albumin (negative APP) decreased significantly in the infected

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**Abstract of Ph.D. Thesis**

**Department : Veterinary Biochemistry**

**Major Advisor : Dr. D. J. Kalita**

ducks. The liver specific biomarkers ALT, AST, ALP, total bilirubin, direct bilirubin and indirect bilirubin were significantly increased in the infected ducks.

The serum cytokines IL- 1, TNF-  $\alpha$  and IL- 4 were significantly increased in infected ducks as compared to healthy and recovered birds. Pati ducks in the healthy and recovered groups had significant higher values ( $P \leq 0.05$ ) of IL- 1. RT- qPCR analysis revealed significant upregulated expression of studied innate immune genes (TLR 2, TLR 3, TLR 21 and RIG-I) in different tissues *viz.* liver, spleen, intestine, brain and PBMC of infected ducks and the same genes were seen to remain upregulated post recovery.

Attempts can be made in future to further explore targeted immunomodulation in ducks which will help to enhance the resistance potential of ducks to duck plague virus infection. Documentation of different hemato-biochemical and innate immune genes expression profile will help in future to undertake a suitable breeding strategy to develop disease resistant varieties of ducks against duck plague virus infection.

# **Development of A Chitosan Based Packaging Film Incorporated With Zinc Oxide Nanoparticles and Green Tea Extract: Its Effect on Shelf Life of Meat and Meat Product (Chicken)**

*Santosh Upadhyay*

The present work was aimed at developing an active biopolymeric packaging film based on chitosan with antioxidant and antimicrobial activity and to assess its effect on shelf life of meat and meat product. Zinc oxide nanoparticle (ZnO NP) at a concentration of 2%w/w of chitosan and green tea extract (GTE) at 0.2% w/w of chitosan film was used after determining the antimicrobial activity of ZnO nanoparticles using agar well diffusion assay and antioxidant activity of GTE using DPPH inhibition assay. Four different combinations of films were prepared- F1 (Chitosan alone), F2 (Chitosan+ZnONPs), F3 (Chitosan+GTE) and F4 (Chitosan+ZnONPs+GTE) and compared with commonly used LDPE (control) packaging film for their physicochemical, mechanical, antioxidant and antimicrobial activities. The SEM of the films at resolution of 5000x revealed uniformity of the film in all four different types of combinations confirming the proper dissolution of the added zinc oxide nanoparticles and green tea extract in the film. All the four combinations of films were transparent and of desired thickness. The films F2 and F4 were found to have tensile strength but low elongation at break % as compared to LDPE. The films F2 and F4 showed potent antimicrobial property as compared to other films while F3 and F4 showed potent antioxidant activity. The film F4 possesses both strong antioxidant and antimicrobial activity with good tensile strength and was found to be the best among all the four film combinations. The developed films were then used for wrapping of fresh meat and meat loaf (chicken) and to assess their effect on shelf life at both ambient and refrigeration temperature. Samples without film were used as negative control. The fresh meat wrapped with F4 could maintaining the quality attributes in terms of physicochemical properties like TBARS, pH, colour and microbiological qualities like standard plate

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**Abstract of Ph.D. Thesis**

**Department : Veterinary Biochemistry**

**Major Advisor : Dr. (Mrs.) Rita Nath**

count and coliform count below the threshold level up to 12 hours at ambient temperature and up to 9 days of storage at refrigeration temperature. The meat loaf wrapped with F4 could be kept up to 15 hours of storage at ambient temperature and up to 15 days of storage at refrigeration temperature maintaining the quality attributes in terms of pH, TBARS, SPC, colour and textural properties. Sensory panel evaluation also suggested that the meat loaf wrapped with F4 remained acceptable up to 15 days at refrigeration temperature with good sensory scores. A significant difference ( $p < .01$ ) in crude protein and ether extract contents were observed in the fresh meat and meat loaf without film and those wrapped with F1, F2 and F3. However, minimum decline was observed in samples wrapped with F4. Migration studies on zinc oxide nanoparticles revealed no significant migration of zinc oxide nanoparticles from the film to the food matrix.

# **Studies on Mineral Status and Therapeutic Management of Pigs Reared under Intensive and Semiintensive System**

*Jyoti Dubey*

The present study attempts to analyze the effect of feeding chelated trace minerals on growth performance, mineral status, haematological parameters, serum ferritin, total iron binding capacity along with feed conversion ratio and feed conversion efficiency of piglets reared under intensive and semi-intensive system of rearing. The twenty four piglets weaned at 42 days (06 weeks age) were randomly distributed into four treatment groups each having six piglets in such a manner that average body weight of each experimental group was similar. In intensive system of rearing under treatment T1 (control) animals were fed with concentrate and conventional concentrate mixture throughout the experiment period while treatment T2 animals were fed similar to T1 but 100% conventional mineral mixture were replaced by chelated trace minerals. Likewise under semiintensive system of rearing under treatment T3 (control) animals were fed with concentrate and conventional concentrate mixture and T4 conventional concentrate mixture was supplemented with 100% chelated trace minerals per animal per day.

Body weight and average metabolic body weight of experimental piglets at fortnightly intervals under different treatment showed significant difference at the end of experiment at 56 days. Both were significantly higher in treatment group T2 and T4 supplemented with 100% chelated trace minerals than T1 and T3. The data showed significant increase in average daily weight gain among the different treatments up to 56 days in T2 and T4 treatment as compared to control T1 and T3. Statistical analysis of data revealed that on or after 56 days of experiment, DMI was significantly higher in treatment group in T2 and T4 than T1 and T3 Dry matter intake per 100 kg body weight and per kg metabolic body weight at fortnightly intervals among different treatments shows significant difference throughout the experiment among experimental groups.

The feed conversion ratio as well as feed conversion efficiency of piglets was improved when their concentrate mixture was supplemented with chelated trace minerals as compared to inorganic mineral mixture.

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## **Abstract of Ph.D. Thesis**

**Department : Veterinary Clinical Medicine, Ethics & Jurisprudence**

**Major Advisor : Dr. T. C. Dutta**



It was observed that the serum calcium, phosphorus, magnesium, copper, zinc, manganese, iron, cobalt concentrations were significantly higher ( $P < 0.01$ ) in group T2 and T4 as compared to T1 and T3. Serum Ferritin and TIBC concentration on and after 56 days of experiment was significantly ( $P < 0.01$ ) higher on 56th day of trial in the treatment group T2 than T1 and T4 than T3. The results of the present study revealed that mean value for feed cost per unit body weight gain was lower at Rs. 61.08 for T2 as compared to T1 (Rs. 83.79) and the same value for T4 was Rs.36.42 which was lowest owing to maximum weight gain in T4 than any group. Chelation has showed highly significant ( $P < 0.01$ ) difference on concentration of Ca, P, Mg, Cu, Zn, Mn, Fe, Co and Ferritin and significant difference ( $P < 0.05$ ) on TIBC. There was significant difference ( $P < 0.05$ ) due to interaction of chelation and housing on concentration of Ca, P and Mn. Whereas effect of both chelation and housing was observed significantly ( $P < 0.05$ ) on the conc of Mg and Co by two factor ANOVA.

The Hb concentration in serum of experimental piglets during experiment was significantly ( $P < 0.01$ ) higher in the treatment group T2 than T1 and T4 than T3 during the 56 days period of experiment. Statistical analysis of data revealed that Hb concentration, PCV percentage and MCHC concentration differ significantly ( $P < 0.01$ ) in all treatment groups from 14 days onwards. The RBC concentration in experimental piglets varied significantly ( $P < 0.01$ ) from 42 days onwards during the 56 days period of experiment. The MCV value in blood of experimental piglets varied significantly ( $P < 0.05$ ) during the 56 days period of experiment from 28 days onward. The MCH in experimental piglets varied significantly ( $P < 0.05$ ) during the 56 days period of experiment. The WBC concentration in blood of experimental piglets did not vary significantly ( $P > 0.05$ ) during the 56 days period of experiment.

The increased level of Ca, P, Mg, Cu, Zn, Mn, Co and Fe in the serum of the piglets supplemented with chelated trace minerals might be due to the higher bio-availability of these elements from chelated trace minerals as compared to inorganic mineral mixture. Keywords: Chelated minerals, feed efficiency, growth rate, mineral status, haematological analysis, TIBC, Ferritin, piglets.

# **Non-Cerebral Coenurosis With Special Reference to Epidemiology and Molecular Characterization of *Coenurus gaigeri* in Goats**

*Deepa Lahkar*

An epidemiological investigation was carried out to study the occurrence of noncerebral coenurosis in few goat rearing areas of undivided Kamrup district of Assam during the period from August, 2016 to July, 2018.

In the present study, a total of 981 number of goats examined and out of which 53 animals were positive (5.40%), while the occurrence of cerebral coenurosis was recorded only 1.33 per cent. The area wise survey under undivided Kamrup district, revealed highest (7.23%) occurrence of non-cerebral coenurosis in Hajo area while goats from Khanapara area recorded maximum (2.61%) cases of cerebral coenurosis. Non-cerebral coenurosis was significantly ( $p<0.01$ ) highest (10.27%) among goats of 2-3 years of age as compared to other age groups while none of the cases could be recorded in goats below 6 months of age. Similarly, the occurrence of cerebral coenurosis was also recorded highest in the age group of 2-3 years (2.66%). Sex wise, the occurrence of non-cerebral coenurosis was significantly ( $p<0.01$ ) higher (8.10%) in female goats as compared to males (1.69%) in the present study. Similarly, a higher percentage of females were also affected with cerebral coenurosis than the male goats. A significantly ( $<0.01$ ) higher occurrence of non-cerebral coenurosis was recorded in female goats in the age group of 2 to 3 years (14.10%) as compared to males of the same age group. Likewise the occurrence of cerebral coenurosis was also found to be the highest in adult females in the age group of 2 to 3 years than the male goats.

Thigh region was found to be the most common site (26.42%) for predilection of non-cerebral coenurus cysts from where maximum number of cysts were recovered which had significantly ( $p<0.05$ ) higher cyst volume, significantly ( $p<0.01$ ) larger diameter with significantly ( $p<0.01$ ) maximum number of protoscolices per coenurus cyst, as compared to other body locations while brain was the common site of predilection for cerebral coenurus cysts in goats. Both non-cerebral and cerebral

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**Abstract of Ph.D. Thesis**

**Department : Veterinary Epidemiology and Preventive Medicine**

**Major Advisor : Dr. Bipin Chandra Das**

coenurus cysts found in the present study was characterized by a thin transparent wall filled with a translucent fluid of varying volume with presence of numerous invaginated protoscolices, were arranged in clusters and found to attach to the germinal membrane of the cyst wall. However, non-cerebral cyst was additionally enclosed by an outer fibrous connective tissue capsule. Based on the keys and guidelines of Soulsby (1982), the coenurus cysts recovered from the subcutaneous and muscle tissues of goats and from brain in the present study, were tentatively identified as *Coenurus gaigeri* and *Coenurus cerebralis*, respectively.

The mean ( $\pm$  SE) prepatent period of adult taeniids following experimental infection of dogs with non-cerebral and cerebral coenurus cysts from goats, was found to be  $60.20 \pm 1.06$  days (ranging between 57 to 63 days) and  $56.80 \pm 1.91$  days (52 to 61 days), respectively. Dogs infected with non-cerebral coenurus cyst resulted in development of adult taeniids in the jejunum of small intestine from where, 32 numbers of parasites were recovered with intact scolex with evidence of hyperaemia on the mucosa. Similarly, dogs infected with cerebral cysts, also showed evidence of adult taeniids in the small intestine particularly in the jejunum and ileum. The adult taeniids of dogs derived from both noncerebral and cerebral origin, were whitish in colour, and measured 70 to 85 cm and 45 to 62 cm in length, respectively. The number of segments per worm from non-cerebral and cerebral origin was ranging from 61 to 102 numbers and 45 to 73 numbers respectively. The scolex of taeniid parasites derived from non-cerebral and cerebral origin was found to be globular in shape with four cup shaped suckers along with a prominent rostellum with double rows of rostellar hooks. The length of the large hooks in taeniids derived from cerebral origin was significantly ( $p < 0.05$ ) higher as compared to the large hooks of taeniids derived from non-cerebral origin. Similarly, the length of the blade of large rostellar hooks of taeniids from cerebral origin was also significantly ( $p < 0.05$ ) higher as compared to the blade length of taeniids from non-cerebral origin.

The PCR reaction targeting amplification *COI* and *NAD1* gene of *Taenia multiceps* yielded the expected 444 bp and 530 bp products in the present study. The pair wise alignment of both the mitochondrial *COI* gene (*CC\_COI*, *NC\_COI*) sequences of cerebral and non-cerebral cysts showed a similarity of 98-99% and 99-100%, respectively. The phylogenetic analysis based on *COI* gene sequences revealed that the present isolates (*CC\_COI* and *NC\_COI*) were closely related to an isolate of *Taenia multiceps* reported from China (Accession No. KX 547641.1) and showed 99.76% and 100% similarity, respectively which they formed a single clad and thereby confirmed that both the isolates belonged to *Taenia multiceps*. The *NAD1* gene (*CC\_NAD1*, *NC\_NAD1*) sequences of both type of cysts also showed similarity of 97-99% and 98-99%, respectively to the identical sequences of *Taenia multiceps* in the GeneBank database and confirmed the identity of the query sequence to be *Taenia multiceps*. The phylogenetic analysis of *NAD1* sequences revealed that the present isolate *CC\_NAD1* was closely related with a Greece isolate (Acc. No. KR 604804.1), an

Iranian isolate and two isolates from Turkey showing 99.22, 98.92, 98.60 and 98.00% similarity, with which it formed a single clad and thereby confirmed the present isolate to be of *Taenia multiceps*. The other isolate, NC\_NAD1, although showed 99.59% similarity with an isolate of *T. multiceps* from Greece (KR 604804.1) but it formed a separate clad within the same cluster in the phylogenetic tree. Based on the phylogenetic analysis of *COI* and *NAD1* gene sequences, it can be concluded that *Taenia multiceps* is the single valid species and the origin of both non-cerebral (*Coenurus gaigeri*) and cerebral (*Coenurus cerebralis*) coenurus cysts in goats in the present study.

The molecular data based on *COI* and *NAD1* sequences of both non-cerebral and cerebral coenurus cysts in goats was reported for the first time from Assam, India.

## **Epidemiology of Rabies in Assam**

*Prasanta Kumar Boro*

In an epidemiological study on rabies in 11 districts in Assam, 65 post-mortem brain samples belonging to nine species were collected by foramen magnum approach from clinically suspected domestic and wild animals and tested at the WOA Reference Laboratory for Rabies, Hebbal, Bengaluru – 560 024, Karnataka. Simultaneously, a questionnaire survey on the community was undertaken to evaluate the epidemiological determinants on rabies transmission. Forty two (64.61 %) samples tested positive by LFA and DFA. Of the nine species, five species i.e. cattle 27 (41.53%), dog 9 (13.85%), goat 4 (6.15%), pig 1(1.53%) and pony 1(1.53%) were confirmed for rabies. Aggression in 41 (97.62%) cases was the most common signs exhibited by the affected animals before death with only one positive case (2.38%) showing paralytic signs. There was no dog bite history in 33 (78.57%) cases while 9 (21.43%) cases had. Most of the livestock were free ranging and grazed nearby protected areas where presences of wild carnivores were evident. Seasonal distribution revealed similar numbers of cases (45.24%) during rainy and flood season (July-September) and post-harvesting (December-February) winter season. Gender-wise, 20 (47.62%) positive cases of cattle and goats were either pregnant or recently calved. Prevalence of rabies was found to be highest (64.29%) in the animals more than 3 years of age, followed by the animals between 1 to 3 years (23.81%) and below one year of age (11.90%). In rural areas distribution of rabies was highest (52.31%), semi-urban (9.32%) and urban (3.08%). Distribution maps of rabies in different parts of Assam were generated based on the GPS locations of the positive cases and heat map revealed a high risk zone in the Golaghat district. The areas adjoining the tea gardens had higher rabies cases (23, 54.76%). The questionnaire survey revealed a very low level of community awareness regarding rabies and its transmission. Lack of proper information from the field staff, immediate collection of samples from field and transportation of samples to the laboratory maintaining cold chain were the major constraints found during the study.

**Key words:** Rabies, livestock, LFA, DFA, GIS, distribution map, questionnaire, Assam

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**Abstract of Ph.D. Thesis**

**Department : Veterinary Epidemiology and Preventive Medicine**

**Major Advisor : Dr. (Mrs.) Jyoti B. Dutta**

## **Ecoprospecting Local Cattle to Navigate Cultural Values in Lower Assam**

*Liakot Hussain*

Agriculture is the mainstay of the rural people for earning their livelihood and animal husbandry is a subsidiary occupation. Rain fed agro-ecosystem has a distinct place in Indian agriculture, occupying more than 50% of the cultivated area, contributing 44% of the food grains and supporting 40% of the human and 65% of the livestock population. Animal husbandry acts as the buffer in crop failure by providing the subsidiary income to the farming communities by sale of milk, meat, egg, hide, manure and sometimes living animals. The country among the largest population of cattle and buffaloes in the world and all the breeds are admired for their heat tolerance and inherent resistance to so many diseases including ability to thrive under different climatic condition.

The contribution of livestock sector to the national economy in terms of GDP is 4.11 per cent and 25.60 per cent of total contribution of the agricultural sectors to GDP (19th Livestock Census, 2012). India with about 190 million cattle (as per 19th Livestock Census, 2012) has 14.50 per cent of the world cattle population of this 151 million are indigenous. Indigenous cattle are robust and resilient and are particularly suited to the climate and environment of their respective breeding tracts.

Indigenous cattle can be improved with organized breeding programs, cultivated pastures, and silos for storage. Because stronger oxen would pull the plough faster, they could work multiple plots of land, allowing farmers to share their animals. Fewer healthy, well fed cows could provide Indians with more milk. Ecosystem, animal husbandry and sustainability have an inclusive relationship with far reaching impact on world civilization and cultural evolution.

The draught bullocks are a main source of farm power for small farmer to certain extent for medium farmers and for certain operation with large farmer. Livestock sector not only provides essential proteins and nutritious human diet through milk, egg, meat etc. but livestock also provides raw materials and byproducts such as hides and

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**Abstract of Ph.D. Thesis**

**Department : Veterinary Extension Education**

**Major Advisor : Dr. A. Borgohain**

skins, blood, bone, fat etc. which have huge economic importance. Women in the North East have a different status. Rural women form the most important productive work force in the economy of majority of the developing nations including India. Agriculture, the single largest production endeavor in India, contributing around 17.00 per cent of GDP, is increasingly becoming a female activity. The demand for meat and meat products is more in Assam and other North- Eastern States because of the higher tenancy towards non-vegetarian foods of the inhabitants of this region. Marketing comprises of the economic activities involving the movement of the produce from the point of production to the point of consumption. Apparently, it is known that local cattle are raised for purposes like drafting, ploughing, cart pulling, fertilizer, social-economic security and milk production for household consumption. But there might be some other unseen and unknown reasons as well. Therefore, to have an empirical study on utility pattern of indigenous cattle rearing by the farmers of lower Assam, the study on "Ecoprosecting Local Cattle to Navigate Cultural Values in Lower Assam" was undertaken.

Keeping the topic of the study and its objectives in view, the present study was carried out in the ten lower Assam districts of the state namely, South Salmara-Mankachar, Dhubri, Goalpara, Bongaigaon, Baksa, Chirang, Barpeta, Nalbari, Darrang and Udalguri. From each of the selected district, two blocks were randomly selected and from where Twenty Five (25) local cattle rearing farmers representing each block were chosen as respondents. Thus, a total of 500 local cattle rearing farmers (fifty from each selected district) formed the sample size for the present investigation. By and large a random sampling technique was followed for the study. A pre-tested, reliable and valid interview schedule was used for data collection by the researcher personally and the responses were collected on the interview schedule comprising of independent and dependent variables. Based on the data collected and the results obtained the conclusions were drawn and findings were expressed.

#### **Salient findings of the study**

(1) Majority of the respondents 71.6% belongs to middle age group. (2) Majority 94% of the respondents were male. (3) Among the farmers majority 66% had medium level of education. (4) Majority 21.4% of the respondents were matriculate. (5) Majority of the respondents 61.4% had medium families ranging from 1-20. (6) A large number of respondents 79.20.26 per cent belonged to nuclear family type. (7) Majority 26% of the respondents had business as primary source of livelihood. (8) A high majority of the respondents 92.00 per cent had medium type of own housing, (9) Majority 84.40% of the respondents had medium sq. ft. of house per person in the family. (10) Majority of the respondent had maintained medium herd size of local cattle, ranging from 2-14. (11) Majority 58.8% of the respondents had medium level of annual income per local cattle ranging from Rs.1000/- to Rs.9000/-. (12) Majority 72.20 per cent of the respondents had medium level of land holding ranging from 2-6 (Bigha). (12) In the entire study area 85.4% of respondents had noticed medium level of new

development works. (13) Majority 84.8% of the respondents fall in the medium group of annual family income from all sources ranging from Rs. 40000/- to Rs.384000/-. (14) Majority of the respondent had medium annual income from animal husbandry ranging from Rs.8000/-to Rs.96000/-. (15) Majority of the respondent had low level of annual income from local cattle ranging from Rs.8000/- to Rs.34000/-. (16) Majority 59.4% of the farmers had kutcha type of cattle housing. (17) Majority 83.20 per cent of the respondents reared local cattle in semi intensive system. (18) Majority 90.8%of the respondents had medium Rs. 20000/- to Rs. 364000/- level own annual income. (19) Majority 63% of the respondents had medium level of engagement in social activities. (20) Majority 87.6% of the respondents had medium level time devoted in social activities ranging from 1-10 days in a month and majority 64.4% of the respondents had medium level of annual expenditure on social activities ranging from Rs.100/- to Rs.1000/-. (21) Majority 64.4% of the respondents had medium level of association with social organization or office bearer. (22) Majority 85.8% of the respondents were found to have medium extension contact. (23) Majority 69.4% of the respondents had medium level of exposure to various information sources. (24) Majority 79.2% had medium level of perceived credibility of different media/ agency/network. (25) Majority 63.2% of the respondents were categorized in medium risk orientation group towards local cattle husbandry. (26) Majority 65.6% of the respondent had medium level of attitude towards local cattle rearing. (27) Majority 65.2%of the respondents perform medium level of activities relating to local cattle farm practices. (28) Majority 71.2% of the respondents had devoted medium time to local cattle rearing practices in comparison to other livestock and crossbred cattle ranging from 3-8 hrs. per day. (29) Majority 74.6% of the women farmer fall under medium category, (30) Majority 43.6% of the respondents had medium level of economy on breeding practices. (31) Majority 19% respondents practiced selective natural service followed by, (32) Majority 87.4% of the respondents had medium level of economy towards feeding. (33) Majority 93.8% of the respondents had medium level of economy towards management/ health care practices. (34) Majority respondents placed their opinion to regularly degree in first aid treatment during emergency 96.2% special care for increase milk production and 92.4% self-management of sick animals (35) Majority as high as 96.6% respondent showed their opinion on the statement selling their local cattle in the nearby market in regularly degrees. (36) Majority of the respondent 69.2% had medium level of interaction with Sustainability Dimensions. (37) Majority of the respondent 99.6% fall under medium group relating to utility, occasional important and cultural values of local cattle. The co-efficient of multiple regression determinations (R<sup>2</sup>) with 23 independent ariables could explain 38.00 per cent variation to the activities relating to local cattle farm practices. The co-efficient of multiple regression determinations (R<sup>2</sup>) with 23 independent variables could explain 39.00 per cent variation to time devoted to local cattle farming practices. The co-efficient of multiple regression determinations (R<sup>2</sup>) with 23 independent variables could explain 32.00 per cent variation to role of women in local cattle rearing. The co-



efficient of multiple regression determination (R<sup>2</sup>) with 23 independent variables could explain 38.00 per cent variation towards economy of breeding practices. The co-efficient of multiple regression determinations (R<sup>2</sup>) with 23 independent variables could explain 24.00 per cent variation in economy of management and health care. The co-efficient of multiple regression determinations (R<sup>2</sup>) with 23 independent variables could explain 31.00 per cent variation in marketing. The co-efficient of multiple regression determination (R<sup>2</sup>) with 23 independent variables could explain 38.00 per cent variation in sustainability dimensions. The co-efficient of multiple regression determinations (R<sup>2</sup>) with 23 independent variables could explain 53.00 per cent variation in utility, occasional important and cultural values of local cattle. Illiteracy among many of the farmers was not a healthy sign for the scientific management of local cattle farming. So, higher education of the farmer was expected for the adoption of new practices in the livestock rearing to boost national economy. A proper organized marketing system supported by the state owned agencies might work tremendously in this regard. A study on the patterns of local cattle trading in the other International border areas may be undertaken with the economic parameters' dependency on such matters.

## **Characterizat Ion of Outer Membrane Vesicles (OMVs) of *Pasteurella multocida* of Avian Origin**

*Anamika Gogoi*

The Fowl Cholera, an infectious disease of poultry, waterfowl and many other birds is caused by *Pasteurella multocida*. To overcome those hurdles in poultry industry, focus has been given to identify immunogenic subcomponent of the causative agent and their use in development of modern vaccines. The present study was undertaken with a view to evaluate immunogenic potential of Outer Membrane Vesicles (OMVs) of *Pasteurella multocida* as well as their release under the influence of various environmental and physico-chemical factors.

The extraction of OMV fraction was made from a highly pathogenic strain of *P. multocida* capsular type A associated with Fowl Cholera. The release of OMVs by the selected isolates was found to be significantly ( $p < 0.001$ ) highest under the influence of iron deficient condition (2, 2 bipyridyl), exhibiting a protein concentration of 18.3 mg/ml. Similarly, the influence of pH in iron restricted environment was also have an impact on OMV release, which was found to be significant ( $p < 0.05$ ) in reverse direction. A positive correlation could also be made in respect to the oxidative and antibiotic stress with release of OMVs. The comparative protein profiling of OMVs, OMPs and whole cell lysate of the selected pathogenic *P. multocida* type A isolate could exhibit more distinct and prominent protein bands in OMV fraction. The OMV fraction could also reveal the ompA (37.7-38.1 kDa), which was not prominently observed in other two fractions.

The immunogenic potential of the extracted OMV fraction revealed an increasing trend of the mean antibody titre in both the immunized groups, with (Group I) or without (Group II) booster. The immunized birds of group I exhibited a significantly rising trend ( $p < 0.05$ ) of the mean serum antibody titre from the day of the vaccination, until it reached its peak ( $5947.41 \pm 62.6$ ). The peak titre was observed on 28th day of post primary immunization, following booster on 21st day post immunization. Similarly, the immunized birds of group II the mean serum antibody titre

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of 7th dpi was continued to increase significantly at every weeks of observation till it reached peak on 21st ( $4576.27 \pm 42.9$ ). The declining trend of the mean serum antibody titre was observed in the birds of group II from the day 28th of post immunization ( $4219.12 \pm 64.5$ ) and continued till end of the study, *i.e.* the 60th dpi ( $3813.83 \pm 148.5$ ). No significant difference could be observed between the two preparations, with and without booster in respect to the mean serum antibody titre till 21st dpi. Challenge trial could establish 100 per cent protection of vaccinated birds against homologous challenge, while development of clinical signs in the immunized birds was observed, following heterologous challenge. There was no significant difference between OMVs administered group and control group was observed in terms of blood SOD and GPx activity.

# **Phenotypic and Genotypic Characterization of Methicillin Sensitive and Resistant *Staphylococcus aureus* (MSSA & MRSA) Isolated from Bovine Mastitis**

*Arfan Ali*

The present study was undertaken on characterization of *Staphylococcus aureus* isolated from bovine mastitic milk in respect of their phenotypic and genotypic characteristics more particularly resistance to methicillin (MSSA & MRSA) and other groups of antimicrobial agents, presence of methicillin resistance and other virulence genes. To carry out the study, a total of 1328 quarter milk samples from 812 animals of organized and unorganized dairy farms of Kamrup (M), Kamrup (R) and Nalbari districts of Assam were screened by California Mastitis Test (CMT) out of which 630 animals (1328 quarter) were found positive for mastitis. The 630 mastitic animals comprised 117 clinically and 513 subclinically affected dairy cows. The overall prevalence of mastitis including clinical (14.41%) and subclinical form (63.18%) mastitis in these three districts was 77.59%. Maximum number of animals had infection involving two quarters in both clinical (47.86%) and subclinical (52.44%) mastitis. Involvement of right hind quarters was higher (28.91%) than the left hind quarters (28.13%) in clinical mastitis, while it was higher in left hind quarters (29.10%) than right hind quarters (26.21%) in subclinical mastitis. Higher prevalence rate of clinical (15.36%) and subclinical (68.76%) mastitis was recorded in organized farms in comparison to clinical (12.13%) and subclinical (49.79%) mastitis in unorganized farms.

A total of 194 isolates of staphylococci were obtained from 630 bovine mastitic milk, out of which 151 (77.84%) coagulase-positive isolates identified as *Staphylococcus aureus* by phenotypic tests were confirmed genotypically by detection of *S. aureus* specific *aroA* gene by PCR. Of the 151 isolates, 54 (35.76%) were from clinical and 97 (64.24%) from subclinical mastitis and all of them produced coagulase and fermented mannitol. The prevalence of *S. aureus* associated mastitis was found to

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be 46.15% and 18.91% for clinical and subclinical forms, respectively. The prevalence of MRSA was 9.27% (14) as determined by ceftazidime resistance in phenotypic tests and confirmed by detection of *mecA* gene by PCR. The MRSA isolates were completely resistant (100%) to methicillin, cloxacillin, ceftazidime, tetracycline, streptomycin, colistin and mupirocin followed by higher degree of resistance to gentamicin and oxytetracycline (85.71% each) and moderate resistance to neomycin (50%). The MSSA isolates exhibited higher degree of sensitivity (73.72 – 100%) to tetracycline, amoxiclav, ceftazidime, ciprofloxacin, colistin, neomycin, streptomycin, mupirocin, ceftriaxone, gentamicin, cloxacillin, oxytetracycline, teicoplanin except cefepime to which they were least sensitive (54.01%). Out of 151 *S. aureus* isolates, 55 (36.42%) were multidrug resistant (MDR) which exhibited resistance against 4-12 antimicrobial agents. Among the MDR isolates, 14 (25.45%) were MRSA which showed resistance to 9-12 antimicrobial agents.

A comparative study on antimicrobial resistance spectrum of MRSA and MSSA strains was conducted by disc diffusion and E-test using 10 antimicrobial agents which included penicillin, ampicillin, oxacillin, amoxiclav, ceftazidime, ceftriaxone, gentamicin, ciprofloxacin and teicoplanin. All the MRSA isolates (14) exhibited similar pattern of resistance to all the agents except ceftazidime to which three isolates showed variation. All of the 38 representative MSSA isolates were sensitive to ceftazidime, oxacillin and teicoplanin in both the tests. One to three isolates showed variation in resistance pattern to rest of the antimicrobial agents. The E-test was found to be more effective than disc diffusion method for determining sensitivity of clinical isolates to antimicrobial drugs. In phenotypic characterization, all the coagulase positive isolates (MSSA and MRSA) caused alpha or beta haemolysis on sheep blood agar and showed susceptibility to novobiocin and resistance to polymyxin B which are typical characteristics of *S. aureus*. All the 151 *S. aureus* isolates harboured the virulence associated *nuc* (thermonuclease) and *spa* (staphylococcal protein A) genes and *lukF-PV* by six (6) and *bap* by two (2) isolates as revealed by PCR assay. The isolates which showed presence of *lukF-PV* and *bap* genes were methicillin resistant strains of *S. aureus* (MRSA).

# **Molecular Detection and Characterization of Newcastle Disease Virus Strains from Poultry**

*Bhriku Kumar Neog*

Newcastle disease is a highly transmissible and acute fatal disease of poultry caused by virulent strains of *Avian paramyxovirus type 1* (APMV-1) which is commonly known as the Newcastle disease virus (NDV). *Avian paramyxovirus type 1* exhibit great variation in their pathogenicity and the severity of the disease produced varies with the host species and the strain of virus involved. Newcastle disease can have devastating effects on the poultry industry due to the high morbidity and mortality associated with virulent strains of the virus. A study was undertaken to detect and characterize different NDV strains circulating among the native poultry population. To investigate the presence of NDV in clinically suspected backyard chickens, a total of 289 tissue samples were collected from 74 birds at necropsy from nine districts of Assam and tested using haemagglutination inhibition (HI) and reverse transcriptase polymerase chain reaction (RT-PCR). Out of the 289 tissue samples, 24.57 % and 47.05 % samples were found to be positive for NDV in HI assay and RT-PCR respectively. Of the 74 clinically suspected chickens 52.70 % birds were found to be positive for NDV in HI assay while 91.89 % birds were found to be positive for NDV in RT-PCR. Among the different tissue samples tested for presence of NDV, a significantly higher number of tissue samples from spleen, trachea, lung, proventriculus and caecal tonsil tested positive for NDV irrespective of the test used. To detect NDV in apparently healthy chickens, 186 numbers of oropharyngeal swabs and 146 numbers of cloacal swabs were tested using HI assay and RT-PCR. Of the 186 oropharyngeal swabs tested, 24.57 % and 15.05 % swab samples were found to be positive for NDV in HI assay and RT-PCR respectively. Further, out of 146 cloacal swabs tested, 6.16 % and 21.23 % swab samples were found to be positive for NDV in HI assay and RT-PCR respectively. A total of 18 tissue samples, identified as NDV positive using HI assay and RT-PCR, were processed for isolation of NDV using SPF embryonated chicken eggs (ECEs) of 9-11 days of incubation. The presence of the virus in the allantoic fluid of the inoculated

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ECEs was confirmed by two RT-PCR techniques, one of which targeted a 767 bp sequence of the F gene while the other targeted a 426 bp sequence of the HN gene of NDV. NDV from all the 18 tissue samples (100 %) was detected in the allantoic fluid of ECEs using the RT-PCR techniques. Six representative NDV isolates were sequenced by outsourcing and subjected to phylogenetic study. The consensus sequences of the isolates were subjected to multiple sequence alignment with reference sequences from GenBank databases. A phylogenetic tree was then constructed where five of the isolates clustered with genotype XIII of Class II NDV while one clustered with genotype II of Class II NDV cluster. Evaluation of the amino acid composition of the F0 cleavage site revealed the presence of the consensus sequence 112R-R-Q-K-R-F117 in case of the five genotype XIII isolates whereas the genotype II NDV isolate possessed the sequence 112G-R-Q-G-R-L117 at the F0 cleavage site of the fusion gene. Thus, five isolates from the present study were identified as virulent NDV strains while one isolate was identified as an avirulent strain. A multiplex reverse transcriptase-polymerase chain reaction (mRT-PCR) was standardized for simultaneous detection and differentiation of different pathotypes of NDV. Three specific oligonucleotide primers were used in the mRT-PCR for amplification of the target sequences of the F gene of NDV. The pathotypes of NDV was differentiated based on the products generated by the mRT-PCR. A product in size of 364 bp was obtained in case of the lentogenic strains while for mesogenic strains two products in size of 364 bp and 204 bp were generated. In case of velogenic strains only one product in size of 204 bp was generated. All the 18 NDV isolates from the present study was characterized using the mRT-PCR. Out of the eighteen isolates one isolate was identified as a lentogenic and two were identified as mesogenic. The other 15 isolates were identified as velogenic strains. A standard RFLP technique was also used to validate the results of the mRT-PCR. The RFLP involved digestion of a RT-PCR amplified 363 bp fusion gene product by *HinfI* restriction enzyme. The virulent and avirulent strains of NDV were differentiated based on the *HinfI* digestion patterns exhibited on 3 % agarose gels. The results of pathotyping obtained using RFLP analysis, corroborated the results of the mRT-PCR. A local isolate of NDV (AS/KM/CG 01) from non-vaccinated backyard chicken was subjected to complete genome sequencing by outsourcing. Evaluation of the genomic data revealed that the genome of the NDV isolate AS/KM/CG 01 consists of six genes arranged in tandem that encodes for six structural proteins namely, the nucleocapsid protein (NP), the phosphoprotein (P), the matrix protein (M), the fusion protein (F), the hemagglutinin-neuraminidase protein (HN), and the polymerase protein (L). The isolate possessed a genome of approximately 15 kb. Evaluation of the F0 cleavage site within the fusion gene of the isolate revealed the presence of the consensus amino acid sequence 112G-R-Q-G-R-L117 which is typical of lentogenic strains of NDV. Phylogenetic study revealed that the NDV isolate belong to genotype II of class II NDV cluster. It was also found that the isolate has close relationship with previously reported genotype II NDV isolates from India and China. The isolate also showed more than 97

% homology with NDV vaccine strain LaSota. The study was summarized with the findings that genotype XIII NDV of class II cluster is predominant among the poultry flocks of Assam. Detection of genotype II NDV of class II closely related to NDV vaccine strain LaSota in the present study suggests a possible spillover of vaccine-type viruses from vaccinated poultry or feral avian reservoirs to non-vaccinated backyard chickens. However further studies are needed on this aspect.



# **Molecular Detection and Characterization of Foot and Mouth Disease Virus (FMDV) and Study of Cytokine Expression in Naturally Infected Local/Crossbred Cattle from Assam**

*Derhasar Brahma*

Foot and mouth disease (FMD) is a transboundary and the most contagious disease of cloven-hoofed animals including domestic and wild ruminants and pig, and has a great potential for causing severe economic loss due to loss of production and deprivation from international trade of animal products to FMD free countries. FMDV may occur in all the secretions and excretions of acutely infected animals, including expired air. Following recovery from the acute stage of infection, infectious virus may persist in the oropharynx of some ruminants (carriers), where live virus or viral RNA may continue to be recovered from oropharyngeal fluids and cells for upto 6 months or more. In this study, besides Sandwich ELISA, molecular detection and typing of FMDV was done using multiplex Reverse Transcription Polymerase Chain Reaction (mRTPCR), Reverse Transcription Loopmediated Isothermal Amplification (RT-LAMP) and SYBR Green real-time PCR targeting 3D gene. Isolation and molecular characterization of FMDV by sequencing was done. Also, study of expression of cytokines like interferon (IFN- $\alpha$ , IFN- $\beta$ , IFN- $\gamma$ ) as well as certain interleukins (IL-1 $\alpha$ , IL-1 $\beta$ , IL-2, IL-6, IL-10 and IL-12) and tumour necrosis factor (TNF- $\alpha$ ) was estimated at mRNA level by SYBR Green real-time PCR from whole blood (White Blood cells) samples during the natural infection and during the period of persistence. This study was carried out in a total of 129 animals, comprising of 93 crossbred (vaccinated) and 36 local (non-vaccinated) cattle and additionally 12 healthy in-contact animals were taken as control animals. For carrying out this study, Tissue (n=29), whole blood (n=36) and oropharyngeal fluid (n=190) samples were collected as per standard procedure in 50% glycerol, EDTA and 0.8 M PBS/ transport media, respectively. OP fluid was collected from recovered animals until complete recovery (i.e. 1<sup>st</sup>, 3<sup>rd</sup>, 6<sup>th</sup> and 9<sup>th</sup> month) from

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FMD infection. All the RNA extractions were done using Qiagen RNA extraction kit. We found that, out of 29 tissue samples, 20 samples were positive for serotype O, 9 were positive for serotype A and none of the samples was positive for Asia-1 by the multiplex RT-PCR as well as RT-LAMP. FMDV could be detected in 86.21%, 100%, 100% and 100% of tissue samples by sandwich-ELISA, mRT-PCR, RT-LAMP and SYBR Green real-time PCR respectively. Sensitivity test was run using 10 fold serial dilution of RNA extracted from FMDV antigen and found that, the real-time PCR was more rapid and highly sensitive technique of all, secondly the RT-LAMP, followed by the mRT-PCR. From the follow-up cases of the FMD recovered cattle, 38 (23.75%), 47 (29.38%) and 49 (30.63%) OPF samples (n=178) were found to be positive for FMDV by the multiplex RT-PCR, RT-LAMP and SYBER Green real-time PCR respectively, indicating persistence (carriers). The SYBR green real-time PCR was very much useful for detection of persistence from the OPF samples. However, OPF (n=12) and blood (n=12) samples from all the healthy controls and blood (n=12) from persistent animals were negative for FMDV. All blood samples (100%, n=12) from the clinically FMD infected cattle were positive for FMDV. The persistence of FMDV in oropharyngeal region of cattle lasted for upto 3 to 4 months in most of the FMD infected cattle. Persistence in crossbred (vaccinated) cattle didn't last for more than 4 months. Only 2 Local non-vaccinated cattle (1.6%) was found to have persistence upto 6-7 months after infection. The overall number of persistent animals and the rate of persistence in cattle (n=129) at 1st month, 3rd month and 6<sup>th</sup> month were 32 (24.81%), 15 (11.26%) and 2 (1.6%) respectively, and was slightly higher in the local non-vaccinated compared to the crossbred vaccinated cattle. No statistical significance was observed between the two groups as the P value was found to be 0.23 (>0.05) and the Chi-square value was 5.57. The sequencing results showed that the Serotype O sequence (MZ501211-G-02-19, MZ501212-G-03-19 and MZ501213 Op) shared 98.81% identity with Pakistan isolate MN953620, 96.43% identity with India isolate KY579948.1 (Nagaland, submitted by RRC Assam) and 94.05% identity with India complete genome isolate MN983158.1; and the Serotype A sequence (MZ501214-Mg/01/19) shared 95.29% identity with Indian isolate HQ832583.1 and 94.24% identity with Bangladesh isolate KT982204. The identity range was 98.81%-96.43% and 95.29%-92.22% for type O and A respectively, based on the nucleotide sequence Blast search in NCBI. The multiple sequence alignment showed that there are some minor changes in the nucleotide sequences with the consensus sequences. There were nucleotide insertions in the 3953 and 3954 positions in two of the query sequences of FMDV type O. Whereas, in FMDV type A, there were nucleotide insertions at 3807, 3813-3815 and 3841 positions and deletions at 3771 and 3874 positions of the nucleotide sequences. The result from this study shows that cytokine genes had general trend of upregulation during acute infection and decreased level of expression or down regulation during persistence. Cytokines in blood were generally upregulated in both acute infection and persistence, but compared to acute, there was decreased mRNA level of expression of cytokines during persistence

except the down regulation of IFN- $\beta$ , IL-2 and IL-6, whereas, all but IFN- $\alpha$  and IL-1 $\alpha$  were down regulated in OPF during persistence. These cytokines may have certain role in persistence of FMDV by suppression of immune response and also by having anti-inflammatory or immunomodulatory response in carrier cattle. Thus, from this study, we can conclude that, molecular detection techniques are the most sensitive and specific techniques for detection of FMDV and particularly for diagnosis of persistence from OPF samples. Persistence occurred in 32 cattle (25%) after 1st month of the FMDV infection, out of which the proportion of local non-vaccinated cattle was slightly higher. And that cytokines may have a role in persistence of FMDV in cattle.

# **Development of a Suitable Vaccine Formulation Against Type A *Clostridium perfringens* Associated Necrotic Enteritis in Broiler Chicken**

*Hiramonni Sarmah*

Necrotic enteritis (NE) is one of the most clinically dramatic and important bacterial disease of poultry industry. It has a great negative impact on broiler industry due to production losses, increased mortality, increased feed conversion ratio. The cost of NE worldwide was estimated to 2 billion dollars per year with 1% daily mortality. Most common age of outbreaks of NE in broiler flocks raised on litter are between the second and fifth week of age. NE in broiler chicken is commonly associated with *Clostridium perfringens* toxin type A, while involvement of type C is very rare.

The study was undertaken to develop a suitable vaccine preparation against *C. perfringens* type A associated NE for broiler chicken. During the study clinical samples, viz., intestinal content, intestinal scrapings from broilers died of suspected form of NE and faecal swabs from live affected birds with clinical symptoms suggestive of NE were screened for *C. perfringens*. A total of 26 repository isolates of *C. perfringens* maintained in Department of Microbiology, College of Veterinary Science, Khanapara were also considered for the present study. All the isolated *C. perfringens* recovered from NE affected broiler birds along with the repository were characterized with respect to the toxin types, detection of gene(s) associated with virulence and secretory protein, pathogenicity for mice, release of toxins and secretory proteins in cell free supernatant and resistance patterns towards antimicrobial agents. The detailed characterization was carried out with an idea to identify a suitable vaccine candidate for the development of vaccine preparations against NE in broiler chicken.

Clinical samples, comprising of intestinal scrapings (42), intestinal contents (30) were collected from 72 dead broiler chickens with suspected form of necrotic enteritis. Another 23 faecal samples were collected from an equal no. of clinically affected live broiler birds by swabbing. A total of 41 isolates were identified as toxin type A, only

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10 isolates exhibited additional virulent genes viz *netB*, *tpeL* and *gapC* genes either alone or in combination. All the eluted amplified PCR products of target genes with respective band sizes were confirmed by DNA sequencing. All total of 10 isolates of *C. perfringens* type A positive for *netB* alone (5), and *netB* with *tpeL* and *gapC* (5), were subjected to mouse pathogenicity trial. The mouse pathogenicity trial revealed variable pathogenicity, producing clinical symptoms in 21 inoculated mice within 72 hrs of observation, while 17 of the clinically affected mice were succumbed to death. The highest mortality was observed in group of mice inoculated with S8. On SDS-PAGE analysis cell free supernatant of S8 could exhibit highest 16 different visible bands with MW, ranging from 12 to 250 kDa. The four additional virulence associated proteins, NetB (33 kDa), GPD (40 kDa),  $\alpha$ - toxin (43 kDa) and tpeL(180 kDa) were also distinctly visible. On immunoblotting clear immune dominant antigenic proteins identified as netB (33 kDa), GPD (40 kDa), alpha (43 kDa) and tpeL (180 kDa). were observed in cell free supernatant of S8 and other few strain. On antimicrobial resistance profiling highest resistance pattern was observed against ciprofloxacin (80.0%), followed by norfloxacin and tetracycline (60.0% each), gentamicin (30.0%) and levofloxacin (20.0%). Gatifloxacin, cefmetazole, clindamycin, metronidazole, and tigecycline were found to be effective against all the isolates. After selection of a suitable strain of *C. perfringens* type A, six different vaccine formulations, i.e., non-adjuvanted crude toxoid (I), non-adjuvanted crude toxoid with bacterin (II), non-adjuvanted crude toxoid with sonicated supernatant (SS) and bacterin (III), adjuvanted crude toxoid (IV), adjuvanted crude toxoid with bacterin (V) and adjuvanted crude toxoid with SS and bacterin (VI) were prepared. Comparative evaluation of the six vaccine formulations was carried out in respective groups of broiler birds, with respect to their serum antibody titer. Among the vaccine formulations, combination of crude toxoid, bacterin and SS was found to be superior in respect to the mean serum antibody titer in vaccinated bird (group VI), throughout the study period throughout study period. The passive mouse protection study could reveal that the pooled immunized serum samples of 21<sup>st</sup>, and 28<sup>th</sup> day could protect the mice with the challenge with homologous strain of *C. perfringens*.

# **Biofilm Production, Associated Genes and Antimicrobial Resistance of Escherichia Coli Isolated from Bovine Mastitis**

*Himasri Das*

Livestock production sector acts as one of the greatest contributors towards economic development of the country. Mastitis is considered to be one of the most common diseases of high yielding dairy cows which can cause decline in the milk production that ultimately leads to great economic loss in both developed and developing countries. Bovine mastitis can be divided into two types, clinical mastitis and subclinical mastitis. The present study was undertaken on phenotypic and genotypic detection of biofilm producing E. coli isolated from bovine mastitic milk and their antimicrobial resistance profile against commonly used selected groups of antibiotics. To carry out the study, a total of 560 quarters from 140 animals of both organized and unorganized dairy farms in and around Guwahati were screened for mastitis by California Mastitis Test (CMT) out of which 108 animals were found positive for mastitis. The overall prevalence of mastitis including clinical (15%) and subclinical form (62.14%) in both types of farms was 77.14%. In quarter wise distribution of mastitis, involvement of hind quarter was found to be more frequent. A total of 33 E. coli were isolated from 108 milk samples of mastitic dairy cows. All the isolates were screened for biofilm producing ability when tested by using on qualitative as well as quantitative detection methods viz., Congo red agar, Christensen tube and Tissue culture plate methods and all of them were found to be biofilm producers. All the E. coli isolates were tested for presence of biofilm associated genes, viz., csgA, fimH and luxS. The csgA gene was detected in 30 (90.90%) isolates, fimH in 31(93.93%) isolates and luxS was found in 30 isolates (90.90%). On relative quantification of mRNA expression of csgD gene revealed that the  $\Delta$ CT value is significantly and negatively associated with biofilm production (P value<0.05). The E. coli isolates showed 100% sensitivity to Gentamicin, Neomycin and Amoxicillin+Sulbactam followed by Streptomycin (96.97%), Colistin (84.85%), ciprofloxacin and Ceftriaxone + Sulbactam (72.73% to

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each), Cefoperazone+ Sulbactam (69.70), Enrofloxacin and amoxicillin (63.64% to each) and Ceftriaxone (39.39%). However 100% resistance was observed for Cloxacillin followed by Ampicillin (96.97%) and Sulfadiazine (90.91%) on Disc diffusion test. In the present study, a total of 15 (45.45%) isolates were found to be multidrug resistant. Among all the MDR biofilm producing isolates, 6 were strong biofilm producers, 5 were moderate and 4 were weak biofilm producers and a significant correlation has been found between the strength of biofilm production and presence of MDR isolates ( $p < 0.01$ ). Our present finding has shown that the MIC values of Ceftriaxone, Amoxicillin, Gentamicin, Streptomycin were significantly correlated with strength of biofilm ( $P \text{ value} < 0.05$ ). Out of 33 *E. coli* isolates tested, 18 (54.54%) were confirmed as ESBL producers based on double disk synergy test (DDST) and E-test. Further genotypic characterization of ESBL producing *E. coli* showed that ESBL encoding gene blaCTX-M was detected in 13 (39.39%) isolates with a product size of 585bp, blaSHV gene was detected in 3 (9.09%) isolates with a product size of 393bp and blaTEM gene was detected in 6 (18.18%) isolates with a product size 506bp.

# Phenotypic and Molecular Characterization of *Riemerella anatipestifer* Isolates from Ducks

*Monuj Kr. Doley*

*Riemerella anatipestifer* cause one of the most economically important infectious diseases among the domesticated duck population. The present study was conducted to isolate *R. anatipestifer* and also to phenotypic and molecular characterization of the isolates. During the study period, 27 suspected field outbreaks were attended in five district of Assam. A total of 624 samples were collected and processed for isolation followed by phenotypic and molecular characterization. All confirmed isolates (n=95) were screened for two important virulence genes *ompA* and *cam* gene. Further, the confirmed field isolates were also subjected for antimicrobial resistant pattern against 28 most commonly used antimicrobial agents to determined suitable antimicrobial regime. Pathogenicity test was also conducted from isolates recovered from dead ducks in suitable host system.

On bacteriological examination, 121 isolate (19.39%) could be recovered based on phenotypic characteristics (cultural, morphological and biochemical). Phenotypically, highest bacteria could be isolated from brain and heart tissue (28.57%) followed by spleen and liver (26.19%) and least from ocular swab (12.50%). All the isolates produced small, smooth, circular, mucoid, glistening and dew drop like colonies on blood agar under micro-aerophilic condition for 18-24hours. The colonies were found to be non haemolytic on blood agar except 4 isolate (11.12%), watery, discrete, translucent with characteristics odour of culture. Biochemically, all the isolates showed positive for catalase and oxidase test (100%), 97 isolates for gelatin liquefaction test (80.16%) whereas found negative for indole, methyl red, Vokes-Proskauer, H<sub>2</sub>S, ornithine decarboxylase *etc.* On sugar fermentation tests, 10 isolates revealed positive for trehalose and xylose (8.26%), 7 isolates for lactose (5.78%) test. Among the phenotypically identified suspected isolates only 95 isolates (78%.51) could be recovered through PCR assay targeting *16S rRNA*, ERIC sequence and *gyrB* gene with equal positivity.

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Phylogenetic analysis of the representative isolates based on species-specific *16S rRNA* gene revealed formation of single clade with two reference strains HXb2 (CP011859.1) and D-743 (AY871831.2) of China. Moreover, within the clade four isolates (ASC/AAU/RA5, ASDi/AAU/RA4, ASS/AAU/RA3 and ASK/AAU/RA1) formed one sub-clade, whereas ASD/AAU/RA2 formed another sub-clade with HXb2 and D-743 strains. The analysis revealed that *R. anatipestifer* circulating in Assam is closely related to the Chinese strains of the organism and at least two different strains are prevalent in the study area. The pairwise sequence identity analysis of *16s rRNA* gene sequences among the isolates were between 96.5-100 % with divergence ranged from 0 to 3.5 % among the strains. Based on pairwise sequence identity, all isolates ASC/AAU/RA5, ASDi/AAU/RA4, ASS/AAU/RA3 and ASK/AAU/RA1 formed one molecular sub-group whereas isolate ASD/AAU/RA2 was far from this molecular group. Among all the stains of *R. anatipestifer*, the largest divergence (3.5 %) was exhibited by the isolate ASD/AAU/RA2. There were no significant divergence among ASC/AAU/RA5, ASDi/AAU/RA4, ASS/AAU/RA3 and ASK/AAU/RA1, whereas ASD/AAU/RA2 showed 1.7% divergence when compared with other four isolates from Assam. These findings additionally support the phylogenetic analysis which is suggestive of circulation of at least two different strains in Assam.

Similarly, phylogenetic analysis targeting tree *gyrB* gene elicited that all the five *R. anatipestifer* isolates of Assam forms one clade in the cluster 1 with five reference Chinese strains RA9913 (JN969056), WJ4 (CP041029), XG19 (CP076675), RA-CH-1 (CP003787), and HXb2 (CP011859). This analysis revealed that *R. anatipestifer* circulating in Assam are closely related to Chinese strains. The Pairwise sequence identity analysis of *gyrB* gene sequences of *R. anatipestifer* were between 92-100% and revealed that all the isolates of Assam formed one molecular sub-group with Chinese strains. The pairwise identity among the isolates of Assam is between 99-100%. These findings additionally support that the *R. anatipestifer* strains circulating in Assam has close resemblance with *R. anatipestifer* strains of China.

Pathogenicity trial with pathogenic isolates in duckling revealed highest mortality within 48-72 hours (53.34%) followed by 24-48 hrs (33.34%) post inoculation (pi) and bacterium could be reisolated from the death duck.

The antimicrobial (28) resistant pattern of field isolates ( $n=95$ ) revealed 100 per cent sensitive to enrofloxacin, ciprofloxacin, cefotaxime, sulphadiazine and sulphafurazole whereas piperacillin+tazobactam, methicilin, rifampicin, colistin were found to be 100 per cent resistant. All the isolates of *R. anatipestifer* displayed an expanding resistance pattern to number of antibiotics such as 88.89% to clindamycin, 81.48% to oxytetracycline, 85.18% to ofloxacin, 70.37% to streptomycin, 51.85% to chloramphenicol, 37.03% towards cefixime, 29.62% towards gentamicin *etc.* The group wise antibiotic resistant patterns of *R. anatipestifer* isolates revealed that most of the isolates were resistant to tetracycline (81.46%) group followed by penicillin (74.69%), Phenicol (51.84%), aminoglycosides (40.74%) and flouroquinolones (28.39%) *etc* while

highest susceptibility were recorded towards carbapenems (100%) followed by Sulphonamides (95.07%), cephalosporins (90.13%), quinolones (81.49%), and macrolids (77.77%),

The molecular screening of the field isolates towards virulent gene through PCR assay revealed that all the isolates were found positive for conserved *ompA* gene (100%) whereas only 4 isolates (4.25%) were found to be positive for *cam* gene.

# **Digestive Tract Protozoan Parasitism in Domestic Birds With Special Reference to *Trichomonas gallinae* in Assam**

*Munmi Saikia*

The present study was undertaken to ascertain the prevalence of protozoan parasites inhabiting the digestive tract of domestic birds which included pigeon (*Columba livia domestica*), chicken (*Gallus gallus domesticus*), duck (*Anas platyrhynchos domesticus*) and quail (*Coturnix coturnix japonica*) in the state of Assam, India. The study was conducted for a period of two years w.e.f. April 2017 to March 2019 in 8 districts of Assam viz. Kamrup (Rural and Metro), Dhubri, Barpeta, Nalbari, Darrang, Baksa, Lakhimpur and Dhemaji. A total of 1278 pooled faecal samples and 1207 throat swabs were collected for study.

Faecal examination by floatation method for the presence or absence of oocyst of coccidia and by Modified Ziehl- Neelsen staining and Kinyoun's staining method for detection of *Cryptosporidium* infection was carried out in domestic birds and overall prevalence of digestive tract protozoa was recorded as 34.66%. Identified species were *Eimeria labbeana* (26.35%), *E. columbarum* (8.69%) and *E. columbae* (3.53%) from pigeon; *Eimeria tenella* (19.13%), *E. acervulina* (9.46%), *E. necatrix* (6.88%), *E. maxima* (2.36%) and *Cryptosporidium baileyi* (3.01%) from chicken; *Eimeria battakhi* (19.86%) from duck and *Eimeria tsunodai* (13.29%), *E. bateri* (5.69%), *E. uzura* (3.16%) and *Cryptosporidium meleagridis* (4.43%) from quail. Season wise, highest prevalence was recorded from pigeon in pre monsoon (58.33%) and lowest in monsoon (27.17%); in chicken highest in monsoon (57.00%) and lowest in pre monsoon (28.69%); in duck highest in winter (52.45%) and lowest in post monsoon (17.28%); in quail highest prevalence was seen during monsoon (61.11%) and lowest in winter season (14.28%). District wise, highest prevalence (80%) was recorded from Kamrup (rural and metro) and lowest from Dhemaji (22.22%) in pigeon; in chicken highest (82.60%) from Dhubri and lowest from Lakhimpur (28.16%); in case of duck and quail highest prevalence was recorded from Dhubri (51.72%) in duck and (45%) in quail and

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lowest percentage was recorded from Baksa (22.22%) and (17.85%) from Darrang respectively.

Observation on the prevalence of *T. gallinae* was done by Giemsa staining and culture and overall prevalence was recorded as 28.91%. In pigeon, the prevalence was recorded as high as 71.12% and in chicken it was 6.25% but *T. gallinae* was not recorded from both duck and quail in natural condition. In pigeon, prevalence was found in squab as 79.47% which was the highest. In young bird, it was 61.11% and in adult, prevalence was 70.00%. Female birds showed a prevalence rate of 75.51% while in male, it was 66.36%. In chicken prevalence rate was 6.73% in females and 6.00% in males. Season wise, highest number of cases (87.12%) in pigeon was recorded in winter and lowest in monsoon (60.58%). In chicken, *T. gallinae* infection was recorded only in two seasons; post monsoon showed slightly higher prevalence (15.49%) than winter (13.79%). District wise, maximum number of positive samples (78.65%) was recorded from Kamrup (rural and metro) in pigeon and in chicken, highest prevalence of *Trichomonas* infection was reported from Baksa district (34.78%).

Comparative evaluation of direct smear (Giemsa staining) and culture methods (Wet mount) for detection of *T. gallinae* revealed culture method to be sensitive and superior to direct smear method.

Five media, viz. modified Diamond's media, Medium199, Minimum Essential Medium (MEM), RPMI 1640 and Nutrient broth were used for culture and maintenance of *T. gallinae* parasite. Medium 199 showed the highest growth of organism upto 144-168 hours with motile trophozoites in comparison with other four media in the present study.

Polymerase chain reaction (PCR) employed for amplification of *Fe hydrogenase* gene of *Trichomonas gallinae* from positive cultured materials of pigeon and chicken showed clear 290 bp band fragment. Molecular characterization of *T. gallinae* from pigeon and chicken isolate of Assam in the present study showed 100% similarity with isolates of Iran and Austria.

To determine the virulent nature of the trichomonads and its transmissibility to different hosts, experiment was performed with or without immunosuppressive drugs in chicken, duck, quails and mice taking pigeon as its natural host. Pigeon strain of *T. gallinae* orally inoculated at concentration of  $4 \times 10^4$  trophozoites in birds and intra peritoneal inoculation in mice revealed presence of parasites in all bird species while mice developed abscess which is an indicator of *T. gallinae* infection. Pathological lesions like yellowish to whitish masses of caseous necrotic materials were seen in the beak, oral cavity, oesophagus, crop and proventriculus of pigeon and mild gross alterations were observed in other experimental host. Histopathological alterations were also found more in pigeon than other infected birds.

In the present study, five different drugs used for *in vitro* and *in vivo* efficacy against *T. gallinae* were Flagyl 400 (Metronidazole), Ornida (Ornidazole), Tiniba 300

(Tinidazole), Sulcoprim (sulphadiazine and trimethoprim) and Vetfur-TL (Metronidazole, Furazolidone and Loperamide). Concentration of drugs @10, 20 and 30 mg/ml for *in vitro* study and 20 and 30 mg/kg for *in vivo* study revealed 100% efficacy of the drugs Metronidazole, Ornidazole and combination of Metronidazole, Furazolidone and Loperamide at 30mg/ml *in vitro* and 30mg/kg in *in vivo* condition.

# **Epidemiology and Molecular Identification of Trematode Parasites of Duck with Special Reference to Echinostome**

*Nanswita Borah*

A survey was conducted in five different districts of Assam for a period of one year from September' 2020 to August'2021 to investigate on the epidemiology and molecular identification of trematode parasites of duck along with the pathological changes caused by the latter and furthermore, identification of the snail harboring the echinostome cercariae and molecular identification of echinostome cercariae.

Out of 1411 fresh faecal samples examined, 411 samples were found positive for helminths with 29.13 per cent prevalence. Infectivity percentage was highest in Kamrup (rural) district and lowest in Udalguri district. Trematodes evinced highest prevalence of 18.00 per cent followed by nematodes with prevalence of 17.51 per cent and finally cestodes with lowest prevalence of 2.62 per cent. Study revealed eggs of *Notocotylus* sp., *Prosthogonimus* sp., *Echinostoma* sp., segments of cestodes, larvae of *Strongyloides avium*, *porrocaecum* sp., *Tetrameres* sp., *Heterakis* sp. in faecal samples of infected ducks. 303 faecal samples were positive for single infection with prevalence of 21.47 per cent and 108 samples were positive for mixed infection with prevalence of 7.65 per cent. The seasonal prevalence of trematodes on faecal examination of ducks from different districts of Assam depicted highest in monsoon with 28.93 per cent and lowest in winter with 7.82 per cent. The prevalence of trematodes on faecal examination of duck raised under free-range was higher (19.91%) than semi-intensive system of rearing (16.10%).

Out of 2786 ducks examined on post-mortem, 2092 ducks were found positive for helminths with 75.09 per cent prevalence. Infectivity percentage was highest in Kamrup (rural) district and lowest in Udalguri district, respectively. Cestodes showed overall highest prevalence of 50.90 per cent followed by trematodes with prevalence of 44.29 per cent and finally nematodes with lowest prevalence of 17.26 per cent. 1146 ducks with an overall prevalence of 41.13 per cent were positive for single infection and 946 ducks with prevalence of 33.96 per cent for mixed infection.

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On the basis of morphological studies, 9 different species of trematodes, 7 different species of cestodes and 4 different species of nematodes were identified and recorded. Trematodes were identified as *Echinostoma revolutum* (7.11%), *Echinostoma paraulum* (18.23%), *Echinostoma friedi* (0.29%), *Hypoderaeum conoideum* (18.52%), *Psilochasmus oxyurus* (0.04%), *Tracheophilus cymbius* (0.04%), *Prosthogonimus ovatus* (0.04%), *Notocotylus attenuates* (0.04%). Cestodes were identified as *Hymenolepis collaris* (14.28%), *Hymenolepis lanceolata* (11.59%), *Fimbriaria fasciolaris* (7.93%), *Raillietina tetragona* (4.74%), *Raillietina echinobothridia* (5.03%), *Raillietina cesticillus* (3.30%), and *Amoebotaenia cuneata* (4.02%). Nematodes were identified as *Porrocaecum* sp. (0.68%), *Heterakis gallinarum* (5.53%), *Heterakis dispar* (4.02%), and *Tetrameres* sp. (7.04%). *Notocotylus attenuates* and *Amoebotaenia cuneata* was first time reported from Assam in duck.

The prevalence of trematodes on post-mortem examination of ducks on the basis of sex depicted higher prevalence in females (46.00%) than males (42.62%). The prevalence of trematodes in post-mortem examination of ducks on the basis of age showed higher in adults (48.93%) than young ducks (38.95%). The prevalence of trematodes on post-mortem examination of ducks on the basis of breed showed highest in Pati ducks (49.24%), followed by Khaki Campbell ducks (45.76%), Chara-chambelli ducks (42.14%) and lowest in White pekin ducks (39.16%). Seasonal prevalence of trematodes on post-mortem examination of ducks depicted highest in monsoon with 49.62 per cent and lowest in winter with 38.25 per cent. Prevalence of trematodes on post-mortem examination of ducks on the basis of rearing duck showed higher in free-range (47.44%) than semi-intensive system of rearing (40.91%).

For molecular identification of trematodes namely, *Echinostoma revolutum*, *Echinostoma paraulum*, *Hypoderaeum conoideum* and *Echinostoma friedi* (morphologically identified) were subjected to PCR (COX -1 gene of *Echinostoma revolutum*, *Echinostoma paraulum*, *Hypoderaeum conoideum* and ITS2 gene of *Echinostoma friedi*). The trematode, *Echinostoma revolutum* collected from different districts on the basis of COX-1 sequence identity showed 97.80-99.63% identity with *Echinostoma revolutum*, *Echinostoma paraulum* collected from different districts on the basis of COX-1 sequence identity showed 99.07-99.54% identity with *Echinostoma robustum*, *Hypoderaeum conoideum* collected from different districts on the basis of COX-1 sequence identity showed 99.08%-99.74% identity with *Hypoderaeum conoideum*. *Echinostoma friedi* on the basis of ITS2 sequence identity from Kamrup (rural) and Kamrup metropolitan districts showed 100% identity with *Echinostoma friedi*. DNA extracted from adult trematode parasites yielded positive results for COX-I genes of *E. revolutum*, *E. paraulum* and *Hypoderaeum conoideum* by PCR analysis, yielded the amplicons size of 818 bp, 216 bp, and 765 bp, respectively and 1000bp for *E. friedi* for ITS2 gene.

On post-mortem examination, intestine of ducks infected with the species under the genus *Echinostoma* and *Hypoderaeum* showed slight gross lesions except catarrhal

enteritis and congestion in the mucosal surface, mainly in the jejunum, ileum and caecum. *Psilochasmus oxyurus* showed catarrhal enteritis and congestion in the mucosal surface of the small intestine. Trachea infected with *Tracheophilus cymbius* exhibited bloody mucosal exudates in the site of attachment. No observable gross pathological lesions could be seen in oviduct and caecum affected with *Prosthogonimus ovatus* and *Notocotylus attenuates*, respectively. This may be due to low level of infection encountered in the present investigation. Microscopic changes associated with the species under the genus *Echinostoma*, *Hypoderaeum*, and *Psilochasmus* showed marked thickening with infiltration of inflammatory cells including lymphocytes, eosinophil, plasma cells and macrophages in the intestine. Some of the villi were degenerated and necrosed. Desquamated epithelial lining of intestinal villi were found to be deposited in the lumen of the intestine. Haemorrhagic patches could be seen in the tip of some villi. Hypertrophy of goblet cells was seen in the villi. The glandular epithelium showed vasculature and distortion which have further undergone necrosis. Most of the lymphoid follicles in ileum were found to be enlarged and degeneration of lymphoid cells was also observed. Muscle cells showed necrosis and hyalinization. Blood vessels showed congestion and dilation along with haemorrhages in subserosal layer of intestine. Histopathology, of trachea infected with *Tracheophilus cymbius* showed heavy infiltration of leucocytes in the mucosa and degeneration with necrosis in submucosal layer.

Snail, *Indoplanorbis exustus* (0.55%) and *Lymnaea luteola* f. *ovalis* (0.37%) were recorded as the intermediate host of echinostome cercariae. No cercarial infection was recorded from *Lymnaea acuminata* f. *rufescens*, and *Bellamya bengalensis* f. *typica*. District-wise Monthly prevalence of echinostome cercaria in *Indoplanorbis exustus* depicted maximum shedding from the month of June to September from the different districts of Assam. District-wise Monthly prevalence of echinostome cercaria in *Lymnaea luteola* f. *ovalis* depicted maximum shedding from the month of June to October from the different districts of Assam.

Morphological identified echinostome cercariae (4 representative samples) collected from different districts of Assam were subjected for molecular identification where ITS2 and COX -1 gene of the parasite was subjected to PCR. Cercariae of *Hypoderaeum conoideum* and *Echinostoma revolutum* (molecularly identified) are commonly prevalent in the snails of Assam.



## **Efficacy of Selected Herbal Preparations against Gastrointestinal Nematodes with Special Reference to *Haemonchus contortus* in Goats**

*Neelakshi Deka*

The present study was carried out to ascertain the prevalence of gastro-intestinal nematode parasites of goats in and around the undivided Kamrup district of Assam and to estimate the anthelmintic efficacy of the three selected indigenous herbal plants viz., *Butea frondosa* (Polakh), *Carica papaya* (Omita) and *Corchorus fascicularis* (Morapat) by *in-vitro* and *in-vivo* evaluation in goats naturally infected with gastro-intestinal nematodes. The study was conducted for a period of one-year w.e.f. October 2020 to September 2021 in Kamrup Rural and Metro districts of Assam.

A total of 576 faecal samples were collected for the study. Faecal examination by Flotation Technique and Modified McMaster Method was carried out and overall prevalence of gastro-intestinal nematodes was recorded to be 63.89 %. Month-wise prevalence of gastro-intestinal nematode was also recorded where July month recorded the highest prevalence of 91.84 percent and February recorded the lowest prevalence of 31.81 percent. Monsoon season recorded the highest prevalence of 84.28 percent and winter season recorded the lowest prevalence of 35.06 percent. Among the three breeds of goat examined during the present study, Assam Hill goats recorded highest prevalence of 69.80 percent. The 6 months to 1 year age-group animals showed highest prevalence of 76.42 percent and female animals (doe) recorded the highest prevalence of 76.34 percent. The positive faecal samples were put in faecal culture for development of nematode larvae which revealed *Haemonchus* sp., *Trichostrongylus* sp., *Oesophagostomum* sp. and *Strongyloides* sp. larva in the study area. Polymerase chain reaction (PCR) was employed for molecular identification of *Haemonchus contortus* which showed a distinct band at 265 bp.

Three types of leaf extract viz., ethanolic, hydroethanolic and aqueous extracts of each of three plants were prepared. The percent yield of ethanolic extract of *B. frondosa*, *C. papaya* and *C. fascicularis* was found to be 11.02, 7.81 and 13.72 %

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(w/w) respectively. For hydroethanolic extract the percent yield was found to be 12.81, 15.19 and 19.60 % (w/w) respectively and the percent yield of aqueous extract was found to be 16.02, 35.28 and 32.87 % (w/w) respectively. Phytochemical analysis of ethanolic, hydroethanolic and aqueous extract of leaves of *B. frondosa*, *C. papaya* and *C. fascicularis* revealed the presence of flavonoids, glycosides and triterpenes. Acute toxicity studies with ethanolic, hydroethanolic and aqueous extracts of the leaves of *B. frondosa*, *C. papaya* and *C. fascicularis* did not show any behavioural change or gross abnormality within 48 hours @ 2000 mg/kg body weight in mice. The extracts were considered to be safe up to a maximum dose of 2000 mg/kg.

Three different concentrations viz., 50, 100 and 200 mg/ml was used for all the nine leaf extracts prepared from the three plants. Among the three plants studied in *in-vitro* trial, *B. frondosa* was observed as the best plant having *in-vitro* anthelmintic efficacy. Based on the findings of the *in-vitro* studies, the hydroethanolic extract of *B. frondosa* was selected to undergo *in-vivo* evaluation in goats naturally infected with *Haemonchus* sp., *Trichostrongylus* sp., *Oesophagostomum* sp. and *Strongyloides* sp. using two doses, 250 and 500 mg/kg body weight. At 250 mg/kg body weight, the percent efficacy was 80.18 % and 72.79 % on Day 7 and 14 respectively, and at 500 mg/kg body weight the percent efficacy was 69.46 % and 73.12 % on Day 7 and 14 post-treatment respectively. The pulverized leaves of *B. frondosa* was also incorporated in urea-molasses-block (MUMB, Herbal Anthelmintic) and fed to goats naturally infected with *Haemonchus* sp., *Trichostrongylus* sp., *Oesophagostomum* sp. and *Strongyloides* sp. The anthelmintic efficacy upon feeding of medicated urea molasses block (MUMB, Herbal Anthelmintic) incorporated with *B. frondosa* was found to have 88.16 % and ii 86.34 % efficacy on Day 7 and 14 post-treatment respectively. Ivermectin was used as the standard anthelmintic drug which gave 96.90 % and 93.79 % efficacy on Day 7 and 14 post-treatment respectively.

Haemato-biochemical studies of treated goats under the *in-vivo* trial showed significant improvement in haemoglobin, packed cell volume, total erythrocyte count and total leukocyte count in groups fed with hydroethanolic extract of leaves of *B. frondosa* and MUMB (incorporated with *B. frondosa*) from Day 0 pre-treatment to Day 28 post-treatment. Total protein and albumin concentration improved significantly in groups treated with hydroethanolic extract of *B. frondosa*. Aspartate transaminase and alanine transaminase was found to improve significantly in groups treated with hydroethanolic extract of leaves of *B. frondosa* and MUMB (incorporated with *B. frondosa*) from Day 0 pre-treatment to Day 28 post-treatment.

*B. frondosa* leaf extract and MUMB was found to possess significant *in-vitro* and *in-vivo* anthelmintic activity and improved the haemato-biochemical parameters substantially during the present study. This indicates that *B. frondosa* has the potential to be used as herbal anthelmintic. MUMB with herbal incorporation can be recommended to be used for the control of gastro-intestinal nematodosis in goats.

This indicates that the extract of leaves of *B. frondosa* is a potent and effective herbal anthelmintic. Incorporation of the herbal leaves as powder form in medicated urea molasses block (MUMB, Herbal Anthelmintic) can be used for the control of gastro-intestinal nematodes in goats. The conventional use of synthetic anthelmintics has led to the development of anthelmintic resistance in goat farms not only in Assam but also India and the world as a whole. Therefore, newer anthelmintics need to be developed to overcome the problem of anthelmintic resistance and control of gastro-intestinal nematode parasites of goat.

## **Tick and Tick-Borne Parasitic Diseases of Dog Prevalent in and Around Guwahati, Assam**

*Pallabi Devi*

The study was conducted to record the prevalence of ticks on dog and haemoparasites borne by them. Molecular identification and characterization of the prevalent tick species was also done in order to know their taxonomic status and evolutionary relationship. The study was conducted from March, 2021 to February, 2022. 1440 dogs were examined for the presence of ticks on their body. Out of 1440 dogs, 986 (68.47%) were found to be infested with ticks. 504 (35.00%) ticks were identified as *Rhipicephalus sanguineus*, 260 (18.06%) were identified as *Haemaphysalis bispinosa* and 222 (15.42%) were found to be mixed infestation. The highest prevalence of *R. sanguineus* ticks during August (61%) and the lowest during February and December (25%). Highest prevalence of *H. bispinosa* was recorded during August (26.67%) and the lowest during February and January (10.00%). Mixed infestation was highest during August (35.0%) and lowest during December (5.0%). The month-wise prevalence was found to be non-significant by statistical analysis (P value: 0.964948). The highest prevalence of ticks was recorded during the monsoon (95.42%) followed by the post-monsoon and the lowest during winter (37.5%). Statistically season has no significant influence on the prevalence of ticks on dogs (P value: 0.6541). The highest percentage of dogs infested with *Rhipicephalus* and *Hemaphysalis* tick at the age of 2-3 years (53.49%) and 6 month to 1 year (18.24%) respectively and lowest in 9-10 years (0%). The prevalence of ticks was significantly influenced by the age of dogs (P: 2.28695E-08). Labrador breed of dogs (98.23%) were found to be most infested by ticks followed by Local/mongrel (91.30%) and the least in St. Bernard (7.14%). The breeds of dog were found to be significantly influence the prevalence of ticks (P: 2.1666E-17). The female dogs showed higher prevalence of ticks (52.54%) than their male counterparts (47.46%). The most preferred site of attachment of the ticks on the dog's body was ears (28.39%) followed by head (18.56%) and paws/toes (17.64%). Morphological study of both the prevalent tick species were done and characteristic diagnostic features were figured out with photograph. Molecular identification and

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**Abstract of Ph.D. Thesis**

**Department : Veterinary Parasitology**

**Major Advisor : Dr. Saidul Islam**

characterization of prevalent tick species were done by amplification of the 16S rRNA gene by PCR. Phylogenetic analyses by neighbor joining method were performed and the pair wise distance of 16S rRNA were done with MEGA X software. The pair wise distance study revealed that the *R. sanguineus* strain As/AAU/RS-01 was found to be 100% identical to the isolates of tropical lineages and is 6.4-7.5% divergent with the isolates of temperate lineages. *H. bispinosa* strain AS/AAU/HB-01 formed the clade with other isolates of *H. bispinosa*. The closely related isolates of AS/AAU/HB-01 were observed to be Chipahikhola isolate, Itanagar isolate and Arunachal pradesh isolates. The pair wise distance of AS/AAU/HB-01 showed divergence of 0-3.6% with other isolates of *H. bispinosa* and with other species of *Haemaphysalis* was between 9.3-14%. 4119 numbers of Giemsa's stained thin blood smears were examined under the light microscope for presence of tick-borne hemoparasites. The prevalent of five tick borne haemoparasites in dogs were recorded were *Babesia gibsoni* (10.34%), *Babesia canis* (0.92%), *Hepatozoon canis* (0.39%), *Anaplasma (Ehrlichia) platys* (0.12%) and *Ehrlichia canis* (0.22%). Out of 526 positive blood samples, 100 randomly selected positive samples were confirmed with PCR by amplification of 18S rRNA gene for (*B. gibsoni*, *B. canis*, *H. canis*) and 16S rRNA gene for (*A. platys* and *E. canis*) and found that PCR shows more sensitivity than light microscopy. Overall prevalence of tick borne haemoparasites, irrespective of season, breed, age and sex is recorded to be highest in the month of July (16.92%) followed by September (16.19%) and lowest in the month of February (4.18%). The highest prevalence of *Babesia gibsoni* was noticed in Labrador breed (12.93%) followed by local/mongrel dogs (11.53%) while *Babesia canis* was mostly encountered in Lhasa apso dogs (2.63%) followed by Boxer breed (2.38%) of dogs. Similarly, Pomeranian breed was found to be mostly infected by *Hepatozoon canis* (1.96%) followed by Doberman (1.55%) dogs. On the other hand, the rickettsial organism *Anaplasma platys* affect mostly Shitzu (3.85%) dogs followed by Dalmatian breed of dog (2.56%) and *Ehrlichia canis* was found to affect mostly Lhasa apso (2.63%) followed by Boxer dogs (2.38%). It has been noticed that out of all 18 breeds of dog in the present study, Labrador breed of dog is found to infect most by different haemoparasites followed by local/ mongrel dogs. Female dogs were recorded to be more affected than the male dogs. Statistical analysis revealed that sex of dog has significant influence on the prevalence of tick-borne hemoparasites (P: 0.040134). The highest prevalence of hemoparasites was seen in 1-2 years of age (17.70%) followed by <1 year (16.32%) and 2-3 years (14.88%) of age. The lowest prevalence was observed in 11-12 years of age (2.86%) and mixed infection of *Babesia canis* and *Babesia gibsoni* is found to be highest of all other combination of infection.

## **Ixodid Ticks Their Acaricide Resistance and Tick-Borne Haemoparasites in Cattle**

*Rabeya Begam*

Present study with an aim to obtain current information on the prevalence and acaricidal resistance status in ticks and prevalence of haemoparasitic infection in cattle in and around Guwahati. Prevalence of *Rhipicephalus (Boophilus) microplus* was recorded as 49.27% throughout the year in all the breeds of cattle and *Haemaphysalis bispinosa* as 2.72% was recorded in a few Zebu cattle. Overall tick prevalence was 51.99% in cattle (n=777). Prevalence of tick infestations was highest (74.04%) in Zebu in cattle, followed by crossbred Holstein Friesian (52.87%) and lowest (42.27%) in crossbred Jersey. Season-wise, overall infestation was found highest in Monsoon (67.33%) followed by Pre-monsoon (58.85%), Post-monsoon (43.18%) and lowest in Winter (32.18%) season. Age-wise, highest prevalence rate was observed more in 1-5 years' age group of cattle (58.62%) followed by >5 years (50.81%) and lowest (39.65%) in calves. Breed-wise, zebu cattle (74.04%) were found more susceptible to tick infestation followed by crossbred Holstein-Friesian cattle (52.87%) and crossbred Jersey (42.27%). Sex-wise, females were found more susceptible (53.71%) than the males (45.22%). On the basis of distribution of ticks on the body of cattle irrespective of breed type, highest infestation was recorded from neck (94.30%) followed inguinal region (71.03%), brisket (67.33%), head (50.24%), leg (40.84%) and tail (11.88%). On the basis of types of farm irrespective of breed type, infestation was recorded higher in unorganized farm (80.50%) compared to organized farm (6.25%). Acaricide resistance test conducted through AITDD, AIT and LPT showed resistance against the ticks of unorganized farm of Ganeshnagar area of Basistha. AITDD revealed 90 per cent resistance against cypermethrin and 86.00% resistance against deltamethrin. AIT revealed LC<sub>50</sub> and LC<sub>95</sub> values as 62.08 ppm and 122.28 ppm for deltamethrin, 227.08 ppm and 473.70 ppm for cypermethrin. LPT revealed LC<sub>50</sub> and LC<sub>95</sub> as 30.98 ppm and 70.43 ppm for deltamethrin, 161.09 ppm and 356.24 ppm for cypermethrin. Both AIT and LPT showed level 1 resistance in the *R. (B) microplus* ticks. Prevalence of haemoparasites on blood smear examination revealed *Babesia bigemina* (0.51%),

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*Anaplasma marginale* (11.45%) and *Theileria orientalis* (51.99%) which was subsequently confirmed by PCR. The overall prevalence of haemoparasites of cattle in and around Guwahati was recorded as 63.96%. Season-wise prevalence was found to be highest in Monsoon (86.85%) followed by Pre-monsoon (72.92%), Post-monsoon (55.30%) and lowest in Winter (32.67%) season. Age wise, the highest prevalence was seen in 1-5 years' age group of cattle (82.07%) than >5 years (75.06%) and lowest (10.34%) in calves. Breed-wise, prevalence of haemoparasites was recorded to be highest in crossbred Holstein-Friesian (65.59%) followed by crossbred Jersey (64.71%) and Zebu cattle (57.69%). Females were found more susceptible to haemoparasitic infection (69.83%) than the males (40.76%). On the basis of types of farm irrespective of breed type, haemoparasitic infection was recorded higher in unorganized farm (93.29%) and lower in organized farm (17.33%). PCR amplified the haemoparasite DNA of *B. bigemina*, *A. marginale* and *T. orientalis* which showed clear band at 1124 bp, 714 bp and 776 bp, respectively. The present study revealed *R. (B). microplus* as the predominant tick infesting cattle of the study population. Acaricide resistance test conducted through AITDD, AIT and LPT showed development of resistance against the ticks of unorganized farm of Ganeshnagar area of Basistha. *B. bigemina*, *A. marginale* and *T. orientalis* were present in cattle of the study population. Present study also revealed that haemoparasites are widely prevalent in cattle throughout the study area indicating haemoparasites possess a major constraint for the well-being of the cattle health in Assam.

# **Pathology and Molecular Diagnosis of Necrotic Enteritis in Chicken**

*Debasish Behera*

The present research work was carried out with an aim to study the pathology necrotic enteritis with isolation and molecular detection of *C. perfringens* and experimental production of the NE in chicken to compare between the *C. perfringens* type A and C in terms of hematological, biochemical and pathomorphological alterations. Total 320 numbers of samples based on different clinical signs/pathological conditions were collected from 15 districts of Assam. Isolation and identification of *C. perfringens* was done by cultural and morphological characteristics and confirmation was done by detection of *cpa* gene of *C. perfringens* by PCR. In this study 20 (15.03%) intestinal content and 9 (4.81%) cloaca swabs were found to be positive for *cpa* gene of *C. perfringens*. Isolation of bacteria from the samples collected during monsoon was found to be highest in comparison to other seasons. Study showed around 80% of the total isolates of *C. perfringens* was from the birds of 4-6 weeks of age. The *C. perfringens* isolated from the enteritis samples were found to be highest. Total 29 samples were found to be positive for *cpa* gene (324 bp) encoding for alpha gene and *cpb* gene (180 bp) encoding for beta gene was detected in 11 isolates. The additional virulence toxin genes of *C. perfringens* like *TpeL* and *NetB* were also detected. The gross lesions of NE in field condition revealed haemorrhagic, eroded, detached dead mucosal tissues in intestine. Formations of diphtheritic membrane, distention of intestine were also observed in intestine. Liver, kidneys and lungs showed congestion, haemorrhage and focal areas of necrosis. Spleen and Bursa of Fabricius in some birds was found to be moderately enlarged. The gross lesion of brain was found to be limited to mild congestion of meningeal blood vessels. Histopathology of NE in chickens revealed congestion of blood vessels in the lamina propria and submucosa with vacuolation of epithelial cells of intestinal villi along with necrosis making the villi broader and shorter. Different developmental stages of coccidia were also seen in the mucosal epithelial cells. In other organs such as liver, kidneys, heart, lungs, spleen, bursa of Fabricius and brain showed variable nature of histopathological lesions like

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congestion, haemorrhage and focal areas of coagulative necrosis. Experimental production of NE was done in chicken by infecting *C. perfringens* isolate Type A and type C with and without coccidia in separate groups. The clinical signs shown by the experimentally infected birds were diarrhoea, dehydration, depression, reluctance to move, loss of appetite, ruffled feathers, drooping of wings and head and huddling. The clinical pathology of experimental birds showed, significant decrease in TEC level, hemoglobin (g/dl) level as well as in PCV (%) and significant increase in TLC in the birds of infected group in comparison to the control. Serum ALT and AST both showed a significant increase ( $P < 0.01$ ) and total protein showed a significantly decreased ( $P < 0.05$ ) level. The gross lesion revealed congestion and haemorrhage and focal areas necrosis of mucosa of intestine. Enlargement, congestion, haemorrhage with focal areas of necrosis of the liver were common gross findings in all the experimentally infected groups. This might be due to damage to RBC in entero-hepatic circulation by  $\alpha$  toxin of *Clostridium perfringens*. Kidneys, heart, lungs, spleen and Bursa of Fabricius revealed moderate degree of congestion and haemorrhage. Variable degrees of vascular changes in terms of gross lesions were observed in all most all the infected groups. The histopathological lesions revealed developmental stages of coccidia (schizonts & merozoites) and infiltration of large no of mononuclear cells and few polymorhonuclear cells in intestine. The intestinal villi have undergone necrosis and necrosed cells were sloughed off from the mucosa. Liver revealed marked fatty change in hepatocytes, congestion in the sinusoids. Kidneys showed focal areas of inter tubular congestion. Heart and lungs revealed focal areas of mononuclear cell infiltration as well as congestion and haemorrhage. Spleen and Bursa of Fabricius showed depletion of follicles and brain showed neuronal degeneration and necrosis with neuronophagia. Based upon the clinical signs, gross and histopathology, the present study revealed the groups infected by both coccidia and clostridial isolate showed distinctly more pronounced qualitatively and quantitatively in terms of clinical signs and pathological lesions. It has been also observed in this study that *C. perfringens* type A was found to be more virulent in terms of pathogenesis and pathomorphology in comparison to *C. perfringens* type C. TEM evaluation of experimentally infected birds showed disruption of intercellular junctional complexes, formation of gaps between enterocytes and delimitation of boundaries of individual enterocytes. Disintegration of nuclear material, dilatation of endoplasmic reticulum, disruption of cristae of mitochondria, increase intracytoplasmic vacuolizations and membrane bound vesicles were also prominent ultrastructural alterations in this study. Data were subjected to statistical analysis and analyzed by SAS System ('Local', X64\_7PRO) using one way analysis of variance (ANOVA). Means were presented as mean  $\pm$  standard error (SE) and were compared by the Duncan test at the 0.05 level of probability.

## **Pathology and Molecular Diagnosis of Helicobacter Infection in Pig**

*Kongkon Jyoti Dutta*

*Helicobacter* is a zoonotic bacterium that has been associated with gastritis and ulcerative lesion in the stomach of pig. Prevalence of *Helicobacter* infection in pig was determined from four districts of Assam during the period from July, 2021 to June, 2022. The prevalence of *Helicobacter* infection was found to be 39.9% and 45.67% by RUT and PCR test, respectively. The age wise prevalence of *Helicobacter* infection revealed highest in adult pigs 42.37% (RUT) and 48% (PCR) in comparison with piglet 23.07% (RUT) and 16.66% (PCR). Among different farms the highest prevalence was recorded in unorganized farms 45.53% (RUT) and 52.17% (PCR) in compared to organized farms 32.96% (RUT) and 37.10% (PCR). The presence of HLOs in different regions of the stomach by RUT was recorded as Parsoesophagea (1.48%), Cardia (2.95%), Fundus (15.27%), and Pylorus (20.27%). The maximum positivity was recorded in pylorus and fundus region with 20.27% and 15.27% respectively. The presence of HLOs in different grades of gastric macroscopic lesions was determined. The positivity of HLOs in different grades of gastric macroscopic lesions recorded as: 1+ (Early or mild) (28.12%), 2+ (Severe) (37.03%), and 3+ (more severe+ ulcers) (56.89%). The maximum positive RUT was detected in Grade 3+ (58.89%). HLOs were detected by brush cytology from the mucosal surface satined with Giemsa and Gram's stain in 22.66% and 16.74% of the samples respectively. The gross lesions of gastritis were recorded in 203 (58%) stomachs out of 350 pig carcasses examined. The present investigation recorded early or mild gastric lesions (1+) in 31.53%, severe lesion (2+) in 39.90% and more severe lesions and ulceration (3+) in 28.57% of the stomach examined grossly. The recorded lesions were various grades of lesions as thickening of the gastric wall, corrugation of the gastric folds, congestion and haemorrhages, necrosis and sloughing of the gastric mucosa, erosions and ulceration in the parsoesophagea as well as glandular regions of the stomach. The frequency of various histopathological lesions in affected stomach were Hyperkeratosis (17.28%), Parakeratosis (14.81%), Epithelial hyperplasia (44.44%), Glandular degeneration (60.49%), Vacuolation of glandular

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epithelium (56.79%), Lymphoid follicle (62.96%), Inflammatory cell infiltration (Neutrophil (32.09%), Lymphocyte (45.67%), Eosinophil (23.45%), Macrophage (28.39), Plasma cell (25.92%), Sloughing & erosion (53.08%), Ulcer, Congestion and Haemorrhages (39.50%), Glandular abscess (9.87%), Fibrosis (4.93%), Metaplasia and Dysplasia (3.70%), and Detection of *Helicobacter* (9.87%). Ultrastructurally, *Helicobacters* with bacillary morphology, inflammatory cells on the gastric mucosa and biofilm formation by coccoid form of *Helicobacters* were detected. PCR analysis of the gastric samples showed the presence of *Helicobacter* spp in 37 (45.67%) and *Helicobacter suis* in 17 (20.98%) samples. PCR detection rate was found to be higher from the pylorus and fundic region and severe gastric lesions of the stomach. To study the zoonotic potential of *Helicobacters*, a total of 30 saliva samples from pig farmers were subjected for PCR out of which *Helicobacter* spp. was detected in 8 numbers of samples. Further, *Helicobacter suis* (2) and *Helicobacter pylori* (3). Phylogenetic analysis revealed that *Helicobacter suis* detected from pig handlers and pig stomach samples shares above 99% identity suggesting zoonotic transmissions of *Helicobacters* from pig to human.

# **Pathomorphological and Molecular Diagnosis of Infectious Bursal Disease**

*Muzaharul Islam*

The present investigation was carried out to know the pathomorphology of Infectious Bursal Disease in different organized and un-organized poultry farms in and around the Guwahati city, Kamrup district, Assam.

Altogether 1650 birds were necropsied, out of which 1279 birds from 29 different outbreaks were diagnosed as suspected of IBD based on gross lesions observed. Clinical signs commonly recorded were vent pecking, dullness, depression, anorexia, ruffled feathers and yellowish white diarrhea.

In gross pathological study, bursa of Fabricius were found to be invariably affected with lesions like swelling, edema and hemorrhage. Few bursa of Fabricius showed atrophy. Moderate to severe haemorrhages in the breast and thigh muscle were consistently observed. The kidneys were enlarged and mottle with whitish pale colour appearance. Hemorrhagic lesions were also noticed in extra bursal lymphoid organs like spleen, thymus and caecal tonsils.

Histopathologically, there were mild to severe depletion of lymphocytes in the bursa of Fabricius, spleen, thymus and caecal tonsils. Heterophilic infiltrations were also consistently observed in these organs. Complete depletion of lymphocytes with formation of cystic cavity were noticed in some bursal follicle. Marked thickening of the inter-follicular space with proliferated fibrous connective tissue were another characteristic bursal lesion observed. Muscle sections revealed haemorrhages and necrosis. Kidney showed degenerative changes and necrosis in proximal and distal convoluted tubules. There were glomerular shrinkage in few cases. Degenerative changes of the hepatocytes were the commonly observed histopathological changes in liver.

In scanning electron microscopic study of bursa of Fabricius, moderate to severe erosion and ulceration of mucosal plica and exposure of reticular fibers were noticed after exuviations of epithelial and other cells were noticed. Button like depressed structures were seen in follicles and some follicles appeared as empty craters due to

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complete lymphocytic depletion. Spleen and thymus also showed moderate to severe lymphocyte depletion characterized by presence of homogenous mass. In transmission electron microscopic, spherical virus particle without a clear membrane were observed in the cellular debris of the cytoplasm of the follicular cells. Mitochondrial changes like cristolysis were also recorded.

The disease was confirmed by detection of viral antigen and viral nucleic acid in 165 representative samples by Indirect IPT and 612 representative samples by RT-PCR.

## **Evaluation of Anthelmintic Efficacy of Certain Indigenous Plants Against Experimentally-Induced *Ascaridia galli* Infection in Local Birds (*Gallus domesticus*)**

*Archana Hazarika*

The present study was an attempt to evaluate the anthelmintic efficacy of certain indigenous plants against experimentally induced *Ascaridia galli* infection in local birds (*Gallus domesticus*). A total of five (5) indigenous plants viz., *Nyctanthes arbor-tristis* (Sewali), *Butea monosperma* (Palash), *Melia azedarach* (Ghora neem), *Erythrina stricta* (Madar), and *Ficus hispida* (Dimoru) based on indigenous technical knowledge (ITK) and ethnomedical uses Three types of extracts, viz. ethanolic, hydroethanolic and aqueous extracts of each of the five plants were prepared for *in vitro* and *in vivo* studies. *A. galli* was used as the test parasite for *in vitro* studies. Three different concentrations, 10, 25 and 50 mg/ml was used for *in vitro* studies. Rats were used for acute toxicity studies while local indigenous birds of either sex were used for induced infection with *A. galli* and *in vivo* studies. A total of twelve groups (each plant having three types of extracts and three different doses, 100, 500 and 1000 mg/kg body weight, two control groups and one standard group ) of each of the two plants consisting of six (6) birds in each group were used for *in vivo* studies.

A total number of  $1000 \pm 50$  infective ova were inoculated to each of the experimental bird except birds of negative control group. Piperazine hydrate liquid was used as standard drug @ 200mg/kg body weight. The percentage yield of ethanolic extracts of *N. arbor-tristis*, *B. monosperma*, *M. azedarach*, *E. stricta*, and *F. hispida* were found to be 14.56, 12.50, 16.84, 13.16 and 5.84 percent (w/w) respectively, for hydroethanolic extract, the percentage yield were found to be 17.0, 8.3, 38.90, 10.56 and 9.62 percent (w/w) respectively and the percentage yield of aqueous extracts were found to be 27.56, 14.48, 27.26, 47.62 and 19.24 percent (w/w) respectively. Phytochemical analysis of ethanolic, hydroethanolic and aqueous extracts of *N. arbor-tristis*, *B. monosperma*, *M. azedarach*, *E. stricta*, and *F. hispida* revealed the presence of steroids, alkaloids, phenolic compounds, tannins, flavonoids, glycosides and triterpenes. Acute

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toxicity studies with ethanolic, hydroethanolic and aqueous extracts of *N. arbor-tristis*, *B. monosperma*, *M. azedarach*, *E. stricta*, and *F. hispida* did not show any behavioural change or gross abnormality nor any sign of toxicity upto 14 days of observation and mortality was absent within 48 hours @ 2.0 g / kg body weight in rats. The extracts were considered to be safe up to a maximum dose of 2000 mg/kg.

Among the five plants studied for *in vitro* efficacy *N. arbor-tristis* was observed as the best plant having *in vitro* anthelmintic efficacy followed by *B. monosperma*, *M. azedarach*, *E. stricta* and *F. hispida*. Based on the findings of the *in vitro* studies, *Nyctanthes arbor-tristis* and *Butea monosperma* were selected to undergo *in vivo* studies in birds artificially infected with *A. galli* worms. Oral treatment with ethanolic, hydroethanolic and aqueous extracts of *N. arbor-tristis* and *B. monosperma* did not show any signs of hyperactivity or behaviour alterations throughout the study period. The biological evaluation was carried out at doses of 100, 500 and 1000 mg/kg. No signs of toxicity were observed. Birds dosed with the extract continued to feed normally. In birds treated with ethanolic, hydroethanolic and aqueous extracts of *N. arbor-tristis* and *B. monosperma* at 100, 500 and 1000 mg/kg body weight, there were no significant differences on the 7<sup>th</sup> and 14<sup>th</sup> day post treatment. However, the difference in mean body weight gain of this group was significant ( $P < 0.05$ ) on 21<sup>st</sup> and 28<sup>th</sup> day post treatment. The changes in body weight were not dose dependent. The increase in body weight after treatment with *Nyctanthes arbor-tristis* and *Butea monosperma* were comparable to standard Piperazine treated group.

Almost all biochemical and haematological parameters showed a significant ( $P < 0.05$ ) increase from 14<sup>th</sup> day post treatment in all the groups, at all the doses and types of extracts of *N. arbor-tristis* used. However, *B. monosperma* leaf extract showed a significant ( $P < 0.05$ ) increase from 21<sup>st</sup> day post treatment in all the groups, at all the doses and types of extracts used. Piperazine treated group showed significant increase 14<sup>th</sup> day post treatment as compared to control. Treatment with ethanolic, hydroethanolic and aqueous extracts of *N. arbor-tristis* and *B. monosperma* caused a significant reduction in egg output in the droppings of treated birds from 7<sup>th</sup> day onwards upto 28<sup>th</sup> day in comparison with infected controls ( $P < 0.05$ ). Piperazine hydrate brought down the mean EPG from  $733.33 \pm 268.22$  at pre-treatment to  $106.67 \pm 23.33$  at 28<sup>th</sup> day post treatment. The ethanolic, hydroethanolic and aqueous extracts of *N. arbor-tristis* and *B. monosperma* at all the doses used showed an efficacy above 80% indicating that the plants are effective against *A. galli*. Piperazine treated group showed an efficacy of 88.99% and 93.15%. The ethanolic, hydroethanolic and aqueous extracts of *N. arbor-tristis* and *B. monosperma* at all the doses used showed FECR above 80 indicating that *A. galli* is not resistant to these two plants. Piperazine treated group showed FECR of 89 and 93 indicating that *A. galli* is prone to resistance to Piperazine as the 95% confidence level is 90 for standard drugs. The plant extracts not only depressed the faecal egg output but also significantly reduced the adult worms population in parasitized birds.

The total worm count at necropsy was significantly lower. Piperazine treated group showed no worm recovery.

In conclusion, extracts found to possess significant *in vitro* anthelmintic activity did not increase the biochemical or haematological values significantly. It is concluded that further study is needed, of longer duration, to study the anthelmintic activity against *A. galli* infection in poultry. The plant extracts not only depressed the faecal egg output but also significantly reduced the adult worms population in parasitised birds. This is desirable as it has the advantage of reducing the deleterious effects on individual birds and contamination of the environment with parasite eggs. *in vivo* studies indicated that both the plant extracts and *Piperazine hydrate* response did not differ significantly. The plant leaves crude extract can be used as alternative de-wormer. *Butea monosperma* and *Nyctanthes arbortristis* reduced FEC by 80%. FEC reductions greater than or equal to 70% was considered biologically significant.



## **Therapeutic Efficacy and Role of Cytokines on Wound Healing in Rats by Selected Medicinal Plants of Mizoram**

*C. Lalmuanthanga*

The present study was undertaken to evaluate the potential effect of methanol, chloroform and ether extracts of *Parkia timoriana*, *Securinega virosa*, *Abelmoschus moschatus*, *Scoparia dulcis* and *Blumea lanceolaria* in three different models of wound in rats, incision, burn, diabetic excision wound models and also the polyherbal formulation of the plants at three different combination in diabetic wound model in rats. The cytokine, IL- 6, TNF- $\alpha$  and IL-10, blood biochemical profile, histopathological examination of tissue, antimicrobial effect of different extracts of plant under study and the analysis of the antioxidant property of the plants were undertaken to find the correlation with the wound healing property of plant extracts.

The yields of methanol extract of *Parkia timoriana*, *Securinega virosa*, *Abelmoschus moschatus*, *Scoparia dulcis* and *Blumea lanceolaria* were 166.93gm (16.693%), 78.00 (7.80%), 60.00 (6.00%), 117.00 (11.70%) and 50.68 (5.068%) per 1000 gram of dry powder

The preliminary analysis of phytochemical constituent of plant shows that *Parkia timoriana* extract was found to contain tannins, saponins, flavonoids, terpenoids and alkaloids. *Securinega virosa* extract was found to contain tannins, flavonoids, terpenoids and alkaloids. *Abelmoschus moschatus* extract was found to contain tannins, flavonoids, terpenoids; alkaloids and phlobotannins. *Scoparia dulcis* extract was found to contain tannins, saponins, flavonoids, terpenoids and alkaloids and *Blumea lanceolaria* extract was found to contain flavonoids, phlobotannins, terpenoids, alkaloids and tannins. All the plant extracts were found to be safe @ 2000 mg/kg after testing the acute oral toxicity in rats and mice.

Topical administration of methanol, chloroform and ether extract of *Parkia timoriana*, *Securinega virosa*, *Abelmoschus moschatus*, *Scoparia dulcis* and *Blumea lanceolaria* in incision wound model in rats @ 10 and 20 % w/w ointment increased the

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**Major Advisor : Dr. D. C. Roy**

breaking strength of wound when compared with control and standard treated groups at  $P < 0.001$  significant level. An increasing trend in the total protein, albumin and globulin level of wound tissue was observed with some variation between control and the treated groups. The level of AST, ALT and glucose in the treatment groups were significantly lower than the control group at  $P < 0.05$  and  $P < 0.001$ .

The percent of wound contraction after topical application of 10 and 20% w/w ointments of methanol, chloroform and ether extracts of *Parkia timoriana*, *Securinega virosa*, *Abelmoschus moschatus*, *Scoparia dulcis* and *Blumea lanceolaria* in burn wound model in rats were significantly higher ( $P < 0.001$ ) on day 4, 8, 12 and 16 as compared to control group and standard group; but individual variation for significant different with standard drug treated group occurs amongst the plant extracts. There were remarkable fibroblast collective tissue proliferation, collagenation, mononuclear infiltration, angiogenesis, vascular engorgement and epithelialisation on histopathological examination. In excision diabetic wound model in rats, the methanolic, chloroform and ether extracts of *Parkia timoriana*, *Securinega virosa*, *Abelmoschus moschatus*, *Scoparia dulcis* and *Blumea lanceolaria* administered @ 250 and 500mg/kg P.O. showed significantly increased ( $P < 0.05$ ;  $P < 0.01$  and  $P < 0.001$ ) percent of wound contraction on day 4, 8, 12 and day 16 as compare to the control group and the epithelialisation time were significantly reduced. Regenerating skin appendages tissue proliferation, mononuclear infiltration which confirm the healing action which are quite comparable to the standard (Vitamin E) treated group. Biochemical analysis revealed that the blood glucose, protein, globulin and albumin levels in control groups are significantly higher in most of the cases and AST, ALT and *creatin kinase* are significant reduced at  $P < 0.05$ ;  $P < 0.01$  and  $P < 0.001$ .

The cytokine analysis of blood plasma on day 1 and day 9 of post wound creation and after treatment with plant extracts shows that the level of IL-6 and TNF- $\alpha$  were decreasing on day 9 as compared to the previous sampling. The different extracts of plants at two different dosing @ 10 and 20 % w/w ointment showed the significance difference ( $P < 0.05$ ;  $P < 0.01$  and  $P < 0.001$ ) between the groups. Contrary to the level of IL-6 and TNF-  $\alpha$ , the level of IL-10 was increased doubled fold or more on day 9 in all the treated groups. The topical application of Poly I MZ, Poly II MZ and Poly III MZ @ 20% w/w ointment each on diabetic incision wound showed significantly increased the breaking strength when compared to control group.

## **Evaluation of Wound Healing Properties of *Flacourtia jangomas* and *Pongamia pinnata***

*Farida Rahman*

The present study was undertaken to evaluate the wound healing property of hydroethanolic and chloroform extracts of two different medicinal based plant *Flacourtia jangomas* and *Pongamia pinnata* on excision, incision, dead space and diabetic wound model. Each experiment was carried out for 12 days separately. Extracts were prepared from the barks of *Flacourtia jangomas* and seeds of *Pongamia pinnata* plant. A total of 384 albino rats of Wistar strain were divided into two groups each for *Flacourtia jangomas* and *Pongamia pinnata* plant having eight subgroups consist of six rats per group. The extracts were applied topically at the dose rate of 1%, 2.5% and 5% on excision, incision and diabetic wound model. For dead space wound model extracts were administered orally at the dose rate of 100, 300 and 900 mg/kg body weight to evaluate the toxic effect of the extracts on different blood biochemical parameters along with its wound healing potential. Wound healing efficacy was assessed by the rate of wound contraction, epithelialization period, breaking strength for excision and incision wound model; wet and dry weight of granulation tissue and its hydroxyprolein content was measured for dead space wound model. *In vivo* antioxidant activity was also estimated in blood and tissues on the last day of the experiment. Phytochemical study of both the plant extract of *Flacourtia jangomas* and *Pongamia pinnata* revealed the presence of alkaloid, flavonoid, terpenoids, tannin, saponin, glycosides and steroid.

Result of the present study revealed, topical application of the ointments prepared from the respective plants exhibited its healing potential in a dose dependent manner at different significant level of ( $P < 0.05$ ,  $P < 0.01$ ,  $P < 0.001$ ), as evident from the decreased in wound size, epithelialization period and increased in tensile strength. Wet and dry weight of granulation tissue and its hydroxyprolein content were also well correlated with the healing pattern observed. Oxidative stress was also found to be ameliorated by the treatment with the plant extracts during healing process. On the other hand, toxicological evaluation of the extracts on different blood biochemical parameters,

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such as AST, ALT, ALP, glucose, cholesterol, creatinine total protein and urea did not show any significant alteration on 0 and 12<sup>th</sup> day of the experiment.

From the present study it can be concluded that both the plant extracts have good wound healing property and chloroform extract of *Pongamia pinnata* plant showed better efficacy and can be used commercially due to its easy availability.

# **Toxicological Analysis of Nanoparticles and Microparticles Used as Oral Vaccine Delivery Systems for Poultry**

*Anupam Datta*

The present study was conducted to monitor the follicular dynamics and hormonal profile of Assam local cows (Lakhimi) and the effect of exogenous kisspeptin-10 on the follicular dynamics and hormonal profile of Lakhimi cows. Six Lakhimi cows were maintained at experimental animal shed, Department of Veterinary Physiology, AAU, Khanapara-781022, which were healthy and regularly cyclic were utilized for the study. Using a linear array ultrasound scanner, the ovaries of each cow were examined every alternate day throughout the estrous cycle starting from observed estrus to subsequent standing estrus. The day-to-day diameters of follicles were profiled in a ovarian map. Blood samples were also collected from the jugular vein every alternate day for estimation of hormonal profiles and to observe the expression pattern of KiSS1 and KiSS1R. After these, all the animals were injected with exogenous kisspeptin-10 @ 1.3µg/kg b.wt. intravenously on the day of estrus and repeated the same experiments. Monitoring the follicular wave patterns revealed that 66.7% and 33.3% of Lakhimi cows exhibited 2 wave cycle and 3 wave cycle respectively. In two-wave cycle, the first and second wave emerged on day  $1.16 \pm 0.30$  and  $10.83 \pm 0.47$  while in three wave cycle, first, second and third wave emerged on day  $0.83 \pm 0.16$ ,  $7.33 \pm 0.49$  and  $12.16 \pm 0.47$  of the cycle. In two wave estrous cycle  $3.5 \pm 0.42$  and  $4.33 \pm 0.49$  number of follicles (>3 mm) emerged at first and second wave emergence while in three wave cycle  $3.83 \pm 0.47$ ,  $2.83 \pm 0.30$  and  $3.66 \pm 0.33$  number of follicles (>3 mm) emerged at first, second and third wave emergence in Lakhimi cows. Maximum size of the DF of the first and second follicular wave in two wave estrous cycle was  $8.49 \pm 0.49$  and  $11.51 \pm 0.54$  mm on the mean day  $6.83 \pm 0.40$  and  $20.16 \pm 0.30$  while maximum size of the DF of the first, second and third follicular wave in three wave cycle was  $9.41 \pm 0.87$ ,  $8.51 \pm 0.26$  and  $12.41 \pm 0.69$  mm on the mean day  $6.16 \pm 0.47$ ,  $15.5 \pm 0.56$  and  $20.33 \pm 0.33$  in Lakhimi cows. Dominant follicles at day 4 and day 6 of first follicular wave grew faster

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under kisspeptin treatment than untreated cows in three and two wave cycle respectively. The mean diameter of dominant follicle was also increased in kisspeptin treated than untreated cows. The concentration of progesterone (ng/ml) was found highest in Untreated and treated cows up to day 10 of estrous cycle ( $10.94 \pm 1.93$  and  $14.34 \pm 1.88$ ) for Untreated and treated cows respectively. It was found that the level of estradiol was highest on day before estrus (day 20) and on the day of heat (day 0) during estrous cycle for both the group. But, in the treatment group the level of estradiol (pg/ml) was significantly higher ( $p < 0.05$ ) on both day 0 ( $344.31 \pm 39.38$ ) and day 20 ( $273.30 \pm 40.30$ ) as compared to untreated animals. The LH profile was also evaluated in various stages of estrous cycle in Lakhimi cow to determine the efficacy of exogenous Kisspeptin. The level of LH was found highest on day 1 of estrous cycle and was found to be significantly higher in treated cows ( $13.24 \pm 1.48$ ) as compare to untreated ( $7.97 \pm 1.03$ ) animal.

# **Optimization of Culture Media for *in-vitro* Bovine Embryo Development: Growth Factors and Serum Influences**

*Dipannita Baishya*

The present experiment was conducted to study the effect of certain growth factors (EGF, IGF-1 and their combination) and serum influences on possible potentialization of culture media for *in vitro* cattle embryo development. In experiment I, 224 nos. of cattle ovaries were collected. The mean number ovarian follicles recovered per type-I ovary were 5.30 which was significantly higher ( $P \leq 0.001$ ) than the corresponding values 3.27 of the type-II ovaries. The mean recovery of cumulus oocyte complexes per type-I ovary was 3.41 and the corresponding value was 1.67 in type-II ovaries. Two different types of maturation and culture media viz: SBMM (Serum Basic Maturation Media) containing modified TCM-199+ serum (10%, Fetal Bovine Serum)+ Sodium pyruvate + glutamine + gentamicin + pFSH + hMG inj+ E2 (estradiol), SFBMM (Serum Free Basic Maturation Media) containing modified TCM-199 + PVP + BSA + Sodium pyruvate+ L-glutamine+ pFSH+ gentamicin + hMG inj+ E2 (estradiol), SBCM (Serum Basic culture media): mCR2aa stock +10%FBS+ Gentamicin, SFBCM (Serum Free Basic Culture Media) containing mCR2aa stock+ BSA-V+ PVP+ Gentamicin were used for *in vitro* maturation and *in vitro* culture of the oocytes. EGF (30ng) and IGF-1 (100ng) were added in maturation media as well as embryo culture media singly and in combination in both the groups of media. Frozen bull semen straws of proven fertility were used and prepared for *in vitro* capacitation by density gradient method using B.O. media. The results revealed a significant ( $P < 0.05$ ) increase in maturation rate in serum supplemented media than serum free media ( $75.43 \pm 3.25$  vs  $64.20 \pm 3.77$ ) based on cumulus cells expansion. The cleavage percentages of serum supplemented culture media was found to be significantly higher ( $P < 0.05$ ) than serum free culture media ( $70.33 \pm 3.21$  vs  $55.81 \pm 4.33$ ). In experiment -2: A total of 318 nos. of ovaries were collected with a recovery of 65 per cent culturable oocytes, representing 6.5 COCs per ovary. Growth factors EGF (30ng/ml), IGF-1 (100ng/ml) and their combination (EGF + IGF - 1) were used in serum basic and serum free basic maturation

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and culture media for the study. There was no significant difference in respect of maturation, fertilization and embryonic development between EGF supplemented, IGF-1 supplemented and their combination (EGF+IGF-1) in serum and serum free basic culture media. However, when compared with the results of serum free basic maturation media supplemented with 30ng EGF and serum basic maturation media without EGF, the mean *in vitro* maturation percentage based on extrusion of polar body were found to be significantly higher ( $P<0.05$ ) in supplemented media than the serum basic maturation media ( $70.00\pm 14.49$  vs  $54.17\pm 7.19$ ). Similarly, when comparison was made with IGF-1 supplemented serum free basic maturation media with serum basic maturation media without IGF-1, the *in vitro* maturation percentage based on cumulus cells was found to be significantly higher ( $P<0.05$ ) than serum basic maturation media ( $67.27\pm 6.33$  vs  $75.43\pm 3.25$ ). However, in case of serum free basic maturation media supplemented with 30ng EGF+100ng IGF-1, the mean *in vitro* maturation percentage based on extrusion of polar body was significantly higher ( $P<0.05$ ) than serum basic maturation media ( $80.00\pm 10.33$  vs  $54.17\pm 7.19$ ). The efficacy of EGF supplemented serum free basic culture media and serum basic culture media in respect of cleavage and early embryonic development was comparable at cleavage (2-cell) and blastocyst stage, while significantly higher ( $P<0.05$ ) values were observed in 4 cell ( $57.14\pm 4.83$  vs  $47.25\pm 4.86$ ), 8 cell ( $45.71\pm 4.83$  vs  $31.87\pm 4.99$ ) 16 cell ( $37.14\pm 4.72$  vs  $20.88\pm 3.21$ ) and morula stage ( $27.62\pm 4.36$  vs  $7.69\pm 4.32$ ) in EGF supplemented serum free culture media than serum basic culture media. Similarly, when the efficacy of IGF-1 supplemented serum free basic culture media were observed, no significant difference was obtained in 2-cell, 4-cell and blastocyst stages. On the contrary, the serum supplemented media showed significantly higher ( $P<0.05$ ) 8-cell ( $45.71\pm 4.86$  vs  $31.87\pm 4.99$ ), 16-cell ( $37.14\pm 4.72$  vs  $20.88\pm 3.21$ ) and morula stage ( $27.62\pm 4.36$  vs  $7.69\pm 4.32$ ) than serum basic culture media. EGF+IGF-1 supplemented serum free basic culture media when compared with serum basic culture media, significantly higher ( $P<0.05$ ) values were found in respect to 2-cell ( $79.63\pm 2.35$  vs  $70.33\pm 3.21$ ), 4-cell ( $65.00\pm 4.83$  vs  $47.25\pm 3.23$ ), 8 cell ( $56.00\pm 3.42$  vs  $31.87\pm 4.99$ ) 16 cell ( $48.00\pm 4.72$  vs  $20.88\pm 3.21$ ) morula ( $37.00\pm 2.13$  vs  $7.69\pm 4.32$ ) and blastocyst stage ( $10.23\pm 2.08$  vs  $4.40\pm 3.11$ ). From the above findings, it can be concluded that addition of EGF and IGF-1 in combination in serum free basic maturation media has better stimulatory effect on nuclear maturation of oocytes in comparison to EGF and IGF-1 supplementation individually. EGF and IGF-1 in combination in Serum Free culture media significantly increased blastocyste rates when compared with serum based culture media.



# **Physiological, Behavioural and Molecular Changes in Piglets in Response to Weaning Stress**

*Gloria Tigga*

The present experiment was conducted to study the effect of weaning stress on various physiological, biochemical, hormonal, hematological response including behavioural changes and pattern of gene expression profile of HSP27, HSP70 and HSP 90 in piglets weaned at different age. The present investigation was carried out in Hampshire x Ghungroo cross-bred piglets of instructional farm of NRC on pig, Rani. Three litters of six piglets were taken for the study and were weaned at different age of 28 days (Gr-I), 35 days (Gr-II) and at 42 days (Gr-III).

Blood collection was scheduled from the day of weaning (0d) , 7<sup>th</sup> day, 15day followed by subsequent collections at 15 days interval up to six months of age. Physiological and behavioural studies were done at the piggery farm and molecular studies were done in the laboratory of NRC on pig, Rani whereas biochemical, hormonal and hematological studies were conducted in the laboratory of the department of Biochemistry, Nuclear research laboratory of the department of Physiology and in the laboratory of Teaching Veterinary Clinical Complex of C.V.Sc., Khanapara, Guwahati respectively.

No significant difference was found in average growth rate and body weight at maturity among the groups. There was significant difference in rectal temperature (day 30, 45 and 60) and respiration rate (day 0 and 15) found between Gr-I and Gr-II. The mean heart rate (beats/ minute) was found towards decreasing trend in all the groups.

The level of biochemical indices were found to be varied within normal range on day 15 post-weaning and the variations in the level in later part were found to be associated with hormonal level and age related. Higher level of phosphorus was found in piglets of Gr-III as compared to Gr-I and Gr-II. During the initial phase of experimental period significantly lower level of iron was found in piglets of Gr-I as compared to Gr-II (day 15 and 30) and Gr-III (day 0 and 15). Significantly higher level ( $P<0.001$ ) of zinc was found in Gr-III as compared to Gr-I and Gr-II from day 75 onwards. Significantly lower level of copper was found in Gr-II as compared to Gr-I and

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Gr-III on day 15 and 30 which may be the cause of subnormal hemoglobin level (%) in this group during this period. The range of cortisol level was comparatively higher throughout the experimental period.

Significant differences ( $p < 0.001$ ) were found in the level of hematological parameters *viz* TEC, Hb% and PCV between younger and older pigs on day 0 to 45. Significantly higher level of neutrophils and cortisol were observed in younger piglets. Initially, there was increase in neutrophil (%) and decrease in lymphocyte (%) indicating a stress response on day 15 post-weaning in all the groups, with significantly higher level in Gr-I. The mean values of DLC *viz.* neutrophil (%) (day 15, 30, 45, 60, 75, 90) and lymphocyte (%) (day 30, 45, 60, 75, 90) were found to be significantly higher and lower respectively in Gr-I as compared to Gr-II.

Significantly higher number of feeding bouts ( $P < 0.05$ ) and higher level of aggression ( $P < 0.05$ ) on d+2 and d+7 was observed in Gr-III compared to Gr-I and Gr- II. The level of mRNA expression of HSPs *viz;* HSP27, HSP70 and HSP90 were found to be increased significantly ( $P < 0.001$ ) on day 7 in piglets of Gr-I. Significantly higher level of mRNA of HSP90 was expressed in Gr-I on day 15 as compared to piglets of Gr-II and Gr-III` indicating that adaptive process were slower in younger piglets.

# **Effect of Selenium and Zinc-Oxide Nanoparticles on Cryopreserved Semen Quality and Fertility of Assam Hill Goat**

*Sayed Nabil Abedin*

Nanoparticles (NPs), due to their smaller size and unique surface properties can be incorporated into a variety of reproductive biology procedures. The present investigation was carried out from September, 2021 to July, 2022 on four (4) Assam Hill Goat bucks (10 ejaculates per buck) to investigate the effect of supplementing zinc oxide (ZnO) and selenium (Se) NPs in TRIS extender on seminal attributes, lipid peroxidation (LPO) profile, antioxidant enzyme activities *viz.*, superoxide dismutase (SOD), catalase (CAT) and Glutathione-S-transferase (GST), relative heat shock protein (HSP) mRNA levels and fertility of cryopreserved Assam Hill Goat semen. The size morphology and zeta potential values of ZnO and Se NPs were evaluated. Qualified semen samples were divided into five (5) aliquots and then diluted in TRIS extender containing ZnO and Se NP supplementation at different concentrations (T0: control; T1: 0.1mg/mL ZnO NPs; T2: 0.5 mg/mL ZnO NPs; T3: 0.5 µg/mL Se NPs and T4: 1 µg/mL Se NPs). Diluted semen was packed in 0.25 mL straws and then stored in liquid nitrogen. After thawing, post-thaw attributes *viz.*, motility, viability, morphology, plasma membrane integrity (PMI), DNA integrity and mitochondrial membrane potential (MMP) were evaluated. The different treatment groups were also checked for potential NP internalization under transmission electron microscope (TEM). Lastly, straws from the best among the ZnO and Se NP treatments were used for artificial insemination (AI) in does (n=35) synchronized by Ovsynch protocol.

Results showed that ZnO and Se NPs were poly-crystalline in nature with particle size below 100 nanometers. The evaluated post-thaw sperm *in vitro* attributes were significantly ( $p<0.05$ ) higher in groups containing ZnO and Se NPs supplementation in comparison to control group. Overall, ZnO NPs @ 0.1 mg/mL (T1) had significantly ( $p<0.05$ ) higher post-thaw sperm *in vitro* attributes in comparison to Se NPs @ 1 µg/mL. ZnO and Se NP supplementation also significantly ( $p<0.01$ ) lowered cryocapacitated (B and AR pattern) spermatozoa in comparison to control. The antioxidant

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enzyme activities (SOD, CAT and GST) were significantly ( $p < 0.001$ ) higher in T1 in comparison to T0. The LPO was significantly ( $p < 0.001$ ) lowered in T1, T2, T3 and T4 in comparison to T0. The leakages of functional enzymes *viz.*, aspartate aminotransferase (AST), alanine aminotransferase (ALT) and lactate dehydrogenase (LDH) were significantly ( $p < 0.001$ ) lower in T1 in comparison to other groups. Post-thaw sperm motility and MMP had a highly significant ( $r = 0.580$ ,  $p < 0.05$ ) association in T1. SOD ( $r = 0.445$ ) and CAT ( $r = 0.949$ ) had a highly significant ( $p < 0.05$ ) correlation with sperm motility in T1. No internalization of ZnO and Se NPs were observed under TEM. HSP70 and HSP90 mRNA levels were significantly ( $p < 0.001$ ) higher in T1 in comparison to other groups. HSP70 and HSP90 expression levels had a significant ( $p < 0.05$ ) positive correlation with motility in group T1. No significant ( $p > 0.05$ ) differences in pregnancy rates following AI were recorded among the different treatment groups in comparison to control. In conclusion, extender supplemented with 0.1 mg/mL ZnO NPs improved post-thaw semen quality of cryopreserved Assam Hill goat spermatozoa consequently by lowering lipid peroxidation and increasing expression of cryostress associated heat shock genes.

**Keywords:** Zinc oxide, Selenium, Nanoparticles, Assam Hill Goat, Semen quality, Heat shock proteins, lipid peroxidation

## **Ultrasonographic Monitoring of Ovarian Follicular and Luteal Dynamics in Cow**

*Vanlalngilneii Ralte*

The ovarian follicular and luteal dynamics, blood flow pattern in the corpus luteum (CL) including the pattern of follicular wave and luteal development were studied using portable ultrasound device with 5-10 MHz linear array transrectal probe in female Crossbred and Lakhimi, indigenous cattle breed of Assam. In the experiment, twelve each cyclic Crossbred (Jersey X L) and Lakhimi (L) cows were subdivided into two groups *viz.* Group-I/Natural or Spontaneous oestrus and Group-II/Induced or Synchronized oestrus for each breed comprising of six cows in each group. They were evaluated in the subsequent cycle of natural luteolysis (Group-I) and induced luteolysis by prostaglandin F<sub>2</sub> $\alpha$  (Group-II) and circulating steroids were estimated on alternate days of the cycle. From scanning the ovaries for two inter-ovulatory cycle the experimental cows exhibited two and three follicular waves per cycle. Most of the cows 30(62.50 %) exhibited 3-wave cycle and 18(37.50 %) had 2-wave cycle. The diameter of 12.4 mm and 10.5 mm were the threshold diameter for ovulation according to follicle diameter in crossbred and Lakhimi cows, respectively. The inter-ovulatory interval (IOI) was found to be significantly longer ( $P < 0.05$ ) in Crossbred cows experiencing 3-wave (21-22 day) than 2-wave (20-21 day) per cycle. The first wave emerged on day 0 (day of ovulation) to day 1 of cycle with mean day of  $0.13 \pm 0.12$  to  $0.83 \pm 0.38$  in both the breed and group. The second wave onset was significantly ( $P < 0.05$ ) earlier ( $9.00 \pm 0.19$ ,  $8.50 \pm 0.22$ ) in 3-wave cycle than the 2-wave cycle ( $10.50 \pm 0.29$ ,  $10.67 \pm 0.21$ ) in both Crossbred and Lakhimi cows. The average number of follicles ( $\geq 2$  mm) observed on wave onset was 10-13 in Crossbred and 9-13 in Lakhimi cows. The first wave dominant follicle (DF) became deviated in between day 3 to 4 in both the breeds, while the second wave DF deviated on day 11-12 in Crossbred and day 10-11 in Lakhimi cows exhibiting 2-wave cycle. Deviation of the third DF occurred on day 17-18 in both the breeds. Maximum mean diameter of DF in the second waves recorded as  $8.74 \pm 0.52$  and  $7.70 \pm 0.27$  mm in Crossbred and Lakhimi cows respectively in 3-wave cycles was

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significantly smaller ( $P < 0.05$ ) than the second wave DF diameter ( $12.83 \pm 0.65$  and  $10.53 \pm 0.76$  mm) in 2-wave cycles in both crossbred and Lakhimi cows. The DF maximum diameter was attained significantly ( $P < 0.05$ ) earlier in 3-wave cycle in both the first and second wave than in 2-wave cycle. The average growth rate of ovulatory DF in 3-wave cycle was 1.19 and 1.37 mm/day in Group-I and II respectively in Crossbred while, 0.88 and 1.18 mm/day in Group-I and II respectively in Lakhimi. The dominant follicles of the first wave (non-ovulatory) began atresia on day  $8.0 \pm 0.41$  at the rate of 1.36 to 1.53 mm/day in Crossbred cow and on day  $7.75 \pm 0.25$  at the rate of 0.97 mm/day in Lakhimi cows. The developing CL was detected on day 0 to day 1 in both Crossbred and Lakhimi cows. Maximum diameter (mm) of the CL for the two and three follicular wave cycle in Lakhimi ( $15.29 \pm 0.64$  mm and  $15.08 \pm 0.45$  mm) were significantly smaller ( $P < 0.05$ ) than in Crossbred cows ( $22.98 \pm 0.87$  mm and  $21.94 \pm 0.66$  mm). Onset of luteal regression of the 2-wave cycles (day 12 to 13) was significantly earlier ( $P < 0.05$ ) than in the 3-wave cycle (day 15 to 16). In early luteal phase (day 0 to 5) the Doppler signal increased to  $65.73 \pm 5.02$  mm<sup>2</sup> in Crossbred and  $57.30 \pm 9.83$  mm<sup>2</sup> in Lakhimi. During the mid-luteal phase (day 7 to 13) the area gradually increased to  $119.82 \pm 5.54$  mm<sup>2</sup> in Crossbred and  $93.82 \pm 4.12$  mm<sup>2</sup> in Lakhimi cows then rapidly declined in the late luteal phase (day 15 to 18) to  $10.66 \pm 2.02$  mm<sup>2</sup> in Crossbred and  $11.99 \pm 5.38$  mm<sup>2</sup> in Lakhimi. Similar pattern was observed in 2-wave cycle. On the day of oestrus, the mean serum Oestradiol-17 $\beta$  level ranged from  $35.75 \pm 0.64$  to  $51.01 \pm 2.13$  pg/ml in Crossbred and  $32.43 \pm 0.74$  to  $35.74 \pm 0.97$  pg/ml in Lakhimi while the serum progesterone level ranged from  $0.58 \pm 0.71$  to  $1.27 \pm 0.33$  ng/ml in crossbred and  $0.43 \pm 0.77$  to  $0.47 \pm 0.76$  ng/ml in Lakhimi cows. There was a positive correlation between LBF area and progesterone level in 2-wave crossbred ( $r = 0.92$ ), 2-wave Lakhimi ( $r = 0.82$ ), 3-wave crossbred ( $r = 0.81$ ) and 3-wave Lakhimi ( $r = 0.90$ ) during the cycle. There was positive correlation between DF size and oestradiol level in 2-wave ( $r = 0.40$ ) also in 3-wave crossbred and Lakhimi cows ( $r = 0.41$ ). Negative correlation was observed between DF size and progesterone level in 2-wave ( $r = -0.47$ ) and in 3-wave ( $r = -0.40$ ) in crossbred and Lakhimi cows.

# **Circulation of Japanese Encephalitis Virus in Mosquito Vectors, Amplifying Hosts and Its Association with Human Incidences in Assam**

*Aditya Baruah*

Japanese encephalitis (JE) is a re-emerging mosquito-borne flaviviral zoonotic disease and a major cause for concern to childhood mortality and morbidity in countries of Southeast Asia including India. The disease has appeared in sporadic as well as epidemic forms since 1976 in Assam. The present study was envisaged to study the sero-prevalence of JE in pigs, the density pattern of mosquito vectors in JE endemic localities and to draw an association between the occurrence of JE in humans with serological studies in pigs and mosquito density.

A total of 200 blood samples of pigs were collected during the study period (June-September, 2021) from Lakhimpur district of Assam. Out of these screened samples, 19% were found positive for antibodies against JEV. The sero-prevalence in different months was observed to be: June (16%), July (28%), August (20%) and September (12%). Sero-prevalence in Urban areas and Peri-Urban areas was observed to be 17.5% and 20%, respectively. The sero positivity in pigs based on their rearing practice in study area was recorded highest in Semi Intensive (25%) followed by intensive (17.5%), tethering (13.33%) and least in scavenging (10%). The rearing of other animals like ducks, poultry had significant relationship on JE seropositivity in pigs. The presence of stagnant water, water tanks, paddy field in the proximity of the pig farms showed higher sero-positivity ( $p < 0.01$ ).

A total of 8 different species of mosquitoes were identified of which the most predominant was recorded to be *Culex tritaeniorhynchus* (26.58%) followed by *Mansonia* spp. (15.93%), *Culex vishnui* (15.43%), *Culex quinquefasciatus* (14.67%), *Culex gelidus* (10.60%), *Culex fuscocephala* (10.50%), *Culex whitmorei* (4.01%) and *Anopheles* spp. (2.23%).

The envelope E gene of JEV virus was detected from tonsils of pig, pig blood samples, aborted foetus and two pools of mosquitoes viz. *Culex tritaeniorhynchus* and *Mansonia* spp.

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**Department : Veterinary Public Health**

**Major Advisor : Dr. P. Hussain**

A positive correlation was observed between human JE cases and JEV seroprevalence in pigs of Lakhimpur district of Assam where virus was also found to be circulating amongst the collected mosquito indicating an association between them.



# **Sero-Prevalence of West Nile Virus in Poultry Correlating with Mosquitoes in Urban and Peri- Urban Areas of Guwahati**

*Archana Talukdar*

West Nile virus (WNV), an arthropod-borne virus of public health importance is a member of the genus *Flavivirus* belonging to the Japanese encephalitis virus antigenic complex under family Flaviviridae. In Assam, although poultry rearing has traditionally been popular, most of the farmers lack proper scientific knowledge and technique, thereby increasing their risk to contact with different zoonotic diseases. The present investigation was carried out from April, 2018 to March, 2019 to collect baseline data on poultry farms, study the sero-prevalence of WNV in chicken, study the density pattern and determine the infection rate of mosquitoes with WNV and to prepare WNV prevalence map in urban and peri-urban areas of Guwahati. A total 8 locations comprising of 4 locations each for urban areas *viz.*, Chandmari, Hatigaon, Noonmati, Khanapara, and peri-urban areas of Guwahati *viz.*, Jugukuchi, Kamalajari, Garal and Gadebari were selected.

Baseline data revealed that most of the farmers were educated up to higher secondary (41.67%) level and below 46 years (66.67%), rearing both broiler and indigenous chickens in moderately clean or unhygienic farms (83.33%) with 58.33% of the birds being dirty. Presence of in-contact other animals, including cows, pigs, goats, ducks, quails, pigeons and dogs were recorded in 66.67% of farms and majority of the farmers (54.17%) did not consult veterinarian. Vaccination was practiced in 91.67% farms and the farmers used unsafe method of waste and carcass disposal. Screening of a total of 864 serum samples of chickens by ELISA and further confirmation by HI revealed the overall sero-prevalence of WNV to be 3.13%, with 0.69% sero-positivity in urban compared to 5.56% in peri-urban areas. WNV sero-prevalence was recorded in 1 urban and 3 peri-urban locations showing peak sero-prevalence during monsoon (7.29%). Highest sero-prevalence of WNV was recorded in Jugukuchi (11.11%) of peri-urban Guwahati. Sero-prevalence of WNV was significantly very high ( $P < 0.001$ ) in farms having in-contact other animals, stagnant water and agriculture. The association

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**Department : Veterinary Public Health**

**Major Advisor : Dr. Razibuddin Ahmed Hazarika**

between flock size and sero-prevalence of WNV was found highly significant ( $P < 0.01$ ). A total of 21,267 mosquitoes trapped during 1 year study period belonged to 5 genera viz. *Culex*, *Mansonia*, *Aedes*, *Anopheles* and *Armigeres* and 12 different species. Density pattern of mosquitoes revealed *Cx. quinquefasciatus*, *Cx. vishnui* group, *Ma. uniformis*, *Cx. bitaeniorhynchus*, *Ar. subalbatus*, *Ma. annulifera* and *Ae. albopictus* to be dominant species with most predominant species being *Cx. quinquefasciatus* (36.51%). Real time one-step RT-PCR of a total of 288 pooled mosquito samples detected NS5 gene of *Flavivirus* in 26 *Culex* and *Mansonia* mosquito pools. Sanger sequencing of representative amplicons of *Flavivirus* appeared to be negative for WNV but positive for Usutu virus, a mosquito-borne flavivirus which is closely related to WNV. The farms with WNV sero-prevalence in urban and peri-urban areas of Guwahati were spotted and mapped based on their latitude and longitude, which will be of immense support in future for strategic planning to control vector-borne diseases in those areas.

# **Occurrence of Extended Spectrum Beta-Lactamase Producing *Escherichia coli* and *Klebsiella pneumoniae* in Commercial Chicken of Urban and Peri-Urban Farms of Guwahati**

*Chandrani Goswami*

Spread of ESBL producing *E. coli* and *K. pneumoniae* to humans through food substances, including chicken is of major importance as beta lactam are the most favored class of antibiotics for the treatment of bacterial infection. In Assam, although chicken rearing has traditionally been popular, knowledge, attitude and practices (KAP) indicators of the farmers about antimicrobial usage and antimicrobial resistance (AMR) are lacking. The present investigation was carried out from April, 2021 to September, 2022 to collect baseline data on chicken farmers' KAP on antibiotics, their usage and AMR, study the occurrence of ESBL producing *E. coli* and *K. pneumoniae* in chicken by phenotypic and molecular methods, study the genetic diversity among representative *E. coli* and *K. pneumoniae* isolates based on 16S rRNA sequencing and to prepare ESBL producing *E. coli* and *K. pneumoniae* prevalence map in urban and peri-urban commercial chicken farms of Guwahati. A total of 12 locations from urban and peri-urban areas and a total of 10 chicken meat selling markets from urban areas of Guwahati were selected for the study.

Baseline data revealed that most of the farmers were educated up to higher secondary (36.11%) level. In-contact animals, including cows, pigs, goats, ducks, pigeons, fish, cats, and dogs were recorded in 72.22% of total farms. Most farmers (38.89%) sell farm waste after completion of single batch of broiler rearing. Dumping (55.56%) was the most common practice for disposal of dead chickens. Farms (27.77%) were found to be dirty. Urban and peri-urban commercial chicken farmers exhibited poor knowledge and attitudes on usage of antibiotics and AMR.

The overall prevalence of ESBL producing *E. coli* and *K. pneumoniae* was 20.10% and 10.39%, respectively. Highest prevalence of ESBL producing *E. coli*

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(33.80%) and *K. pneumoniae* (29.63%) was recorded during monsoon season. Antibigram assay for phenotypic confirmation of all *E. coli* and *K. pneumoniae* recorded resistance to cefpodoxime and ceftriaxone, respectively. ESBL E-test was recorded to be more effective than CDT. Resistance to at least three classes of antibiotics was revealed by 92.73% of the ESBL producing *E. coli* and 88.42% of the ESBL producing *K. pneumoniae*. All the ESBL producing *E. coli* and *K. pneumoniae* carried blaCTX-M, blaTEM and blaSHV genes, which were present either alone or in combination with one another.

# **Comparative Studies on Wastewater Quality Associated with Livestock Farms, Hospitals and Industries in and Around Guwahati City of Assam**

*Koushik Kakoty*

The physicochemical and bacteriological qualities of wastewater appear to be poorly understood in Assam, and research works into the effects of wastewater are insufficient. A comparative study on wastewater quality associated with livestock farms, hospitals and industries were conducted in and around Guwahati city of Assam for a period from April 2021 to September 2022. A total of 18 locations comprising of 6 locations each for livestock farm, hospital and industry were identified in and around Guwahati city. Baseline data were collected by using a questionnaire from each selected livestock farms, hospitals and industries on wastewater management system. Majority of the livestock farm workers (41.67%) and industrial workers (50.00%) belong to the age group of 31-45 years whereas, hospital workers (50.00%) belonged to the age group of 18-30 years. In all the sectors male were predominant. Majority of the livestock farm workers (66.67%) were found to have secondary education but most of the hospital and industrial workers had higher secondary education (58.33%). In livestock farm, a smaller number of sewage treatment plant (16.67%) was recorded and all the sectors neither reuse nor sampled their wastewater. Most of the livestock farm workers were unaware of wastewater management and the use of protective equipment was less in comparison to hospital and industrial workers. The mean physicochemical parameters such as pH, turbidity, total dissolved solid, total suspended solid, total solid, biological oxygen demand and electrical conductivity were higher in livestock farm wastewater than hospital and industrial wastewater. Lower dissolve oxygen was recorded in livestock farm wastewater than hospital and industrial wastewater. Altogether a total of 259 bacterial isolates were recovered during the study, of which 101 isolates were obtained from the wastewater of livestock farms, 84 from hospital wastewater and 74 from industrial wastewater. Overall prevalence rate of *E. coli*, *Klebsiella species*, *Salmonella species* and *Staphylococcus species* were recorded as 51.35%, 16.22%,

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**Major Advisor : Dr. R. A. Hazarika**

20.84% and 11.58%, respectively. *E. coli*, *Klebsiella species* and *Staphylococcus species* showing highest resistance against Ceftriaxone (65.41%, 54.76% and 63.33%) and *Salmonella* showing more resistance against Cefotaxime (46.29%). The prevalence of antimicrobial resistance gene *bla*TEM (20.00%) is higher in *E. coli*, *bla*CTX-M (28.00%) in *Klebsiella species* and *sulI* (15.00%) in *Salmonella species*. The predominance of *nuc* and *mecA* gene in *Staphylococcus species* were 95.00% and 10.53%, respectively. In the present study the various physico-chemical parameter limits of wastewater collected from livestock farms, hospitals and industries were found higher than that of WHO prescribed limits. Discharging such untreated wastewaters into water bodies is responsible for major source of water pollution leading to outbreaks of diseases and presence of antibiotic resistant bacteria continues to pose a significant public health problem.

# **Bacteriological Quality and Molecular Detection of Food-Borne Bacterial Pathogens in *Saum*, an Ethnic Food of Mizoram**

*Lallawmzuali Ralte*

*Saum* (a fermented pork fat) is one of the most favourite ethnic foods of the Mizo society. Due to lack of documentation and scanty literature as well as the limited scientific knowledge on *Saum*, the present study was carried out for a period of two year from November 2017 to October, 2019 to collect baseline data on the usage of *Saum*, to study the bacteriological quality and to isolate, identify and detect important food-borne bacterial pathogens viz., *Escherichia. coli*, *Staphylococcus aureus*, *Listeria monocytogenes* and *Salmonella* spp. and to study the antimicrobial resistance as well as to detect the virulence gene of the isolates in *Saum* by PCR. The study area was divided into three agro-climatic zones, viz., Humid Mild Tropical Hill Zone (Western zone); Humid Subtropical Hill Zone (Central zone) and Humid Temperate Sub-alpine Zone (Eastern zone). A total of 120 *Saum* samples collected and 120 questionnaires prepared comprising of 40 each (*Saum* samples and questionnaires) for each zones were sub-divided into 20 (household) and 20 (market) within each zones. The baseline data revealed that out of 120 respondents, the male and female ratio were 1:1 and majority were 40-59 years old (57.50%), educated up to matriculation (27.50%) with 45.00% Government servant. The families reared poultry (34.2%), pig (29.2%), cattle (2.5%) and goat (0.8%) and out of them 33.3% families reared livestock for business purposes. The homemade *Saum* was used by 57.5% families. *Saum* (once procured) were used more than 2 months (31.7%), 1 month (25.0%), 2 weeks (21.7%) and 1 week (21.7%) interval of time. Most of the families (74.17%) never mix old and new *Saum*. Mizo families used plastic sachets (38.3%), glass bottle (34.7%), bottle guard (23.3%) and steel container (3.3 %) for *Saum*. The families stored *Saum* at refrigerator (75.83%), near the fire (22.5 %) and under the sun (1.7%). The families took *Saum* directly (52.5%) while 90.83 % families used *Saum* as seasoning for food and 70.8% families

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**Department : Veterinary Public Health**

**Major Advisor : Dr. Poznur Hussain**

took same preparation of *Saum* more than once. Stomach pain was not recorded in 97.5% and absence of diarrhoea in 100% families due to *Saum*. Positive samples for coliform organisms and faecal streptococcal organisms were 65.00% and 72.5%, respectively. The overall acceptable *Saum* samples ( $m = 10^2$  in 2 class plan) were 44.2% and 33.3%, in Coliform Count (CC) and Faecal Streptococcal Count (FSC), respectively. From all the three zones ( $n=20$ ), the highest contaminated household and market were the Eastern zone household with mean value  $1.82 \pm 0.30$  and  $2.45 \pm 0.18$   $\log_{10}$  cfu/g in CC and FSC and the Western zone Market with  $2.16 \pm 0.19$  and  $2.80 \pm 0.09$   $\log_{10}$  cfu/g in CC and FSC, respectively. Overall ( $n=40$ ) in three zones; the Central zone *Saum* samples was the lowest contaminated with 18% and 52.5% positive sample with mean value of  $1.07 \pm 0.18$  and  $1.09 \pm 0.18$   $\log_{10}$  cfu/g in CC and FSC, respectively and the Western zone *Saum* sample was the highest contaminated zones with 35% positive each with mean value of  $1.19 \pm 0.15$  and  $2.23 \pm 0.16$   $\log_{10}$  cfu/g for CC and FSC, respectively. Out of 120 *Saum* samples, 28, 34, 6 and 4 numbers of *E. coli*, *S. aureus*, *L. monocytogenes* and *Salmonella* spp. were isolated and detected with overall prevalence rate of 23.33%, 28.33%, 5 % and 3.33 % and the 95% Confidence Interval rate were 16%-31%, 20 %- 37 %, 0.9%-8.3% and 1.5- 10.6%, respectively. The highest resistance against ceftriaxone was showed by *E. coli* (42.86%) and *S. aureus* (82.35%) and 100% resistance was showed by *Listeria monocytogenes* against amikacin, ceftriaxone, cefoxitin, kanamycin and nalidixic acid, and *Salmonella* spp. recovered showed 100% resistance against imipenem, nalidixic acid and tetracycline. The virulence genes of 5 *est* gene of *E. coli*, 21 *sea* genes of *Staphylococcus aureus*, 2 *invA* genes of *Salmonella* were detected in *Saum* sample.



# **Molecular Epidemiology of *Mycobacterium tuberculosis* Complex (MTC) and *Mycobacterium avium* subsp. *paratuberculosis* in Peri-Urban and Urban Dairy Farms of Guwahati**

*Nur Abdul Kader*

Bovine tuberculosis (bTB) and paratuberculosis (JD) are the two most common diseases caused by pathogenic mycobacterial species in livestock. Bovine tuberculosis is a chronic type of neglected zoonotic disease caused by *Mycobacterium bovis* which is distributed worldwide. The present study was carried out from December, 2020 to November, 2021 and envisaged to collect the baseline data from peri-urban and urban dairy farms of Guwahati following questionnaire method and molecular detection of *Mycobacterium tuberculosis* complex (MTC) and *M. avium* subsp. *paratuberculosis* (MAP) using specific primer on the targeted DNA. Farms (36) were identified from 12 different locations and the GPS coordinates of latitudes and longitudes of the selected farms were recorded. A total of 360 animals (10 from each farm) were initially screened by SICCT to determine the prevalence of bTB. PCR was carried out from 620 samples for detection of bTB (milk: 360, nasal swab:150 and tissue samples from slaughtered cattle: 110) and for detection of paratuberculosis, 220 samples (milk:100; intestine: 60 and fecal: 60) were targeted.

Baseline data revealed that 61.11% respondents were of illiterate, 66.67% had no awareness about bovine tuberculosis and 41.67% consumed unprocessed milk and milk products. SICCT depicted 38 cattle to be positive reactors for bTB, yielding the overall prevalence of 10.55%. Age group 5 years and above was found to be more susceptible for bTB (17.18%). PCR of 16 (4.44%) milk samples showed presence of *Mycobacterium* genus specific *hsp65* gene and two milk samples revealed the presence of MTC DNA by amplifying the IS6110 sequence. Presence of *hsp65* gene was detected only in 1 (0.6%) nasal swab whereas, out of 110 tissue samples, 24 (21.81%) were detected as genus *Mycobacterium* by the presence of *hsp65* gene in PCR. IS6110 & IS1081 PCR confirmed the presence of MTC DNA in tissue samples 15 (13.36%) and 18 (16.36%), respectively. Speciation of MTC DNA showed 8 (7.27%) and 5 (4.54%)

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**Department : Veterinary Public Health**

**Major Advisor : Dr. A. G. Barua**

by amplifying 500 bp fragments and RD4 region, respectively. Most of the MTBC positive samples in conventional PCR, were detected as positive by real-time PCR targeting insertion element IS6110 and IS1081 with Ct values ranging from 13.45 to 34 and 12.88 to 33, respectively. In molecular detection of paratuberculosis, 7/60 (11.66 %) intestinal samples and 1/60 (1.66%) fecal samples showed the presence of both *hsp65* and MAP specific IS900 gene and their identities were confirmed by sequencing.

The study highlighted the wide spread prevalence of bovine tuberculosis and paratuberculosis in peri-urban and urban dairy farms and it is of utmost importance to undertake a comprehensive epidemiological study and implementation of one health approaches for strategic control and prevention of bTB and MAP.

## **Surgical Sterilization of Captive Sambar Deer (*Cervus unicolor*)**

*Deepjyoti Deka*

Eighteen clinically healthy captive sambar stags, weighing 80-110kgs were divided into three groups, containing of 6 calves in each group, where group-A received xylazine hydrochloride @ 1.5 mg/kg and ketamine hydrochloride @ 2.5 mg/kg bodyweight intramuscularly, group-B received xylazine hydrochloride @ 1.5 mg/kg and tiletamine-zolazepam @ 2.5mg/kg bodyweight intramuscularly and group-C received xylazine hydrochloride @ 1.5 mg/kg + and azaperone @ 1mg/kg bodyweight intramuscularly.

The induction time and recovery time were  $11.83 \pm 1.07$  and  $36.66 \pm 0.95$  minutes respectively in group-A,  $5.16 \pm 0.30$  and  $59.83 \pm 2.40$  minutes respectively in group-B and  $7.16 \pm 0.30$  and  $45.25 \pm 1.09$  minutes respectively in group-C. Induction and recovery were smooth. Muscle relaxation and analgesia were good. Animals of all group exhibited signs of sedation with lowering of head, occasional bellowing, heavy upper eyelid (drowsiness), onset of salivation, reduced tail movement and signs of staggering. Polyuria was observed at recovery.

Heart rate decreased significantly ( $p < 0.05$ ) in group-A, B and C. Respiration increased significantly ( $p < 0.01$ ) and rectal temperature showed non-significant ( $p > 0.05$ ) difference in all the three groups. Respiratory tidal volume increased non-significantly ( $p > 0.05$ ) and respiratory minute volume showed high significant ( $p < 0.01$ ) decreased in the all the three groups. SpO<sub>2</sub> decreased non-significantly ( $p > 0.05$ ) in the group-A, B but in group-C, SpO<sub>2</sub> increased significantly ( $p < 0.01$ ). Hb, TPC, TEC and TLC also decreased non-significantly ( $p > 0.05$ ) in group-A, B and C. Highly significant ( $p < 0.01$ ) increased of PCV in group-A, B and C. ALP increased significantly ( $p < 0.05$ ) in group-A and C. AST decreases non-significantly ( $p < 0.05$ ) in group- A and C. Glucose increased significantly ( $p < 0.05$ ) in all the three groups. Total protein decreased non-significantly ( $p > 0.05$ ) in group-A and B and decreased significantly ( $p < 0.05$ ) in group-C. Creatinine increased non-significantly ( $p < 0.05$ ) in all these three groups. BUN showed non-significant ( $p > 0.05$ ) increase group-A and significant increase in group-B and C.

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**Abstract of Ph.D. Thesis**

**Department : Veterinary Surgery and Radiology**

**Major Advisor : Dr. Kushal Konwar Sarma**

Based on the findings of the study, xylazine - Zoletil® 100 anaesthesia produced a balanced anaesthesia with excellent analgesia and muscle in sambar stags followed by the xylazine-azaperone. Caudectomy has got advantageous over vasectomy in terms of mean time required to perform the surgery. No such behavioral and physical changes were observed among the operated sambar stags over a period of 1 year during the study.

# **Clinical, Cardiopulmonary, Haematobiochemical and Immunological Effects of Isoflurane, Propofol and Ketamine in Glycopyrrolate, Dexmedetomidine and Butorphanol Premedicated Dogs**

*Hitesh Bayan*

The study was conducted to evaluate the clinical, cardiopulmonary, haematobiochemical and immunological effects of isoflurane, propofol and ketamine anaesthesia in glycopyrrolate, dexmedetomidine and butorphanol premedicated dogs. The study was carried out on twenty four number of female dogs presented for elective ovariohysterectomy. The animals were randomly divided into four groups (A, B, C and D) comprising of six animals each. The animals in all the groups were administered with glycopyrrolate 0.01 mg/kg IM followed 15 min by dexmedetomidine 5µg/kg IV and Butorphanol 0.1mg/kg IV. Two min after administration of dexmedetomidine and butorphanol, induction of anaesthesia was done with propofol IV till effect in Groups A and B and with ketamine IV till effect in Groups C and D. The anaesthesia was maintained with isoflurane in Groups A and C. In Groups B and D, the anaesthesia was maintained with continuous rate infusion of propofol 0.2-0.5 mg/kg/min and ketamine 0.002-0.02 mg/kg/min, respectively. The induction doses of propofol were recorded as 0.67±0.07 mg/kg in Group A and 0.68± 0.06 mg/kg in Group B where as the induction doses of ketamine were recorded as 2.55± 0.24 mg/kg in Group C and 2.63±0.26 mg/kg in Group D. Induction was quick and smooth in all the groups enabling easy endotracheal intubation. The analgesia, muscle relaxation and depth of anaesthesia were sufficient for performing major abdominal operations. The mean maintenance dose (mg/kg/min) of propofol and ketamine were recorded as 0.24±0.01 and 0.013.17±0.60 respectively in groups B and D. The mean vaporizer settings (%) for isoflurane were recorded as 1.34 ± 0.06 and 1.28 ± 0.07, respectively in Groups A and C. The recovery time was shortest in Group A and longest in Group D. The quality of recovery was

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**Department : Veterinary Surgery and Radiology**

**Major Advisor : Dr. Kushal Konwar Sarma**

better in Groups B, A & C in sequence as compared to Group D. The changes in the clinical parameters remained within the physiological limits in all the groups. Changes in blood pressure and ECG remained within the physiological limit in all the groups. The respiratory parameters were well maintained with isoflurane but the oxygen saturation values were near the critical level in Group D. The changes in haematological (haemoglobin, TEC, TLC, PCV, granulocytes, platelet and DLC) and biochemical (serum glucose, serum total protein, GGT, ALP, BUN, serum creatinine and LDH) parameters were found to be within physiological limits in all the animals. The immunological parameters exhibited immune suppressions but were transient in nature in all the groups. To conclude, all the anaesthetic combinations were safe and effective for major abdominal surgery in dogs. However, the respiratory parameters were more stable with inhalation agents used for maintenance and near the border line in particularly with ketamine CRI. The CRI with propofol was found to be better than with ketamine for maintenance in dogs premedicated with dexmedetomidine and butorphanol.

# **Ultrasonographic Evaluation of The Internal Organs in Captive and Wild Animals of Assam**

*Nirmali Sarma*

The present study entitled “Ultrasonographic Evaluation of the Internal Organs in Captive and Wild Animals of Assam” was undertaken to perform a clinical and opportunity-based study on a total of 46 captive and free-ranging wild animals belonging to 19 different species, to observe the ultrasonographic morphology of the various internal organs, record their anatomical location and acoustic windows, collect morphometric data and diagnose pathological alterations, if any, and to preferably establish a baseline set of ultrasonographic-splanchnological data on certain species. The studies were conducted in the Assam State Zoo Division, Zoo Road, Guwahati and the Department of Surgery & Radiology, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati.

Out of the 46 animals studied, there were 16 mammals, 1 bird and 2 reptiles. The mammals were further grouped as Omnivores, Herbivores and Carnivores based on their dietary characteristics. Herbivores were further divided into Non-ruminants and Ruminants based on the fundamental anatomical differences of their digestive system. Highest number of animals studied belonged to the group of mammals, consisting of Himalayan Black Bear, Western Hoolock Gibbon, Golden Langur, Asiatic Elephant, Rhesus Macaque, Red Serow, Barking Deer, Hog Deer, Eld’s Deer, Asiatic Lion, Bengal Tiger, Indian Leopard, Striped Hyena, Jungle Cat, Asian Palm Civet and Black Panther. Minimum number of animals studied was a single bird, the Lesser Adjutant Stork. The two reptiles examined were both snakes, namely, the Copper-headed Trinket Snake and Indian Rock Python.

All 46 animals were subjected to thorough observations of their clinico-physiological signs, haemato-biochemical parameters and ultrasonographic studies to perform a survey-based study on these wild species. Radiography was performed in 3 animals only. Thereafter, an attempt was made to correlate the findings of clinico-physiological signs, haemato-biochemical alterations and ultrasonographic findings and radiographic observations in some, for evaluation of the internal structures in different captive and free-ranging wild animals of Assam. Animals that were diagnosed with

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**Abstract of Ph.D. Thesis**

**Department : Veterinary Surgery and Radiology**

**Major Advisor : Dr. Dwijen Kalita**

specific anomalies requiring surgical or medicinal intervention were treated as per standard procedures.

In this study, a total of 33 animals were from captivity while 13 were from free-ranging conditions, 39 animals were subjected to chemical restraint and 7 were managed by physical restraint, 11 animals were deemed clinically healthy but 35 had pathological alterations detected on clinical examinations. There were 24 males and 22 females from different species of wild animals. Furthermore, highest number of animals belonged to the adult age group (36 animals) whereas 4 animals were adolescents and 3 in each group of juvenile and geriatric animals.

In most animals, the ultrasonographic observations could be correlated to the information obtained from anamnesis, behavioural observations, clinico-physiological records, haemato-biochemical parameters as well as radiography in select cases. However, in a few studies, it was observed that the clinico-physiological and haemato-biochemical findings were inconsistent with the ultrasonographic findings. Radiography provided excellent detail of the skeletal disorders, however, sufficient information pertaining to soft tissues could not be obtained. This could be attributed to the superimposition of soft tissues on a Skiagram.

Ultrasonography aided in the outstanding visualisation of most of the internal organs in almost all species of the captive and free-ranging wild animals taken for study, by application of which the anatomical locations, ultrasonographic morphology, morphometrics and pathological conditions of different internal organs could be recorded. However, certain challenges were also encountered during sonographic studies; obstruction to the passage of ultrasonic waves due to presence of burn lesions, tympanites, ribs and air sacs had caused artefacts leading to lack of visualisation of target organs. Also, sheer large body size of certain animals combined with the mere 16 cm depth of ultrasonic waves caused insufficient visualisation of target organs.

However, ultrasonography effectively aided in the diagnosis of various pathological conditions such as uterine tumour, hepatic fatty changes, hepatic abscesses, ovarian cyst, septate gall bladder and splenic mass. Additionally, this imaging modality aided in detection of a congenital anomaly i.e.; an ectopic left kidney.



## **Effect of Polyherbal Feed Supplementation on Performances of Assam Hill Goat**

*Chinmoy Dutta*

The experiment was conducted for a period of nine months and a digestion trial thereafter to study the effect of feeding a polyherbal feed supplement constituted of Shatavari, Fenugreek and Ajwain mixed in 1:1:1 ratio on different performances of Assam Hill goat. Thirty six healthy weaned kids (eighteen male and eighteen female) of similar age and bodyweight were allocated to three experimental groups, control (C0), treatment-1 (T1) and treatment-2 (T2) with twelve animals in each group (six male and six female). Kids of all the three groups were fed with a standard basal diet consisted of concentrate and green fodder with supplementation of the polyherbal feed supplement @ 1 gm and 2 gm per kg body weight daily in the treatment-1 (T1) and treatment-2 (T2) groups respectively.

The average body weight at 19th fortnight i.e., at 12 months of age were  $13.84 \pm 0.032$ ,  $14.47 \pm 0.021$  and  $16.24 \pm 0.040$  kg control and the two treatment groups (T1 and T2) respectively. The overall body weight (kg) of two treatment groups were significantly higher ( $P < 0.01$ ) than that of control group. In respect of sex, the male animals attained higher bodyweight than that of female animals at all the stages of experiment.

The average fortnightly body weight gain during the experimental were  $0.476 \pm 0.006$ ,  $0.510 \pm 0.005$  and  $0.603 \pm 0.006$  kg for control and the two treatment groups respectively and revealed significant ( $p < 0.01$ ) difference from the fourth fortnight and showing significant differences between the treatment groups, between the fortnights and between both the sexes. The male goats gained more overall body weight i.e.,  $0.556 \pm 0.005$  kg over the female goats i.e.,  $0.503 \pm 0.007$  kg throughout the experiment.

The initial mean values of fortnightly measurement (cm) of body conformation (body length, height at wither, chest girth, neck girth, tail length, length of head, breadth of head, horn length and ear length) of Assam Hill kids in control (C0), treatment-1 (T1) and treatment-2 (T2) groups were similar and non-significant. However, at the end of

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**Department : Livestock Production and Management**

**Major Advisor : Dr. Jyoti Prasad Bordoloi**

experiment, significant differences ( $p < 0.01$ ) among control and two treatment groups were observed for body length, height at wither and chest girth. Other measurements, neck girth, tail length, length of head, breadth of head, horn length and ear length were apparently higher in the treatment groups. Sex wise, the male goats had better body conformation than female animals.

The overall mean values of respiration rate in Assam Hill goats were  $19.68 \pm 0.473$ ,  $19.56 \pm 0.279$  and  $19.68 \pm 0.229$  breaths/min in control (T0), treatment-1 (T1) and treatment-2 (T2) respectively. The average mean values of pulse rate of Assam hill goat fed with polyherbal supplementation during the studies were  $78.56 \pm 0.750$ ,  $78.50 \pm 1.047$  and  $78.40 \pm 0.786$  beats/min for control and the two treatment groups respectively. The overall mean values of rectal temperature of the goats were  $102.38 \pm 0.161$ ,  $102.4 \pm 0.176$  and  $102.32 \pm 0.170$  °F for control and treatment groups respectively. There were no significant ( $P > 0.01$ ) differences in pulse rate, respiration rate and temperature among the three groups and sex wise between male and female animals.

The average values of BCS of the male goats at puberty were  $2.70 \pm 0.032$ ,  $2.94 \pm 0.054$  and  $3.05 \pm 0.074$  as well as at maturity were  $2.72 \pm 0.028$ ,  $3.01 \pm 0.076$  and  $3.15 \pm 0.059$  in control (C0), treatment-1 (T1) and treatment-2 (T2) respectively. In respect of female goat, the overall mean values of BCS puberty were  $2.66 \pm 0.029$ ,  $2.86 \pm 0.037$  and  $2.91 \pm 0.050$  and at maturity the BCS were  $2.68 \pm 0.029$ ,  $2.9 \pm 0.047$  and  $2.94 \pm 0.056$  for animals in Co, T1 and T2 respectively. The results showed significant ( $P < 0.01$ ) difference in BCS at puberty and maturity both in male and female among the three experimental groups. Again, the BCS were found better at maturity than that of puberty in both male and female goats. The average haemoglobin were  $7.36 \pm 0.05$ ,  $7.44 \pm 0.057$  and  $7.52 \pm 0.051$  g/dl in control and two treatment groups respectively as well as  $7.56 \pm 0.053$  and  $7.37 \pm 0.052$  g/dl in male and female respectively. All the values were within the normal ranges and showed no significance differences ( $P > 0.01$ ) among the treatment groups and the sexes. The average blood glucose concentration in different groups during different quaternary varied from  $69.94 \pm 0.864$  to  $73.73 \pm 0.430$ ,  $69.86 \pm 0.884$  to  $74.67 \pm 0.667$  and  $69.38 \pm 0.824$  to  $74.63 \pm 0.597$  mg/dl with overall values as  $71.78 \pm 0.623$ ,  $72.27 \pm 0.926$  and  $72.01 \pm 0.649$  mg/dl in control, treatment-1 (T1) and treatment-2 (T2) groups respectively. Results showed no significant difference ( $P > 0.01$ ) between control and treatment groups. The mean total plasma protein was found to be  $7.37 \pm 0.049$ ,  $7.46 \pm 0.052$  and  $7.52 \pm 0.038$  gm/dl of blood for control, treatment-1 (T1) and treatment-2 (T2) groups, respectively. Sex wise, the overall mean total blood plasma protein for male and female were  $7.51 \pm 0.062$  and  $7.39 \pm 0.047$  gm/dl found no significant differences ( $P > 0.01$ ) among the treatment groups and sexes on overall as well as at any stage of the experiment till the end. However, the respective values improved within the normal range.

The average growth hormone (ng/ml) levels of the experimental goats were  $2.94 \pm 0.097$ ,  $3.02 \pm 0.010$  and  $3.07 \pm 0.012$  in control, treatment-1 (T1) and treatment-2 (T2)

groups respectively. Similarly, the overall mean growth hormone (ng/ml) concentration in male and female were  $2.99 \pm 0.068$  and  $2.97 \pm 0.011$  ng/ml. The level of growth hormone (ng/ml) increased among the treatment groups and the sexes numerically but was not significant statistically. The mean estrogen level (pg/ml) at 1st estrous were found to be  $14.235 \pm 0.015$ ,  $15.288 \pm 0.018$  and  $15.548 \pm 0.012$  for control, treatment-1 (T1) and treatment-2 (T2) groups respectively. Similarly at 5th estrous when the goats attained 60% to 70% of their adult body weight, the mean estrogen level (pg/ml) were found to be  $22.667 \pm 0.012$ ,  $22.867 \pm 0.016$  and  $23.242 \pm 0.013$  for control and two treatment groups respectively. Results revealed significant differences ( $P < 0.01$ ) among the treatment groups during each estrous till 5th estrous. The mean blood testosterone hormone level (ng/ml) at 11th month were found to be  $2.710 \pm 0.176$ ,  $3.008 \pm 0.136$  and  $3.107 \pm 0.179$  and at 12th month  $2.777 \pm 0.175$ ,  $3.222 \pm 0.108$  and  $3.425 \pm 0.187$  for control and treatment groups respectively. The testosterone level was significantly higher ( $P < 0.01$ ) in among the treatment-1 (T1) and treatment-2 (T2) groups.

The mean average age (days) at first heat were  $199.833 \pm 3.842$ ,  $183.333 \pm 2.985$  and  $183.167 \pm 4.110$  for Assam Hill goats in control, treatment-1 (T1) and treatment-2 (T2) groups respectively. The corresponding age at fifth heat were  $283.845 \pm 3.842$ ,  $267.287 \pm 2.982$  and  $267.062 \pm 4.179$  respectively. The duration (hr) of first heat were  $26.087 \pm 0.582$ ,  $28.562 \pm 0.970$  and  $28.627 \pm 1.219$  as well as for fifth heat duration (hr) were  $26.955 \pm 0.436$ ,  $32.317 \pm 1.318$  and  $34.197 \pm 1.010$  for goats in control and the two treatment groups respectively. The age at first heat were significantly earlier ( $P < 0.01$ ) in treatment groups compared to control group. The duration of heat revealed marked variations and was significantly high ( $P > 0.01$ ) in fifth heat.

Routine examination of semen samples revealed the mean values of volume, colour, mass activity, individual motility, normal sperm, live sperm and dead sperm (%) at 11th month and 12th month which showed significant differences ( $P < 0.01$ ) among the control and the two treatment groups. The semen volume ( $0.627 \pm 0.008$  ml) and percentage of live sperm ( $85.355 \pm 0.895\%$ ) were highest in T2 group at 12th month of age. The overall semen qualities were found better in treatment groups. The buck of the treatment groups could had been used for mating or even for collection of semen from 11th month onwards instead of 12th months as level of testosterone hormone (ng/ml) and over all semen quality were well within the optimum range and body condition score was found suitable. The average digestibility of the different organic nutrients in Co, T1 and T2, respectively were as : DM (%),  $59.526 \pm 0.051$ ,  $61.069 \pm 0.058$  and  $61.512 \pm 0.058$ ; CP (%),  $72.027 \pm 0.044$ ,  $74.451 \pm 0.032$  and  $75.015 \pm 0.042$ ; EE (%),  $67.727 \pm 0.012$ ,  $68.155 \pm 0.020$  and  $68.364 \pm 0.033$ ; CF (%),  $54.348 \pm 0.054$ ,  $58.474 \pm 0.033$  and  $59.201 \pm 0.017$ ; NFE (%),  $67.026 \pm 0.039$ ,  $67.507 \pm 0.021$  and  $67.785 \pm 0.035$ ; OM (%),  $64.793 \pm 0.041$ ,  $65.977 \pm 0.050$  and  $66.416 \pm 0.051$ . Digestibility remained higher in both the treatment groups than control and improved significantly ( $P < 0.01$ ).

The average cost of concentrate mixture alone and with addition of the polyherbal supplement @ 1gm and 2gm per kg body weight were (Rs.) 1056.13 in control group, 1532.84 in the T1 and 2168.64 in the T2 group. The higher feed costs in treatment groups were found due to the higher price of the polyherbal supplement costing Rs. 170/Kg. However, the mean body weight gain (kg) was 9.38, 9.63 and 10.54 in Co, T1 and T2, respectively. The findings of the experiment, though cost of feeding is slightly higher in the supplemented groups, those goats indicated better growth and reproduction performances was expected to perform superior yielding higher lifetime return.

# **Effect of Wet and Boiled Diets Feeding on Growth and Carcass Characteristics in Crossbred Hampshire Pigs**

*Lakshya Jyoti Kakati*

Under the supervision of the Department of Livestock Production and Management, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati-22, the study was conducted at field level in a private farm named “Ruhini Deka Pig Farm” situated at Duwoni village under Manipur gram panchayat of Morigaon district. The laboratory work was performed at the AICRP on Post Harvest Engineering Technology, Department of Livestock Products Technology and the Department of Animal Nutrition, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati-22 during the period from August 2021 to January 2022.

A total of 36 (thirty six) weaned Hampshire crossbred pigs were selected randomly from the littermates of 6-8 piglets maintained at the “Ruhini Deka Pig Farm” complex. The pigs (56 days old) were randomly divided into three treatment groups depending upon nearness of body weight in such a manner that each group consisted of twelve piglets with equal number of males and females. The animals were allotted to 3 experimental groups *viz.*, control (reared on standard conventional feed), T<sub>1</sub> (reared on standard conventional wet feed @ the ratio of 1:1.5) and T<sub>2</sub> (reared on standard conventional boiled /cooked feed). Weaned piglets were housed individually under conventional housing system up to the market age (32 weeks). The space allowance per pig was provided 10 x 9 ft. (approx.). The standard conventional feed both grower and finisher feed were prepared as per ICAR (2013) recommendation. Feed was offered in the morning and evening. Clean and wholesome water was provided round the clock throughout the experiment. At the end of the experiment, 3 animals per treatment (the lightest, heaviest and the middle by weight) were selected for slaughter by humane method.

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**Abstract of Ph.D. Thesis**

**Department : Livestock Production and Management**

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Boiled diet could significantly ( $p < 0.05$ ) influence body weight, total and average daily feed intake of crossbred Hampshire pigs. However, average daily gain was not found to be significant during the experimental period yet the findings clearly shows numerical superiority in regards to body weight, average daily gain, total and average daily feed intake. FCE was found to be the best in boiled fed ( $T_2$ ) group showing better efficiency over control and wet fed ( $T_1$ ) group.

Moisture ( $P < 0.01$ ) was affected by soaking and boiling of feed, while crude protein, crude fibre, ether extract, total ash and showed no significant difference. Boiling of feed (grower-finisher) showed significant change ( $p < 0.01$ ) in the phosphorus content of the experimental ration.

The pre-slaughter weight, hot carcass weight and dressing percentage, carcass measures *viz.*, Carcass length, backfat thickness and loin eye area was not affected. Wholesale cuts (ham, bacon, loin, boston butt and picnic) did not show any significant difference ( $p > 0.05$ ) among the groups. Likewise there was no significant difference ( $p > 0.05$ ) in regards to weight of the edible and inedible offals among the treatment groups. In relation to physico-chemical properties, water holding capacity and ultimate pH at 6 hours of *L. dorsi* showed no significant ( $P > 0.05$ ) difference among the groups.

On sensory evaluation of pork, flavour and juiciness revealed significant difference among the groups while colour, texture and overall acceptability of pork showed no difference among the experimental groups. However, the present findings showed numerical superiority among the groups in regards to sensory parameters.

The cost feeding per kg weight gain was found to better at the end of the feeding trial slightly in the boiled fed ( $T_2$ ) group followed by we fed ( $T_1$ ) and control group.

Therefore, it may be concluded that feeding of boiled feed may be suggested for improved productive performance, feed conversion efficiency, superior carcass and pork quality characteristics and better cost of production.

## **Performance of Crossbred Hampshire Pig Fed on Poultry By-Products**

*Nanda Kumar Roy*

An experiment was conducted to study the effects of the inclusion of poultry by-product meal in the ration of pig replacing the fish meal at different levels viz. 50% and 100% on the growth performance, feed conversion efficiency, haemato-biochemical profile, carcass characteristics and meat quality, and cost of feeding in Crossbred Hampshire pigs.

A total of Eighteen (18) weaned Crossbred Hampshire pigs (9 castrated male and 9 female) with an average age of 8 weeks and average body weight of  $11.11 \pm 0.02$  kg were selected from an institutional pig farm (30-Sow Teaching Unit) under the Department of Livestock Production and Management, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati-22. The trial was conducted for 150 days, from 15th October 2021 to 14th March 2022. The piglets were divided into three treatment groups depending upon the nearness of body weight and age in such a manner that each treatment will consist of six pigs (3 male and 3 female in each group) viz. groups C, T1, and T2. The animals under T1 group were provided with Standard conventional feed with 2.5% inclusion of poultry by-product meal replacing 50% of fish meal. However, the animals of T2 group were provided with Standard conventional feed with 5% inclusion of poultry by-product meal replacing 100% fish meal. The control group was provided with standard conventional feed without the inclusion of poultry by-products. The experimental rations were prepared as per BIS-2005.

The average initial body weights (kg) of weaned piglets of all experimental groups were not significant ( $P \geq 0.01$ ) different among the groups which ranged from  $11.08 \pm 0.28$  kg to  $11.13 \pm 0.11$  kg. The average final body weights (kg) of pigs in different groups in the finisher stage were  $69.86 \pm 0.63$ ,  $71.02 \pm 0.49$ , and  $72.08 \pm 0.38$  for C, T1, and T2 groups respectively at the end of the 10th fortnight of the experimental period. The overall average daily gains (kg) during the experimental period were  $0.390 \pm 0.01$ ,  $0.398 \pm 0.01$ , and  $0.405 \pm 0.01$  for C, T1, and T2 groups respectively. The overall body weight gains (kg) during the experimental period were  $58.73 \pm 0.62$ ,  $59.90 \pm 0.45$ , and  $60.99 \pm 0.4$  for C, T1, and T2 groups respectively. Statistical analysis

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revealed that there were non-significant differences in the final body weight (kg), ADG (kg) and overall body weight gain (kg) of pigs in different treatments and control groups during the experiment. The overall Average daily feed intake (DM basis) during the experimental period was  $1.392 \pm 0.01$  kg,  $1.382 \pm 0.01$  kg, and  $1.353 \pm 0.01$  kg for C, T1, and T2 groups respectively. The overall average feed intakes (fresh basis) during the experimental period were  $232.044 \pm 1.38$  kg,  $230.351 \pm 2.23$  kg, and  $225.523 \pm 2.64$  kg for C, T1, and T2 groups respectively. Statistical analysis revealed non-significant differences in the overall daily feed intake and total feed intake (DM basis) of pigs among the different treatment and control groups under the experiment. The overall Average feed conversion efficiency (fresh basis) during the experimental period was  $3.92 \pm 0.21$ ,  $3.78 \pm 0.18$ , and  $3.66 \pm 0.13$  for C, T1, and T2 groups respectively where non-significant differences existed between different treatment and control groups under the experiment.

The average daily changes in body length in the C, T1 and T2 groups were  $0.37 \pm 0.02$ ,  $0.37 \pm 0.01$ , and  $0.38 \pm 0.03$  respectively. The average daily changes in height at withers in the C, T1, and T2 groups were  $0.27 \pm 0.00$ ,  $0.27 \pm 0.00$ , and  $0.28 \pm 0.00$  respectively. The average daily changes in Heart girth in the C, T1 and T2 groups were  $0.37 \pm 0.01$ ,  $0.37 \pm 0.01$ , and  $0.38 \pm 0.02$  respectively. Analysis of variance revealed that there is no significant differences existed between the different treatment and control groups. Higher body length, height at withers, and Heart girth were observed in the T2 group followed by T1 and C groups. The coefficient of correlation of linear body measurements with the body weight of crossbred Hampshire pigs was found to be positively correlated.

Non-significant differences in Hb, WBC, RBC, and HCT levels were recorded during different periods between different treatment and control groups that indicate the poultry by-product inclusion did not influence the hematological profile in Crossbred Hampshire pigs. In the Blood biochemical parameters, the concentration of Serum globulin, glucose, total cholesterol, triglyceride, Ca, and P levels were found within the normal physiological range in all experimental groups. There was a significant difference in respect of serum total protein and albumin at the mod of the experiment.

The Live weight (kg), Slaughter weight (kg), Hot Carcass weight (kg), chilled Carcass weight (kg), Hot dressing percentage (%), chilled dressing percentage (%), Carcass length (cm), Back fat thickness (cm), and Loin eye area (cm<sup>2</sup>) showed non-significant difference among different groups. Wholesale cuts (ham, bacon, loin, picnic, Boston butt, and jowl) showed non-significant differences among the groups. The edible and inedible offal also did not differ significantly ( $P > 0.01$ ). The proximate composition of *L. dorsi* muscle revealed non-significant differences in moisture, CP, EE, and total ash content among the groups. In relation to Physico-chemical properties, WHC (cm<sup>2</sup>) and pH values of *L. dorsi* muscle of crossbred Hampshire pigs revealed non-significant ( $P > 0.05$ ) differences among the different treatment and control groups. On the sensory evaluation of pork, colour, flavor, juiciness, texture, and overall acceptability of pork



showed no difference among the experimental groups. Texture profile and colour profile also revealed no significant difference between different treatments and Control group.

During the grower stage, feed cost (Rs.) per kg gain was 96.29 for the C group, 93.59 for T1, and 87.92 for the T2 group, while during the finisher stage the feed cost (Rs.) per kg gain was 138.17, 132.80 and 129.29 in for C, T1 and T2 respectively. The highest profit (in terms of feed cost/kg gain) was observed in the T2 group followed by T1 and in comparison to the Control group. Thus it can be concluded that the inclusion of poultry by-products up to 5% level in the pig ration replacing fish meal may be recommended in terms of growth and economic production without any adverse effect on general performance.

**Keywords:** Poultry by-product meal, pigs, growth performance, carcass traits, and meat quality.

# Effects of Housing Management on Dairy Cow Productivity

*Raj Jyoti Deka*

The experiment was carried out from January to December, 2021 on different types of housing systems adopted for dairy farming viz. i) Institutional Housing (IH) adopted at institutional level following all the scientific approaches at Instructional Livestock Farm (Cattle) under the Department of Livestock Production and Management, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati-22 and ii) Traditional Housing (TH) adopted by progressive dairy farmers of Amerigog area in Kamrup (M) District of Assam. The experiment was carried out with a total of 36 (Thirty Six) lactating dairy animals (crossbred cows) keeping 18 numbers of animals each under IH (Institutional Housing) and TH (Traditional Housing) management systems. Furthermore, each group was sub-divided into three groups viz. T0, T1 and T2 with 6 (Six) animals in each treatment group. The 6 (Six) animals per group was selected on the basis of apparently similar in parity, physiological status and preceding lactation yield.

Two different treatments were applied in two different IH and TH management system with one group as control in each housing management system i.e. IH and TH. The T0 was considered as the control without treatment and was managed under existing (regular) management system. The T1 was supplemented with dry yeast powder (*Saccharomyces cerevisiae*) with the recommended dose @3.0 gm per cow as probiotics over regular management system and the T2 was supplemented with dry yeast powder (*Saccharomyces cerevisiae*) with the recommended dose @3.0 gm per cow as probiotics over regular management system and modification of the micro climate for more air circulation by fixing dairy fan (side fan). The highest maximum temperature ( $33.83 \pm 0.28$  °C) was recorded in the month of August and the lowest minimum temperature ( $12.66 \pm 0.37$  °C) was recorded in the month of January during the year in both G1 & G2.

The mean monthly lowest outdoor temperature (O Temp.) was recorded as  $18.10 \pm 0.22$  °C and  $18.16 \pm 0.22$  °C in the morning and  $22.06 \pm 0.38$  °C and  $22.14 \pm 0.38$

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OC in the afternoon during the month of January in G1 and G2 respectively. The highest outdoor temperatures were  $31.17 \pm 0.43$  OC and  $31.28 \pm 0.43$  OC in the morning and  $32.38 \pm 0.62$  OC and  $32.33 \pm 0.59$  OC in the afternoon during the month of September in the G1 and G2 respectively.

The mean monthly highest wind speed (Km/hr.) were  $3.07 \pm 0.62$  both in G1 and G2 in the month of April and  $2.58 \pm 0.68$  and  $2.47 \pm 0.69$  in G1 and G2 in the month of March in morning and afternoon respectively. The lowest mean wind speed (Km/hr.) were  $0.21 \pm 0.21$  both in G1 and G2 in the month of February and  $0.13 \pm 0.09$  and  $0.17 \pm 0.07$  in G1 and G2 in morning and afternoon respectively. The lowest mean monthly wet bulb temperatures (WB Temp.) in the morning were  $15.17 \pm 0.21$  and  $15.23 \pm 0.23$  OC in the month of January both in G1 and G2 respectively. However highest mean monthly morning WB Temp. were recorded as  $26.89 \pm 0.16$  OC in the month of August in G1 and  $26.75 \pm 0.23$  OC in the month of September in G2. The mean relative humidity (RH) in percentage were  $87.26 \pm 1.00$  as highest in the month of January and  $69.63 \pm 1.78$  as lowest in the month of April in G1 and  $88.90 \pm 0.93$  as highest in the month of January and  $63.27 \pm 0.82$  as lowest in the month of November in the morning in G2. The analysis of variance (ANOVA) revealed that there is highly significant ( $P < 0.01$ ) difference in DB Temp., RH and THI among the two different housing management viz. institutional housing (G1) and traditional housing (G2). Whereas, there were no significant differences in O Temp., WB Temp. and WS among G1 and G2. But there were highly significant ( $P < 0.01$ ) differences between the months in O Temp., WB Temp., WS, DB Temp., RH and THI.

The overall mean body surface temperature (ST) comprising of all the four seasons were  $36.44 \pm 0.06$  &  $36.44 \pm 0.06$  OC in T0,  $36.41 \pm 0.10$  &  $36.41 \pm 0.10$  OC in T1 and  $36.32 \pm 0.08$  &  $36.32 \pm 0.08$  OC in T2 in the morning and afternoon respectively in G1. The overall mean rectal temperature (RT) comprising of all the four seasons were  $38.18 \pm 0.14$  &  $38.18 \pm 0.14$  OC in T0,  $37.96 \pm 0.27$  &  $37.96 \pm 0.27$  OC in T1 and  $37.72 \pm 0.18$  &  $37.72 \pm 0.18$  OC in T2 in the morning and afternoon respectively in G1. Whereas, the ST were recorded as  $38.29 \pm 0.13$  &  $38.51 \pm 0.10$  in T0,  $38.09 \pm 0.21$  &  $38.32 \pm 0.15$  in T1 and  $37.85 \pm 0.23$  &  $37.94 \pm 0.24$  in T2 in the morning and afternoon respectively in the G2. The overall mean respiration rate (RR) comprising of all the four seasons were  $23.97 \pm 0.26$  &  $23.97 \pm 0.2614$  OC in T0,  $23.80 \pm 0.21$  &  $23.80 \pm 0.21$  OC in T1 and  $23.64 \pm 0.15$  &  $23.64 \pm 0.15$  OC in T2 in the morning and afternoon respectively in G1. Whereas the RR were recorded as  $25.13 \pm 0.34$  &  $25.67 \pm 0.61$  in T0,  $24.52 \pm 0.30$  &  $24.65 \pm 0.34$  in T1 and  $23.99 \pm 0.18$  &  $24.20 \pm 0.20$  in T2 in the morning and afternoon respectively in the G2. The overall mean pulse rate (PR) comprising of all the four seasons were  $57.42 \pm 0.22$  &  $57.42 \pm 0.22$  OC in T0,  $57.08 \pm 0.21$  &  $57.08 \pm 0.21$  OC in T1 and  $56.97 \pm 0.13$  &  $56.97 \pm 0.13$  OC in T2 in the morning and afternoon respectively in G1. Whereas the PR were recorded as  $57.99 \pm 0.24$  &  $58.16 \pm 0.25$  in T0,  $57.64 \pm 0.24$  &

57.85±0.31 in T1 and 57.39±0.22 & 57.64±0.21 in T2 in the morning and afternoon respectively in te G2.

The analysis of variance (ANOVA) revealed that there are significant differences ( $P<0.01$ ) between the G1 and G2 in respect of surface temperature, rectal temperature, respiration rate and pulse rate. There were non-significant differences ( $P>0.05$ ) between morning and afternoon in respect of ST, RT, RR and PR. However, there were highly significant differences ( $P<0.01$ ) were recorded between the seasons in respect to ST, RT, RR and PR. Highest ST were observed in S1 (36.57±0.04 °C) followed by S3, S2 and S1. The total leukocyte count (TLC) were recorded in percentage (%) as 22.57±1.67, 18.30±1.51 and 15.75±1.38, 15.13±0.87, 13.55±1.40 and 12.79±0.89, 23.66±0.96, 21.46±0.94 and 15.44±1.42, 24.02±1.42, 25.76±3.10 and 17.47±0.80 in treatment groups T0, T1 and T2 and during the seasons viz. S1, S2, S3 and S4 respectively in institutional housing (IH). Whereas, the TLC were 19.73±3.19, 19.35±3.12 and 18.36; 18.14±3.11, 15.00±1.68 and 13.93±2.87; 21.61±3.53, 18.36±2.29 and 20.08±2.00; 24.81±3.44, 20.13±2.52 and 19.90±1.29 in treatment groups T0, T1 and T2 and during the seasons viz. S1, S2, S3 and S4 respectively in traditional housing (TH). The analysis of variance revealed that there are non-significant differences in TLC and DLC irrespective of housing management i.e. IH and TH. However, highly significant differences ( $P<0.01$ ) were observed in TLC, neutrophil count, lymphocyte count and monocyte count among the seasons irrespective of IH and TH. But no significant differences were recorded among the treatment group.

The overall mean RBC in percentage in T0, T1 and T2 were 5.51±0.38, 6.06±0.36 and 5.94±0.43 in IH and 5.06±0.26, 4.89±0.27 and 4.98±0.29 in TH. The overall mean PCV in percentage in T0, T1 and T2 were 24.72±1.39, 26.63±1.41 and 27.16±1.45 in IH and 24.85±1.65, 24.49±1.53 and 24.50±1.56 in TH. The overall mean Hb in percentage in T0, T1 and T2 were 9.55±0.36, 10.19±0.42 and 10.23±0.42 in IH and 9.98±0.57, 9.57±0.44 and 9.71±0.39 in TH.

The analysis of variance (ANOVA) revealed that there are significant differences ( $P<0.01$ ) between IH and TH in regards to RBC and PCV, whereas no significant difference was observed between IH and TH in terms of Hb content of blood. But, highly significant ( $P<0.01$ ) differences were observed between the seasons in RBC, PCV as well as Hb concentration. Moreover, non significant differences were also observed among the treatment groups in terms of RBC, PCV and Hb content of blood. The overall mean cortisol level (nmol/L) in T0, T1 and T2 were 34.60±5.73, 28.56±6.58 and 21.11±3.32 in IH and 31.74±4.28, 27.60±6.12 and 21.90±2.67 in TH. The overall mean T3 level (nmol/L) in T0, T1 and T2 were 1.51±0.07, 1.41±0.07 and 1.29±0.05 in IH and 1.49±0.11, 1.43±0.09 and 1.29±0.05 in TH. The overall mean T4 level (nmol/L) in T0, T1 and T2 were 42.69±7.92, 37.20±7.57 and 34.88±6.99 in IH and 45.48±7.26, 38.77±6.94 and 34.47±5.79 in TH.

The analysis of variance revealed that there were non-significant ( $P>0.05$ ) between the IH (G1) and TH (G2) in terms of the hormonal parameters viz. Cortisol, T3 and T4. But highly significant ( $P<0.01$ ) differences have been observed among the seasons in terms of Cortisol and T4. The level of T3 is not significant ( $P>0.05$ ) between interaction of the seasons. Moreover, highly significant ( $P<0.01$ ) levels of Cortisol and T3 were recorded among the treatment groups viz. T0, T1 and T2, where, T4 level was significant ( $P<0.05$ ) among the treatment groups. The mean daily milk yield (Lt.) were recorded as  $6.66\pm 0.97$ ,  $6.61\pm 0.77$  and  $8.84\pm 1.13$  in IH (G1) and  $8.99\pm 1.08$ ,  $9.08\pm 1.00$  and  $9.98\pm 0.66$  in TH (G2) in the treatment groups viz. T1, T2, T3 respectively.

The analysis of variance indicated that there were highly significant ( $P<0.01$ ) differences in average daily milk yield between G1 (IH) and G2 (TH), where, average daily milk yield highest ( $9.35\pm 0.29$ ) in G2 (TH). Highly significant differences ( $P<0.01$ ) were also observed among the treatment group viz. T0, T1 and T2. Highest ( $9.40\pm 0.36$ ) mean daily milk was observed in T2. The mean daily milk per month were also highly significant ( $P<0.01$ ).

The mean fat percentage (%) in the collected milk samples were recorded as  $4.62\pm 0.15$ ,  $4.92\pm 0.03$  and  $5.02\pm 0.07$  in IH and  $4.58\pm 0.14$ ,  $4.96\pm 0.06$  and  $5.11\pm 0.12$  in TH in the treatment groups viz. T0, T1 and T2 respectively. The mean solids not fat (SNF) percentage (%) were recorded as  $8.73\pm 0.03$ ,  $8.80\pm 0.04$  and  $8.81\pm 0.03$  in IH and  $8.77\pm 0.03$ ,  $8.83\pm 0.03$  and  $8.84\pm 0.02$  in TH in the treatment groups i.e. T0, T1 and T2 respectively. The mean total solids (TS) percentage (%) were recorded as  $13.34\pm 0.19$ ,  $13.49\pm 0.17$  and  $13.46\pm 0.18$  in IH and  $13.32\pm 0.20$ ,  $13.53\pm 0.17$  and  $13.48\pm 0.18$  in TH in the treatment groups i.e. T0, T1 and T2 respectively.

The mean protein percentage (%) in the collected milk samples were recorded as  $3.44\pm 0.02$ ,  $3.48\pm 0.02$  and  $3.69\pm 0.16$  in IH and  $3.47\pm 0.02$ ,  $3.50\pm 0.01$  and  $3.75\pm 0.18$  in TH in the treatment groups viz. T0, T1 and T2 respectively. The mean lactose percentage (%) in the collected milk samples were recorded as  $4.45\pm 0.01$ ,  $4.44\pm 0.00$  and  $4.45\pm 0.02$  in IH and  $4.46\pm 0.02$ ,  $4.45\pm 0.01$  and  $4.49\pm 0.03$  in TH in the treatment groups viz. T0, T1 and T2 respectively. The mean ash percentage (%) in the collected milk samples were recorded as  $0.78\pm 0.00$ ,  $0.79\pm 0.00$  and  $0.79\pm 0.00$  in IH and  $0.78\pm 0.00$ ,  $0.79\pm 0.00$  and  $0.79\pm 0.00$  in TH in the treatment groups viz. T0, T1 and T2 respectively. The mean laying and standing time (hrs.) were  $16.78\pm 0.10$  and  $3.24\pm 0.09$ ,  $16.91\pm 0.09$  and  $3.09\pm 0.09$  and  $17.19\pm 0.08$  and  $2.81\pm 0.08$  in T0, T1 and T2 respectively in IH during the S1;  $16.70\pm 0.12$  and  $3.33\pm 0.10$ ,  $16.83\pm 0.09$  and  $3.17\pm 0.09$  and  $17.12\pm 0.09$  and  $3.02\pm 0.15$  in T0, T1 and T2 respectively in IH during the S2;  $15.95\pm 0.23$  and  $4.05\pm 0.23$ ,  $16.05\pm 0.18$  and  $3.95\pm 0.18$  and  $16.71\pm 0.14$  and  $3.42\pm 0.25$  in T0, T1 and T2 respectively in IH during the S3 and  $16.13\pm 0.18$  and  $4.37\pm 0.49$ ,  $16.20\pm 0.19$  and  $3.80\pm 0.19$  and  $16.63\pm 0.17$  and  $3.37\pm 0.17$  in T0, T1 and T2 respectively in IH during the S4. Furthermore, the mean laying and standing time (hrs.) in TH were  $16.82\pm 0.11$  and  $3.17\pm 0.07$ ,  $17.00\pm 0.12$  and  $3.00\pm 0.12$  and  $17.28\pm 0.11$  and  $2.72\pm 0.11$  in T0, T1 and T2 respectively during the S1;  $16.64\pm 0.13$  and  $3.39\pm 0.11$ ,

16.67± 0.16 and 3.33± 0.16 and 17.04± 0.10 and 3.09± 0.14 in T0, T1 and T2 respectively during the S2; 16.05±0.22 and 3.95±0.22, 16.05±0.18 and 3.95±0.18 and 16.73±0.14 and 3.41± 0.25 in T0, T1 and T2 respectively during the S3 and 16.24± 0.13 and 3.76± 0.13, 16.26± 0.15 and 3.74± 0.15 and 16.70± 0.13 and 3.44± 0.23 in T0, T1 and T2 respectively during the S4.

The mean Barn Used Pattern (BUP) in terms of Cow Comfort Index (CCI) and Stall Standing Index (SSI) have been recorded as 81.95 & 18.74 and 82.19 & 17.84 in T0; 82.49 & 17.51 and 82.48 & 17.53 in T1 and 84.56 & 15.78 and 84.69 & 15.83 in T2 in two different housing system i.e. IH (G1) and TH (G2) respectively.

The analysis of variance revealed that there were no significant ( $P>0.05$ ) differences in the barn used pattern of cows between the housing system, seasons and treatment groups viz. T0, T1 and T2. But there were highly significant differences ( $P<0.01$ ) in CCI and SSI (laying and standing position).

# **Amelioration of Heat Stress Through Certain Managemental Interventions in Lactating Dairy Cows**

*Venus Das*

The present experiment was executed in the Instructional Livestock Farm (Cattle) and Sahiwal Cattle Farm under in the Livestock Farm Complex, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati-22 to observe the heat stress amelioration capacity of body cooling and bypass fat feeding during summer season (1st May to 31st August, 2022) in lactating dairy cows.

A total of twenty four (12 Holstein-Friesian crossbred and 12 pure Sahiwal) lactating cows were divided into three groups with eight animals in each group with similar parity, stage of lactation and average daily milk production and with equal number of each breeds. The experimental animals were offered feed twice daily individually @ 4 percent of body weight on DM basis to meet up the optimum nutritional demand (NRC, 2001). Out of total DM 1/3rd was given standard concentrate feed (CP: 18% & TDN: 68.00%) prepared in the farm and 2/3rd was given roughages. Out of total roughage 1/3rd was given as paddy straw and 2/3 mixed green fodders such as Para (*Brachiaria mutica*), Napier (*Pennisetum purpureum*) and Guinea (*Panicum maximum*) grasses in equal parts. In the treatment group bypass fat was fed along with concentrate mixture @ 100 g in the morning and 100 g in the afternoon daily. The experiment was followed by a 7 days of digestibility trial.

The average daily milk yield for T1, T2 and T3 group was 5.94±0.09, 8.26±0.12 and 9.58±0.20 kg, respectively and for Holstein-Friesian crossbred and Sahiwal cow, it was 8.57±0.23 and 7.37±0.13 kg, respectively. The average daily milk yield was significantly ( $p<0.01$ ) higher in T2 and T3 group than the T1 group. The average fat, protein, SNF, lactose, ash, specific gravity and freezing point depression of milk in T1, T2 and T3 group was 3.07±0.11, 3.62±0.13 and 4.31±0.20; 3.46±0.02, 3.53±0.02 and 3.59±0.02; 9.26±0.04, 9.34±0.04 and 9.34±0.04; 5.38±0.03, 5.41±0.03 and 5.48±0.02; 0.75±0.01, 0.78±0.01 and 0.79±0.00; 1.0348±0.0001, 1.0349±0.0002 and 1.0352±0.00 and - 0.63, - 0.64 and - 0.63 percent, respectively and for Holstein-Friesian crossbred

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and Sahiwal cow, it was  $3.74 \pm 0.11$  and  $3.58 \pm 0.14$ ;  $3.53 \pm 0.02$  and  $3.53 \pm 0.0$ ;  $8.06 \pm 0.19$  and  $9.3 \pm 0.03$ ;  $5.42 \pm 0.02$  and  $5.42 \pm 0.02$ ;  $0.77 \pm 0.00$  and  $0.76 \pm 0.00$ ;  $1.0348 \pm 0.001$  and  $1.0351 \pm 0.0001$  and - 0.63 and - 0.64 percent, respectively. The analysis of variance showed that there was highly significant ( $p < 0.01$ ) effect of treatment on the average fat, protein, ash and non-significant ( $p > 0.05$ ) effect on SNF, lactose, specific gravity and freezing point depression. The average fat, protein and ash content (%) was significantly ( $p < 0.01$ ) increased in T2 and T3 groups.

The average daily dry matter intake (DMI), dry matter intake per 100 kg body weight and feed conversion efficiency (FCE) for T1, T2 and T3 groups was  $11.93 \pm 0.21$ ,  $14.66 \pm 0.19$  and  $15.42 \pm 0.22$  kg;  $2.43 \pm 0.03$ ,  $2.98 \pm 0.02$  and  $3.10 \pm 0.03$  percent and  $0.50 \pm 0.01$ ,  $0.51 \pm 0.01$  and  $0.51 \pm 0.01$ , respectively. The average daily DMI, DMI per 100 kg body weight and FCE of Holstein-Friesian crossbred and Sahiwal cow was  $15.40 \pm 0.19$  and  $12.61 \pm 0.16$  kg;  $2.76 \pm 0.03$  and  $2.91 \pm 0.03$  percent and  $0.51 \pm 0.00$  and  $0.49 \pm 0.01$ , respectively. There was ( $p < 0.01$ ) significant increase in DMI in T2 and T3 groups compared to T1 group.

The overall average Temperature Humidity Index (THI) was  $78.01 \pm 0.65$ ,  $74.89 \pm 0.39$ ,  $76.26 \pm 0.39$ ,  $76.26 \pm 0.39$ ,  $80.7 \pm 0.61$ ,  $85.04 \pm 0.64$ ,  $82.80 \pm 0.53$  and  $79.17 \pm 0.22$  for 1st fort night (FN), 2nd FN, 3rd FN, 4th FN, 5th FN, 6th FN, 7th FN and 8th FN, respectively. The average THI value for ILF(C) was  $78.14 \pm 0.97$ ,  $74.99 \pm 0.56$ ,  $76.26 \pm 0.56$ ,  $77.69 \pm 0.70$ ,  $80.90 \pm 0.93$ ,  $85.25 \pm 0.96$ ,  $82.93 \pm 0.77$  and  $79.52 \pm 0.28$  and For Sahiwal cattle farm, it was  $77.87 \pm 0.90$ ,  $74.79 \pm 0.56$ ,  $76.26 \pm 0.56$ ,  $76.26 \pm 0.56$ ,  $80.5 \pm 0.81$ ,  $84.83 \pm 0.88$ ,  $82.66 \pm 0.74$  and  $78.82 \pm 0.33$  during 1st FN, 2nd FN, 3rd FN, 4th FN, 5th FN, 6th FN, 7th FN and 8th FN. There was significantly ( $p < 0.05$ ) highest THI was found during 6th FN.

The average respiration rate, pulse rate, rectal temperature and rumination time in T1, T2 and T3 groups was  $26.84 \pm 0.54$ ,  $26.22 \pm 0.39$  and  $26.22 \pm 0.39$  per min;  $80.33 \pm 2.02$ ,  $67.52 \pm 1.31$ ,  $65.17 \pm 1.30$  per min;  $102.1 \pm 0.17$ ,  $101.4 \pm 0.10$  and  $100.69 \pm 0.08$  °F and  $405.7 \pm 3.30$ ,  $425.59 \pm 4.45$  and  $438.88 \pm 4.45$  min/day, respectively and for Holstein-Friesian crossbred and Sahiwal cows, it was  $27.00 \pm 0.31$  and  $25.85 \pm 0.41$  per min;  $74.44 \pm 1.45$  and  $68.11 \pm 1.41$  per min;  $101.38 \pm 0.11$  and  $101.48 \pm 0.12$  °F and  $422.92 \pm 3.33$  and  $423.85 \pm 3.21$  min/day, respectively. There was highly significant ( $p < 0.01$ ) decrease in pulse rate, rectal temperature and increase in rumination time in T2 and T3 groups than the T1 group. But respiration rate was not affected by treatment in the present study. The average blood albumin, globulin and A: G ratio in T1, T2 and T3 groups was  $5.28 \pm 0.21$ ,  $7.36 \pm 0.27$  and  $8.47 \pm 0.48$  g/dl;  $5.36 \pm 0.21$ ,  $6.91 \pm 0.32$  and  $7.97 \pm 0.33$  g/dl and  $1.01 \pm 0.03$ ,  $1.19 \pm 0.07$  and  $1.09 \pm 0.05$ , respectively and for Holstein-Friesian crossbred and Sahiwal, it was  $6.56 \pm 0.29$  and  $7.51 \pm 0.32$  g/dl,  $6.35 \pm 0.25$  and  $7.13 \pm 0.26$  g/dl and  $1.12 \pm 0.04$  and  $1.07 \pm 0.04$ , respectively. There was highly significant ( $p < 0.01$ ) increase in blood albumin and globulin content in T2 and T3 group compared to T1 group in the present study. The average superoxide dismutase (SOD) level of plasma for T1, T2 and T3 groups was  $8.06 \pm 0.10$ ,  $7.48 \pm 0.13$  and  $7.27 \pm 0.22$  unit/mg of



protein, respectively and for Holstein-Friesian crossbred and Sahiwal, it was 7.69±0.15 and 7.52±0.11 unit/mg of protein, respectively. In the present study, it was found that there was significant ( $p<0.05$ ) reduction in superoxide dismutase level of blood in T2 and T3 group compared to T1 group. The overall mean digestibility coefficient of DM, OM, CP, EE, CF and NFE in T1, T2 and T3 group was 67.05±0.15, 68.26±0.16 and 68.48±0.15; 68.46±0.17, 65.11±0.24 and 68.88±0.15; 64.89±0.24, 65.11±0.24 and 64.70±0.28; 53.69±1.19, 53.57±0.76 and 56.61±0.39; 59.67±0.20, 59.94±0.24 and 60.04±0.21 and 73.74±0.25, 74.74±0.25 and 76.71±0.15 percent, respectively and for Holstein-Friesian crossbred and Sahiwal cows, it was 68.10±0.14 and 67.76±0.17; 68.61±0.12 and 68.47±0.14; 65.01±0.13 and 64.79±0.26; 56.27±0.39 and 52.98±0.87; 60.10±0.18 and 59.67±0.17 and 75.02±0.25 and 75.11±0.27 percent, respectively. The analysis of variance showed non-significant ( $p>0.05$ ) effect of treatment, breed and fortnight on digestibility coefficient of DM, OM, CP, CF and NFE. But in case of EE, there was highly significant ( $p<0.01$ ) effect of treatment and breed on digestibility coefficient of EE. There was highly significant ( $p<0.01$ ) effect of treatment and breed on the average daily cost of feeding and cost of feeding per kg milk yield. The mean cost of feeding and cost of feeding per kg milk yield for T1, T2 and T3 group was Rs. 212.27±3.70, 262.37±2.82 and 302.25±3.31 and Rs. 36.13±0.78, 31.43±0.27 and 32.17±0.58, respectively. Though the total cost of feeding for T3 group was found to be significantly ( $p<0.01$ ) higher due to feeding of bypass fat, but cost of feeding per kg milk yield was significantly ( $p<0.01$ ) lower in T2 and T3 group compared to T1 because of higher milk production. In respect of breed, the daily cost of feeding and cost of feeding per kg milk yield in HF crossbred was significantly higher than pure Sahiwal cows.

The present experiment validated that heat stress can be ameliorated significantly by body cooling and feeding bypass fat during summer season for improvement of milk production and maximize the income from rearing of dairy cattle.

## **Effects of Different Methods of Smoking and Levels of Fat on Certain Quality Characteristics of Buffalo Meat Sausages**

*Anindita Mali*

Buffalo meat sausages were developed employing different methods of smoking and levels of fat to obtain a healthy product with good shelf-life properties and economic feasibility. Three primary treatment groups were prepared, namely- T1 (20% fat), T2 (10% fat + 10% inulin), T3 (7.5% fat + 12.5% inulin), which were subjected to three subgroup A (Conventional smoking), B (3% Liquid smoke), C (7% Liquid smoke). The control was prepared with 20% fat without any sub-treatments. 5 batches of buffalo meat sausages were prepared and evaluated for various important qualitative parameters on the 1st, 7th, 14th, 21st and 28th day of refrigerated storage, including estimation of PAH and cost of production.

The ES and CY were seen to significantly increase with the replacement of fat with inulin and the highest was observed in the treatment group T3. The pH value decreased significantly ( $P < 0.05$ ) in all the treatments in comparison to the control, the lowest of them being T2A ( $5.69 \pm 0.09$ ). With higher inclusion of inulin, the aw, and WHC significantly ( $P < 0.05$ ) increased in the treatment. The TBARS values were significantly ( $P < 0.05$ ) lower in the treatment group T3, ranging (from  $0.30 \pm 0.02$  to  $0.34 \pm 0.03$ ). The tyrosine value did not vary significantly among the control and treatments. However, T3B ( $10.14 \pm 0.38$ ) and T3C ( $10.10 \pm 0.44$ ) were significantly lower. The proximate analysis depicted treatment T3C to have the highest moisture content of  $68.62 \pm 0.45$ . The protein content did not vary significantly between the control and treatment and ranged from 19.05 to 19.72%. The fat content reduced from  $19.12 \pm 0.46$  to  $8.08 \pm 0.33$  when inulin was substituted for fat. The highest fat per cent was observed in T1A ( $19.12 \pm 0.46$ ) and the lowest in T3C ( $8.08 \pm 0.33$ ). The ash content increased from  $1.04 \pm 0.07$  (control) to  $2.63 \pm 0.06$  (T3C) with the addition of inulin at higher percentages. The lowest calorific value was obtained in T3C ( $155.79 \pm 1.42$ ), corresponding to the lowest level of added fat.

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The mean log<sub>10</sub> cfu for total plate count showed significant (P<0.05) differences between the control and other treatments, without any significant difference among the treatments. The buffalo meat sausages were not detected for *E. coli*, yeast and mould, Salmonella and *Staphylococcus*.

The TPA results showed that with higher inclusion of inulin as a fat replacer, the hardness, springiness, chewiness and resilience significantly increased. However, cohesiveness was not significantly affected. The colour profile study depicted a significant increase in the L\* value, with higher inclusion of inulin (54.95 ± 0.22) in T3B; however, the a\* values were inversely co-related to L\*. The b\* did not vary between treatments and control, except for treatment T3C.

The estimation of PAH depicted that the potent carcinogen Benzo(a)pyrene was absent in control and all the treated samples. However, the PAH compounds, Fluoranthene and Chrysene, were observed in the samples in both conventionally smoked and liquid smoke added products. The concentration of Fluoranthene differed significantly and was found to be the lowest in T1B (15.10 ± 0.00) and the highest in T2C (53.47 ± 9.04), while Chrysene content did not vary significantly and ranged from (32.27 ± 0.97 to 38.37 ± 1.77).

Considering the above parameters, T2 was found to be better than other treatment groups, and therefore the sausage samples of T2, along with the control, were subjected to the organoleptic evaluation. The subjective evaluation revealed that the conventional smoking treatment T2A had the highest scores for appearance, colour, flavour, texture and overall acceptability. ii

The developed buffalo meat sausages were found to be stable for up to 21 days under vacuum packaging at a refrigeration temperature (4 ± 10C), after which the microbial counts exceeded the FSSAI standards. The cost of production was calculated based on the market prices of the raw materials. The highest was observed for T3C (Rs. 763.45/kg), while the lowest was for control (Rs. 518.00/kg). Based on the findings of the present study, treatment group T2, in particular, T2A, was the best among all the treatments.

# **Development and Quality Assessment of Solar and Oven Dried Spent Hen Meat Powder**

*Bijoy Kumar Sarkar*

Chicken occupies one of the important constituents of Indian non-vegetarian diet due to cost competitiveness, nutritional quality, universal availability and absence of religious taboos. Spent hen meat represents hardness, poor acceptability and lowers remunerative prices in spite of its good nutritional quality, because of its higher collagen content and toughness of meat compared to those of broilers and roasters. To overcome the problems of toughness of spent hen meat, perishability of fresh meat, high cost involvement in maintaining refrigeration, lack of cold storage facility, energy deficiency in NER, disadvantages of traditional drying etc. a study was undertaken to develop spent hen meat powder with better shelf life at ambient temperature without affecting its quality.

Keeping in view the above facts, the proposed study was undertaken with the following objectives viz. development of technology for preparation of spent hen meat powder by using oven and solar dryer and by incorporating phytochemicals; determination of physico-chemical, microbiological and sensory qualities of spent hen meat powder; selection of an effective and suitable packaging method; and determination of shelf life and cost of production.

A total of five batches of spent hen meat powder were prepared with different formulations with or without addition of the phytoingredients in solar dryer (60-70°C for 30- 32h) and oven dryer (70°C for 18-20h). Control of solar dried spent hen meat powder was packaged with LDPE (150µm) under aerobic (A) and vacuum packaging (B); similarly treatment was packaged under aerobic (C) and vacuum packaging (D) for assessment of quality and identifies shelf stability. At the same time control of oven dried spent hen meat powder was packaged under aerobic (E) and vacuum packaging (F) and treatment was packaged under aerobic (G) and vacuum packaging (H). The results of the investigation are as follows-

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Yield decreased in treatments, whereas hygroscopicity, water hydration capacity, bulk density and solubility do not vary. Water activity, pH and TBARS value increased during storage. Treated samples show lower pH and TBARS value than control. TBARS values of meat powder under vacuum packaging were lower than aerobic packaging during storage. Tyrosine values were higher in oven dried sample compared to solar dried sample. Lightness and yellowness values show an increasing trend, whereas redness shows a decreasing trend during storage period.

Increasing trends in moisture content were observed during the storage periods. Crude protein, crude fat, total ash and carbohydrate content of spent hen meat powder did not differ much between samples and during storage. Decreasing trends of calorific value of samples were observed during storage period kept under aerobic packaging. All the samples were microbiologically safe throughout the storage period. All the samples were acceptable up to 150 days with good sensory scores. Spent hen meat powder can store up to five months at room temperature under both aerobic and vacuum packaging. Main antioxidant compounds present in phytoingredients extract were identified by LC-MS and large numbers of antioxidant compounds were found to be present in the phytoingredients. Solar drying is economical over oven drying for preparation of spent hen meat powder with similar product quality. Vacuum packaging is better to preserve product quality. Addition of phytoingredients increases the cost of production but provides better product quality and shelf stability.

Based on the above study it can be concluded that chemically, microbiologically and organoleptically acceptable spent hen meat powder can be prepared with the use of low cost solar dryer.

## **Technology Upscaling of Certain Traditional Pork Products of Nagaland**

*H. Moaakum Sangtam*

Traditional pork products of Nagaland prepared with locally available plant based ingredients *viz.* *Anishi*, *Silam* and FDS (Fermented dried soya) were evaluated in the present study. Based on the popularity, a purposive survey was conducted in field level to evaluate the level of ingredients used and with an aim to refine and upscale the processing steps and to extend the shelf life of the products. Three formulations were prepared using pork with *Anishi*, *Silam* and FDS along with a control, prepared without adding the above ingredients. On the basis of pilot study, the level of incorporation for *Anishi*, *Silam* and FDS were selected as 5, 10 and 5 percent, respectively. The cooked products were packaged under two different systems *viz.* retort pouch and vacuum packaging. The retort pouched products were subjected to physicochemical, microbiological and sensory evaluation at ambient temperature (25-32oC) for 6 months whereas, the vacuum packaged products were evaluated at refrigeration temperature (4±1oC) for 15 days. The economics of products were also calculated. Under retort processing, the total heating time (min) was recorded to be highest in pork with FDS compared to control, pork with *Anishi* and *Silam*. The proximate composition i.e. percent moisture, crude protein, ether extract and total ash in retort pouch and vacuum packaging revealed highly significant ( $p<0.01$ ) differences in control and the treated products. The pork with FDS revealed highest protein content in both retort and vacuum packaging.

However, no significant differences were observed for different storage periods. For mean scores of pH, TBARS and tyrosine values highly significant ( $p<0.01$ ) differences were observed among control and different product formulations and also during different storage periods. The TPC, coliform and yeast and mould were absent under retort pouch packaging during the entire storage period, conversely under vacuum packaging highly significant differences ( $p<0.01$ ) were recorded in respect of TPC and psychrophilic count among control and all the treated products and at different storage periods. Coliform count was  $<3$  and yeast and mould were absent in vacuum packaged

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products. The amino acid content in control and treated products were decreased with the increase in storage period. Highly significant ( $p < 0.01$ ) differences were observed in texture profile among control and the treated products as well as during different storage periods under retort pouch packaging. In respect of vacuum packaging significant ( $p < 0.05$ ) differences were observed during different storage periods among control and the treated products. Highly significant ( $p < 0.01$ ) differences were observed in colour profile under retort pouch and vacuum packaging in control and among the treated products and during storage period. The sensory evaluation showed highly significant ( $p < 0.01$ ) differences in appearance, flavour, juiciness, tenderness and overall acceptability in control and treated products and during storage period under retort pouch and vacuum packaging and revealed higher scores in pork with *Silam* and FDS compared to *Anishi* and control. The costs of productions were lower in all treated products compared to control under retort pouch and vacuum packaging. Based on the results obtained in the study it might be concluded that traditional pork products could be prepared economically by incorporating traditional ingredients like *Anishi*, *Silam* and FDS at 5, 10 and 5 percent levels using vacuum and retort packaging without any appreciable depreciation in nutritive values and sensory qualities till 15 days for vacuum packaging with refrigeration storage and for retort packaging till 180 days under ambient temperature.

## **Effects of Black Rice Extract on Quality Characteristics of Duck Meat Nuggets**

*Kalpita Saikia*

Duck meat nuggets were prepared by incorporating three different concentrations (0.5%, 0.9% and 1.3%) of black rice ethanol extract (BREE) and other non-meat ingredients to find out the best formulation which can be stored for a reasonable time at refrigeration temperature without affecting their physico-chemical, organoleptic and microbiological qualities. Nuggets were cooked by two different methods, i.e. steam cooking and oven cooking. The formulations prepared in the steam cooking method were CS (0% BRE), T1S (0.5% BRE), T2S (0.9% BRE) and T3S (1.3% BRE) and formulations prepared in the oven cooking method were CD (0% BRE), T1D (0.5% BRE), T2D (0.9% BRE) and T3D (1.3% BRE). A total of five batches of nuggets of each formulation were prepared, and different quality parameters were evaluated. In oven cooking nuggets were cooked in a preheated hot air oven at 120°C till the internal temperature reached  $75 \pm 2^\circ\text{C}$ , Steam cooking nuggets were done in a cooking vat at 80°C for 45min. After that, these were packed in food-grade polyethylene bags, stored under refrigeration temperature and evaluated for various quality traits viz., Water Holding Capacity (WHC), pH, Water activity ( $a_w$ ), Thiobarbituric acid (TBA) value, Total Plate Count (TPC), Total Viable Psychrophilic Bacterial Count (TVPBC), Coliform count, Yeast and Mould count, Staphylococcus count, Antioxidant activity, Colour Profile on 1st, 5th, 10th and 15th days of storage. In addition, Emulsion Stability, Cooking Loss, Proximate Composition, Organoleptic qualities, and Texture Profile of the products were estimated on the day of production (1st day). The production cost of duck meat nuggets were also calculated to find out the best and most economic formulation.

Emulsion stability (ES), Cooking loss and proximate composition of duck meat nuggets did not show significant ( $P > 0.05$ ) differences between control and Black Rice Extract treated products both in steam cooking and oven cooking. The pH values did not differ significantly between the treated and control formulations in both the cooking

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methods. However, there was a significant ( $P < 0.01$ ) decrease in pH value of nuggets during storage up to 15 days. The highest  $a_w$  was recorded in the control formulations, while T3 formulations recorded lowest  $a_w$  value in both cooking methods. The  $a_w$  decreased significantly ( $P < 0.01$ ) from the 1st to 15th day of storage both in the control & treated formulations. The WHC of the nuggets did not differ significantly ( $P > 0.05$ ) among the treatments and control formulations in either of cooking methods. A significant ( $P < 0.01$ ) decrease in the WHC was however observed as the storage period progressed. The TBARS values showed a significant ( $P < 0.01$ ) decreasing trend with increased concentration of BRE in the products. During storage, the TBARS value increased significantly in both the control and BRE treated formulation; though, the highest value was recorded in the control formulations in both the cooking methods. The TPC of duck meat nuggets showed a significant ( $P < 0.01$ ) increase in bacterial load from 1st to 15th day of storage. The TVPBC was absent up to the 5th day of storage, although, the duck meat nuggets showed a significant ( $P < 0.01$ ) progressive increase in bacterial load from 6th to 15th day of storage. The Coliform, Yeast and Mould and, Staphylococcus counts were negative during the storage period. A non-significant ( $P > 0.05$ ) differences were observed between control and treated products in terms of hardness, fracturability and chewiness in both the cooking method, However, springiness, cohesiveness and resilience values of texture profile showed significant ( $P < 0.01$ ) differences between the product groups. The results of colour profile studies showed that the redness ( $a^*$ ) value increased significantly ( $P < 0.01$ ) with the increased incorporation of Black Rice Extract, however during storage, the value decreased significantly in all the formulations. The lightness ( $L^*$ ) and Yellowness ( $b^*$ ) values decreased significantly ( $P < 0.01$ ) with the incorporation of BRE, although, the  $b^*$  value decreased, and the  $L^*$  value increased significantly in all the formulations & in both the cooking methods during storage periods. The incorporation of higher concentrations of black rice extract resulted in higher DPPH free radical scavenging activity. During storage (up to 15 days) it had shown a significant decreasing trend of antioxidant activity in all the formulations and in both the cooking methods. The higher concentrations of black rice extract resulted in higher total phenolic content. The taste panel evaluation studies in respect of overall acceptability scores of duck meat patties involving all the eating quality parameters revealed that the 0.9% BRE treated products (T2) had the highest overall acceptability scores. Though, the panel scores of nuggets recorded for all other treatment groups were found acceptable.

Estimation of production cost of duck meat nuggets indicated that T3 formulation products were more economical than the control and other treated products. Based on the results obtained in the study, it might be concluded that duck meat nuggets could be prepared satisfactorily on the addition of up to 1.3% concentration of BRE and can be stored safely up to 10 days under refrigeration temperature.

# **Influence of Coagulating Enzymes, Iron Fortification and Packaging Methods on The Quality Characteristics and Shelf-Life of Mozzarella Cheese**

*Masuk Raquib*

A study was carried out to develop iron fortified mozzarella cheese from cow's milk, goat's milk and mixed milk using kiwifruit crude extract. The experiment was conducted in the laboratories of Department of Livestock Products Technology, All India Coordinated Research Project on Post- Harvest Engineering and Technology and Department of Veterinary Microbiology, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati -781 022.

Kiwifruit crude extract was prepared from fresh kiwi fruits (*Actinidia chinensis*). The proteolytic enzyme present in the crude extract identified through SDS-PAGE was actinidin having an apparent molecular mass of 24.5 kDa. Optimum level of kiwifruit extract can be used @ 150µg/ml of milk for complete coagulation within 27min for preparation of iron fortified mozzarella cheese.

Mozzarella cheese can be efficiently fortified with ferric chloride safely without giving rise to off-flavour in the product at an optimum level of 1g/lts of milk. Maximum retention of iron (51.29mg/kg) was recorded in mixed milk iron fortified mozzarella cheese samples.

Effect of enzymes and different types of milk were studied on the physico-chemical properties (pH, acidity), proximate composition, water activity, meltability, colour profile, texture analysis, yield, organoleptic properties and microbiological quality of iron fortified mozzarella cheese.

Proximate composition revealed highest values for total solid and ash content for goat's milk iron and fat in mixed milk iron fortified mozzarella cheese, while lowest moisture and fat content were recorded in goat's milk iron fortified mozzarella cheese in the treatment group.

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Texture profile analysis of goat's milk iron fortified mozzarella cheese samples showed higher values for hardness, springiness, cohesiveness and chewiness while cow's milk iron fortified mozzarella cheese samples recorded higher value for adhesiveness and mixed milk iron fortified mozzarella cheese for gumminess parameters.

There was a gradual increase in curd syneresis with advancement of time. Curd syneresis was noted to be highest in cow's milk followed by goat milk and least was observed in mixed milk over a period of 120min.

Mixed milk iron fortified mozzarella cheese enjoyed superior ratings for all the sensory attributes, viz., appearance, colour, body and texture, flavour, saltiness and overall acceptability.

The TVC increased gradually from 0d till 15d of refrigerated storage for all the samples of iron fortified mozzarella cheese under both aerobic and vacuum packaging conditions irrespective of the types of milk and enzymes used. Under aerobic packaging condition, higher TVC were observed for goat's milk sample in both control and treatment group all throughout the storage period. Mixed milk iron fortified mozzarella cheese exhibited least count in both the groups. The TVC of all the cheese samples were higher in aerobic packaging compared to vacuum packing.

Nil counts for Yeast and moulds, *E. coli*, Coliform, *Staph. aureus*, *Salmonella*, *Shigella*, *Listeria monocytogenes* and anaerobic spore counts were noted for all the types of cheese samples under both the packaging conditions, all throughout the storage period, under refrigerated condition

Best before use of mixed milk iron fortified mozzarella cheese samples was found to be 15d under both the packaging conditions with lesser TVC in the vacuum packaged samples.

Based on proximate composition, meltability, sensory attributes microbiological quality and cost of production, the technology developed under treatment group for mixed milk mozzarella cheese is recommended and a suitable protocol for commercial production of iron fortified mozzarella cheese has been proposed.

## Detection and Deactivation of Antimicrobial Residues in Pork

*Param Debbarma*

The present study aims to detect antimicrobial residues in collected pork samples, isolation and *in-vitro* study of the resistance pattern of meat-borne pathogens (*Escherichia coli*, *Salmonella spp.* and *Staphylococcus aureus*) against 12 commonly used antimicrobials in pig husbandry and effect of different cooking methods (*viz.*, boiling, roasting and microwaving) on deactivation/inactivation of antimicrobial residues.

The preliminary screening of 261 pork samples by microbial inhibition assay using endospores of *Bacillus subtilis* MTCC 441 as test organism revealed that none of the samples were positive for antimicrobial residues except 3 (three) which were doubtful to have traces of antimicrobial residues.

A total of 80 pork samples were further screened by Ultra-Fast Liquid Chromatography system (Model: Shimadzu Prominence LC-20AD, Detector-SPD-20AUV/ Vis; C18 Column: BDS Premium, 250 mm x 4.6 mm, 5 m) to detect OTC, TTC, CIP and GEN residues. OTC and CIP residues were detected in 2.5% and 1.25% of the samples, while none of the samples detected TTC and GEN residues.

The overall recovery rate of *Escherichia coli*, *Salmonella spp.* and *Staphylococcus aureus* from the pork samples were 28.75%, 9.09% and 31.25%, respectively. All the isolates showed variable ranges of resistance against the tested antimicrobials. Highest resistance was recorded against ampicillin (75-100%), followed by trimethoprim (37.5-100%), cefepime (25-75%), nalidixic acid (12.5-62.5%), sulfafurazole (0-37.5%), ciprofloxacin (0-37.5%), chloramphenicol (0-37.5%), ceftriaxone (0-25%) and amoxiclav (0-12.5%). All the isolates however, recorded 100% sensitivity against amikacin, gentamicin and tetracycline.

The effect of cooking *viz.* boiling, roasting and microwaving revealed significant reduction ( $p < 0.001$ ) in the residual concentration of antimicrobials (OTC, TTC, CIP and GEN). Cooking by microwaving recorded highest reduction (44.48-91.06%) followed by roasting (32.11-85.92%) and boiling (22.02-73.33%). Thus, cooking temperature and time can have a significant effect on the losses of antimicrobial residues and provides an additional safety margin to the consumers.

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# **Effect of Rice Beer and Phyto-Ingredients on Certain Quality Characteristics of Duck Meat Product**

*Pompi Rani Boro*

The study was conducted in the Department of Livestock Products Technology, Assam Agricultural University, Khanapara, Guwahati-22 to develop a duck meat product incorporating rice beer, phyto-ingredients and spices as marinating ingredients along with control without affecting the physico-chemical, microbial, organoleptic qualities and shelf life of the meat.

A total of five batches of marinated duck meat comprising of 4 different treatments in each batch were prepared. Ducks were collected and slaughtered hygienically and marinated. The marinades were prepared by using rice beer, spice paste and phyto-ingredients. The marinated samples are grouped into following treatments for control (meat and spice paste), Treatment 1 (meat and rice beer), Treatment 2 (meat, phyto-ingredients and spice paste) and Treatment 3 (meat, spice paste, rice beer and phyto-ingredients). The marinated samples were vacuum and aerobically packed and stored in refrigeration temperature for 24 hrs. After these periods, the samples were subjected to various quality assessments. Shelf life studies conducted at interval of 5 days for vacuum packed samples, whereas, aerobically packed samples were assessed for shelf-life studies at an interval of 3 days. The results of the investigation are as follows:

The alcohol content (%) of rice beer found to have  $6.02 \pm 0.2$ . The pH value was  $3.58 \pm 0.09$  and the antioxidant activity (%) was found to have  $16.12 \pm 0.13$ . The results with respect to pH, tyrosine and TBA of marinated duck meat were found to be significantly ( $P < 0.01$ ) higher when compared to control samples. Mean cooking yield was found to be higher in control samples as compared to the treated samples. The cooking yield was significantly lower in treated samples as compared to that of control samples.

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The mean percent of proximate composition of products showed similar trend for both aerobic and vacuum packaging systems. Moisture was high in the Treatment 3 samples as compared to that of control samples, whereas, crude protein, ether extract and total ash was high in control samples. The mean values of moisture, crude protein, ether extract and total ash showed significant differences among the control and treated samples but no significant effect could be seen in both the packaging conditions.

The mean values of colour profile showed no significant differences between the control and treated samples and also no significant effect in both the packaging conditions. The data generated for aerobic packaging method revealed marginally higher L\* values. The L\* value was lower for treated products than that of control products. Redness (a\*) followed a decreasing trend in all the treated products as well in control products. Slight decrease in yellowness in vacuum packaged duck meat products. ii

The mean values of texture profile also showed similar trend in both the packaging systems. The hardness values showed a decreasing trend in treatment 3 as compared to control samples in both the packaging systems. However hardness values were marginally lower in vacuum packaged samples when compared to aerobically packaged samples. Significant differences ( $P < 0.01$ ) could be observed in the control and treated samples for springiness and chewiness, whereas, cohesiveness followed an increasing and decreasing trend and no significant ( $p > 0.05$ ) differences among all the treated samples. The resilience followed uniformly decreasing trend from control to T3 samples. The sensory evaluation showed no significant differences (Appearance, colour, flavour and tenderness), whereas, significant differences were observed for juiciness and overall acceptability. The microscopic study in both (scanning electron microscope and light microscope) revealed swelling of muscle fiber and decrease in inter fibrillar spacing between the muscle fibers and disruption of connective tissue membranes due to use of marinating ingredients. The microbiological quality studies revealed that there is a significant increase ( $P < 0.01$ ) in control samples compared to treated samples during the entire storage periods in both the packaging systems, whereas, total psychrophilic count could not be detected on 1st and 5th day of storage in vacuum packaging but on 10th and 15th day it increases in the storage periods. Similarly for aerobically packaging systems, TVPBC were not detected on 1st day of storage but on 3rd, 5th and 7th day of storage it increases in the storage periods. The Yeast and Mould count and Coliform count were absent in all the storage periods in both the packaging systems. The Sulphite Reducing *Clostridial* organisms and salmonella were also found to be absent in all the samples for both the packaging systems. The shelf life studies of marinated duck meat were studied on the basis of pH, tyrosine, TBARS value, microbiological quality and visible colour and odour changes of the products at refrigeration temperature. Vacuum packaging system was found to be better than the aerobic packaging system. Based on the investigation, it can be concluded that an acceptable marinated duck meat product can be developed for future commercial exploitation.

# **Quality Evaluation and Shelf Life Studies of Pork Nuggets Prepared by Using Different Humectants and Anti-Oxidants**

*Protiva Gogoi*

Now-a-days, humectants and antioxidants are much preferred to be used as additives in the formulation and development of meat products. However, the chemical form of these additives are not preferred by the consumers for their adverse effect on human health and sensory qualities of the products. In the present study, an attempt was made to evaluate the quality and shelf life of pork nuggets by incorporating both natural and chemical humectants and antioxidants at different proportions to find out the best desirable and suitable formulation.

Nuggets were prepared by incorporating different humectants and antioxidants and packaged in aerobic and vacuum packaging methods. These were stored at ambient and refrigerated temperature during which their different quality traits and shelf life studies were undertaken. The formulations prepared were - Control (without humectants and antioxidants), T<sub>1</sub> (chemical humectants and chemical antioxidants), T<sub>2</sub> (chemical humectants and natural antioxidants), T<sub>3</sub> (natural humectants and chemical antioxidants) and T<sub>4</sub> (natural humectants and natural antioxidants). For this, five batches of each formulation were prepared and these were evaluated on day-1 (preparation day) and subsequently on 3<sup>rd</sup> and 5<sup>th</sup> day at ambient temperature and 7<sup>th</sup>, 15<sup>th</sup> and 30<sup>th</sup> day at refrigerated storage temperature on being packaged by aerobic packaging and vacuum packaging methods and then evaluated for various meat quality parameters, shelf life, besides, production cost of pork nuggets.

Emulsion stability (ES) studies recorded  $0.30 \pm 0.05$ ,  $0.30 \pm 0.03$ ,  $0.20 \pm 0.03$ ,  $0.28 \pm 0.02$  and  $0.20 \pm 0.03$ ml/100g for the control, T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> respectively. The pH and TBARS values of pork nuggets showed an increasing trend from the day-1 up to 5<sup>th</sup> day at ambient storage and up to 30<sup>th</sup> day at refrigerated storage in both the packaging methods. The control products of both the packaging methods exceeded the

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threshold TBARS value of 1mg malonaldehyde per kg on 5<sup>th</sup> day at ambient storage and 30<sup>th</sup> day at refrigerated storage. Also, T<sub>1</sub> and T<sub>3</sub> products packaged under aerobic packaging exceeded the threshold limit on 5<sup>th</sup> day at ambient storage temperature. The a<sub>w</sub> of the control and treated pork nuggets showed a slight decreasing trend (p<0.05) from the initial day up to the end of storage period at both the storage temperature with the lowest fall in vacuum packaged T<sub>4</sub> product (0.93±0.00) at refrigerated storage. The FAA studies indicated the presence of 18 FAA in the products. Glutamic acid was by far the most abundant one. The arginine content was also quite high among the FAA on day-1 as well as on subsequent storage days. The glycine content was the least among the FAA during the period of study. The moisture, CP and CF contents of pork nuggets differed significantly (p<0.01) among the control and the treated product groups. There was a significant (p<0.01) decrease in per cent moisture content from the control to T<sub>4</sub> formulation in all the storage days and this was irrespective of the packaging methods employed. However, it increased as the storage days progressed. The per cent CP and CF decreased significantly (p<0.01) with the progression of storage period at both the storage temperature which was highest in the control group and least in T<sub>4</sub> formulation throughout the storage period. The VP products recorded significantly higher CP and CF contents as compared to aerobically packaged ones. The TA contents showed non-significant differences among the control and the treated groups during the whole storage period both at ambient and refrigerated temperature and AP and VP conditions. The TVPC revealed significant increase (p<0.01) in bacterial load from 1<sup>st</sup> to 5<sup>th</sup> day at ambient storage and up to 30<sup>th</sup> day at refrigeration storage. Among the treatment groups, T<sub>4</sub> recorded lowest increase in bacterial count during the entire storage period. The VP pork nuggets had lower counts in comparison to AP nuggets during the storage days. Yeast & mold, Coliform and *Staphylococcus aureus* were not detected during the entire study period. Texture profile studies in respect to hardness, springiness, cohesiveness and resilience values of the control and treated products packaged by AP and VP methods gradually decreased (p<0.01) as the storage period progressed. Highest decline was recorded in control products and the lowest in T<sub>4</sub> group. In regards to chewiness, the values were significantly higher (p<0.05) in control group followed by T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and least in T<sub>4</sub> group. Colour profile studies revealed significant increase (p<0.01) in L\* and b\* values on progression of storage period at both the storage temperature. Highest L\* and b\* values were recorded in the control group followed by T<sub>1</sub>, T<sub>3</sub>, T<sub>2</sub> and least in T<sub>4</sub> group. Vacuum packaged products showed significantly lower (p<0.01) L\* and b\* values than its aerobic counterparts. The a\* values decreased significantly in all the treated and control group on progression of storage days both at ambient and refrigeration temperature. The VP products recorded slightly higher a\* values (p>0.05) than its aerobic counterparts during all the storage days irrespective of storage temperature. Highest decline in a\* value was recorded in the control group and least in T<sub>4</sub> group. Pork nuggets were rated to be superiormost in terms of their organoleptic qualities. Nuggets packaged by VP registered higher panel scores than those of AP in



respect of appearance, flavour, texture, juiciness and overall acceptability. The production cost estimation of pork nuggets indicated lowest production cost for the control products in comparison to the treated ones. However, among the treated nuggets, T<sub>3</sub> registered lowest cost followed by T<sub>1</sub>, T<sub>4</sub> and T<sub>2</sub> respectively.

## **Interaction Studies of Microbial Enzymes and Phytochemicals of *Bael* (*Aegle marmelos*) in Flavour Enhancement of Cow's Milk Ghee**

*Rashmi Rekha Saikia*

A study was conducted to develop flavour and colour enhanced cow's milk ghee using starter cultures as a source of microbial enzymes and phytochemicals of *bael* (*Aegle marmelos*) fruit pulp extract. The experiment was conducted in the laboratories of the Department of Livestock Products Technology, the All India Coordinated Research Project on Post-Harvest Engineering and Technology, the Department of Livestock Production and Management, the Department of Veterinary Biochemistry, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati-781 022; and the Central Analytical Instrumentation Facility, Guwahati Biotech Park Incubation Centre of the Indian Institute of Technology, Amingaon, Kamrup, Guwahati-781 031 during the period from August 2020 to April 2022.

*Lactococcus lactis* ssp. *lactis* var. *diacetylactis* and yoghurt cultures of *Streptococcus thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus* were used @ 3% (v/v) in the study. *Bael* pulp extract was added @ 1% (v/v) to the treatment groups.

Cow's milk ghee was prepared by the heat clarification method. The flavour and colour qualities, FFA contents, antioxidant compounds, sensory attributes, proximate composition and shelf-life of the cow's milk ghee thus prepared were studied. The ghee was stored at ambient temperature to study the shelf-life.

A total of 34 flavour compounds were detected in the samples of the treatment groups as well as the reference sample by GC-MS studies. Identical numbers of FFA were also detected in the ghee samples. The flavour of the ghee was attributed by the FFA along with the other flavouring compounds like the alcohol, hydrocarbons, ketones, terpenoids, organic acids and 9 other compounds identified in the ghee samples.

Ascorbic acid, thymol, phytol and  $\beta$ -sitosterol were the four antioxidant compounds detected by GC-MS. The maximum radical scavenging activity ( $60.160 \pm$

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**Major Advisor : Dr. Trishna Borpuzari**

0.541%) was observed in the sample of T<sub>4</sub>. *Bael* pulp extract added ghee samples had higher DPPH inhibition activity as compared to the other groups and the reference sample.

Colour component b\* was found in higher values in *bael* pulp extract added ghee samples. Highly significant positive correlation was found between the sensory evaluation scores for colour and the colorimetric assessment of the colour components (b\* value).

Higher panel ratings for flavour and colour of the samples of T<sub>4</sub> group indicated that *bael* pulp extract indeed had a positive effect on the flavour and the colour characteristics of cow's milk ghee.

The moisture and ash contents of the ghee were highly significantly influenced by the starter cultures and addition of *bael* pulp extract while only significant difference could be found in their protein content.

Shelf-life study was done based on the FFA and peroxide values. Correlation studies revealed a highly significant difference between FFA and PV while a negative correlation existed between the FFA x antioxidant activity and PV. A gradual increase in FFA and PV along with the increase during the storage period was found in all the treatment groups. Even after 6mon of storage, FFA and PV were found to be much lower than those recommended by the FSSAI (2016).

From the study it was found that the starter culture *Lc. lactis* ssp. *lactis* biovar *diacetylactis* used in the study in combination with the *bael* pulp extract produced cow's milk ghee with improved flavour and colour attributes and had an extended shelf-life at room temperature.

## **Development of Ready-to-Cook Chicken Chips Using Spent Hen Meat Incorporated with Fenugreek Seeds and/or Leaves Powder**

*Dimpi Choudhury*

A study was carried out to develop ready-to-cook chicken chips utilizing spent hen meat incorporated with fenugreek seeds and/or leaves powder. For this study twenty numbers of healthy spent hens were used following standard protocols for slaughtering and processing.

Fenugreek (*Trigonella foenum graecum*) seeds and its fresh leaves were purchased from local market of Guwahati city and processed to powdered form and stored for further use. The fenugreek leaves and the seeds were analyzed for proximate parameters. The fenugreek leaves contained  $85.64 \pm 0.72$  % moisture,  $4.62 \pm 0.14$ % protein,  $0.94 \pm 0.01$ % ether extract,  $1.69 \pm 0.13$ % crude fibre and  $10.73 \pm 0.12$ % total ash. While the fenugreek seeds contained  $10.26 \pm 0.15$ % moisture,  $26.86 \pm 0.10$ % crude protein,  $10.72 \pm 0.15$ % ether extract,  $47.52 \pm 0.39$ % crude fibre and  $3.82 \pm 0.07$ % total ash.

The qualitative phytochemical studies of fenugreek seeds and leaves revealed presence of steroids, phenols, tannins, flavanoids, alkaloids and saponins. The antioxidant activity against DPPH radical, total phenolic content and ferric reducing activity of the fenugreek seeds and leaves were studied using ethanolic extract. The mean per cent values of inhibition of DPPH radical by ethanolic extract were observed to be  $51.40 \pm 2.27$  and  $64.39 \pm 1.73$ % for fenugreek leaves and fenugreek seeds, respectively. The total phenolic content in ethanolic extract of both fenugreek leaves and fenugreek seeds were recorded as  $5.16 \pm 0.06$  and  $15.13 \pm 0.02$  mg GAE/g, respectively. The mean ( $\pm$ SE) ferric reducing activity by ethanolic extract of both fenugreek leaves and fenugreek seeds were found to be  $0.35 \pm 0.03$  and  $0.65 \pm 0.04$ , respectively and thus exhibit remarkable antioxidant activity.

The antibacterial activities of both extracts (fenugreek leaves and seeds) exhibited positive reaction against *Staphylococcus aureus* and *Klebsiella* spp. at different concentrations showing zones of inhibition ranging from 10 to 19 mm. The

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**Major Advisor : Dr. Deben Sapkota**

extracts of fenugreek seeds exhibited anti-bacterial effect against *E. coli* but no effect could be found with fenugreek leaves. Moreover, no antibacterial activity could be observed against *Salmonella* spp. by fenugreek leaves as well as fenugreek seeds.

The research trials were continued in two Phases, i.e., I and II. Under Phase I chicken chips was prepared as per standard formulation incorporating fenugreek seeds and/or leaves @ 0.25, 0.50 or 1.00 % level. The products were stored in sealed LDPE bags at ambient temperature ( $37 \pm 2^{\circ}\text{C}$ ) for a period of 30 days. The samples were evaluated for the physicochemical, proximate and sensory parameters at a regular interval of 10 days starting from 0th day, till 30th day.

The moisture level in all the treatment groups for fenugreek leaves as well as seeds including that of Control progressively increased as storage period extended till 30th day. The protein percentage in the treatment groups with increase in fenugreek seeds level (0.25, 0.50 and 1.00%) showed to have increased as compared to the Control and the values ranged from  $22.33 \pm 0.22$  to  $22.85 \pm 0.09\%$ . The analysis revealed no significant ( $P > 0.05$ ) differences among the various treatment groups incorporated with fenugreek seeds powder. The data analysis revealed no significant ( $P > 0.05$ ) differences in ether

extract among the various treatment groups incorporated with fenugreek leaves powder and control group and with increasing storage period. Significant changes ( $P < 0.05$ ) in total ash content could be noted in the Treatment groups with fenugreek seeds with increase in the level of fenugreek seed powder (0.5 and 1.0%).

Significant increase in pH could be seen on 30th day of storage in all the treatment groups including that of Control. The impact of storage could not be noticed in the products made of, either leaves or seeds in terms of tyrosine value. The water activity remained unchanged till the 20th day of storage, however increased significantly ( $P < 0.05$ ) on 30th day whereas no change observed among the treatment groups for both fenugreek leaves and seeds addition. The cooking yield of  $90.97 \pm 0.76\%$  to  $95.00 \pm 1.77\%$  range was recorded in the chicken chips incorporated with fenugreek leaves and fenugreek seeds powder.

The freshly prepared chicken chips with addition of fenugreek leaves and seeds on day 1 exhibited 'good' colour, texture, crispiness scores under hedonic scale. The sensory evaluation of the chicken chips product treated with fenugreek seeds and leaves powder showed low for flavor, after-taste scores and overall acceptability in the Treatment II (FL with 0.50%), III (FL with 1.00%) and Treatment V (FS with 0.50%) & VI (FS with 1.00%) groups throughout the storage period of 30 days.

Under Phase I trial, based on the statistical analysis obtained, two best groups FL with 0.25% and FS with 0.25% along with combination of both (FL+FS with 0.25 each) were selected for further studies. All the physicochemical values for the treatment groups were found to be under desirable ranges. Significant increase in the moisture

level was found on 30th day of storage as compared to the 0th, 10th and 20th day however, no changes were observed among different treatment groups.

The crude protein values ranged from  $22.36 \pm 0.02$  to  $23.03 \pm 0.06\%$  among all treatment groups. Significantly ( $P < 0.05$ ) high crude protein was recorded in the Treatment A (FS with 0.25%) and Treatment C (FL, FS 0.25% each) when compared with Control. The ether extract and total ash content in chicken chips revealed nonsignificant ( $P > 0.05$ ) changes when compared with the Control group.

Storage days showed significant ( $P < 0.05$ ) effect on pH of the products and treatment with combination of fenugreek leaves and seeds significantly showed lower ( $P < 0.05$ ) pH on 30th day when compared with 0th to 20th day of storage. There was no significant difference between the treatment groups and Control group throughout the storage period and the values remained far below permissible limit for all the products. The analysis of variance showed significant difference ( $P < 0.05$ ) in water activity values on 30th day of storage compared to the aw on the 0th, 10th and 20th day of storage. There was no significant ( $P > 0.05$ ) change in cooking yield of the treatment groups with increase in storage period and among the different treatment groups. The TBA values decreased significantly ( $P < 0.05$ ) on the 10th day of storage and remained static thereafter up to 30 days of storage. The cholesterol content of ready-to-cook chicken chips using spent hen with addition of fenugreek seeds and fenugreek leaves are found to be as  $30.55 \pm 0.14$ ,  $30.45 \pm 0.21$ ,  $30.39 \pm 0.16$  and  $31.44 \pm 0.14\%$  for Control, T-A, T-B and T-C, respectively with no significant ( $P > 0.05$ ) changes among the groups. The colour profile for the chicken chips showed significant differences only in  $L^*$  values while no changes observed in  $a^*$  and  $b^*$  values. A significant increase in mean DPPH activity was noted in all the treatment groups incorporated with fenugreek leaves and seeds powder revealing its potential antioxidant capacity.

The total plate count analyzed for the products were within the limits and were free from Coliform, Salmonella, Staphylococcal bacteria and yeast and mould which ensures the microbial safety of the product.

No significant difference was noticed for colour, texture, crispiness characteristics among the Control and treatment groups but could retain 'good' to 'very good' scores for the product. The chicken chips under all treatment groups scored very less scores in terms of flavour, after-taste and overall acceptability with increase in levels of fenugreek leaves and seeds powder. The chicken chips prepared with the incorporation of spent hen and fenugreek leaves or seeds have revealed good antioxidant profile without any noticeable changes in any other physico-chemical parameters and microbiological profile. Fenugreek leaves at 0.25% level can be effectively used in chicken chip preparation using spent hen meat with 'good' acceptability having cost of production of ` 7.45 per 30g of the product. It could be concluded that a level of 0.25% fenugreek leaves powder can effectively be incorporated in production of ready-to-eat chicken chips as functional food having added health benefits.

# **Analysis of Indigenous Chicken Farming System in Selected Districts of Brahmaputra Valley of Assam**

*Rafiqul Islam*

A study was conducted in all agro-climatic zones of Brahmaputra Valley of Assam to know socio-economic status of indigenous chicken farmers, demographic distribution and morphological characters of indigenous chicken. Different husbandry practices in indigenous chicken, productive and reproductive performances, diseases and mortality pattern, health coverage programme, economics and marketing of indigenous chicken, constraints faced by the chicken farmers, physical and chemical analyses of crop ingesta to know the nutritional status of scavenged chicken and carcass traits were also studied.

One district from each zone was selected on the basis highest indigenous chicken population. Again from each district, 10 villages were randomly selected. Further, 5 numbers of farmers were selected randomly from each district, thus a total of 50 farmers were selected from each district. In this way altogether 200 numbers of farmers were selected for the whole study.

Farmers were selected on the basis of experience and who kept at least 25-30 numbers of indigenous chicken. The data were collected in a pre-structured interview containing all relevant information pertaining to the study by personal interview method. The data were collected during August, 2017 to July, 2018

Majority (42%) of the respondents belonged to middle age group and most of them (83%) were women. Educational background was poor as two-fifth (42.50%) of them had only up to primary level of formal education. Occupationally there were mostly dependent on agriculture and animal husbandry. Some (21.50%) of them were landless and more than half of the respondents had only up to 5 bighas of land. More than fifty per cent of them were economically weaker with a annual income of Rs.1,00,000/-. Majority (64.50%) was married and three-fifth (59.50%) of them were Hindus, followed by Muslims (37.00%). Majority (59.00%) of them belonged to nuclear

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**Major Advisor : Dr. Niranjana Kalita**

family. Mostly (67.50%) women were the owner of the flock and most (62.50%) of them had more than 10 years of experience in chicken farming.

Most (94.68) of the indigenous chicken were normal feathered followed by naked neck (5.32%). Mostly males had red coloured plumage, while females were mostly brown mixed colored. Majority of the chicken had single comb. All the birds had red coloured comb. Majority of the chicken had black coloured shank.

The overall mean flock size recorded as  $29.79 \pm 0.28$  and each flock constituted mostly by chicks (65.01%), followed by growers (18.78%) and adults (16.20%) in the study areas. Majority (56.50%) of the farmers constructed coop for night sheltering and most (63.00%) of the coops were located outside the dwelling house. The mean dimension and floor space of the coop was  $1.73 \times 1.18 \times 1.01$  cubic meters and 2.04 square meters. The coop was constructed by locally available cheap materials. In most of the cases floors (77.50%) and walls (72.50%) were made of bamboo or wooden slated, while 87.50% of the roofs were made of G.I. sheet. The total cost of construction of coop ranged from Rs. 350/- to Rs. 2,250/- with overall mean of Rs. 850/-, which could accommodate up to 30 numbers of chickens. Mostly (74.50%) sand was used as bedding material and 39% of them used bamboo or wooden basket as laying nest. Majority (34.50%) of the respondents cleaned coop weekly once.

All the farmers under study revealed that indigenous chicken were provided with supplemental feed in addition to scavenged feed. Majority (65.50%) of the farmers offered grains followed by crop by-products (18.50%) and concentrate feed (16.00%). Most (70.50%) of them used home-mixed grains, while 57% of the respondents offered supplemental feed twice a day. The amount of supplemental feed ranged from 450 to 1000 g daily with an average of 750 g daily for 25 to 30 numbers of chickens. Majority (59.50%) of the farmers provided feed on the ground by throwing and the feed was provided together irrespective of sex and age in most (71.50%) of the cases. About one-third (32.00%) of them provided feed during monsoon season. Limited access for scavenging was the main problems of indigenous chicken feeding as reported by majority (50.50%) of the respondents. More than 90% of the respondents did not provide water troughs to their birds.

Majority (86.50%) of the respondents used home produced eggs for incubation. All of them practiced natural incubation and most of them used broody hen (96.50%) for incubation. Hatching was done twice in a year by majority (87%) of the respondents. The male-female ratio was erratic and it varied from 1:5 to 1: 20 with an average of 1:8.5. The mean number of eggs set per broody bird varied from  $13.06 \pm 0.26$  to  $13.77 \pm 0.25$  with an overall mean of  $13.59 \pm 0.23$ . Majority (64%) of the farmers retained their cock up to 2 years of age for breeding. More than two-third of the respondents did not practice selection of hatching eggs, while rest (32%) practiced selection on the basis of soundness of shell (68.5). Post-monsoon season was preferred by most (46.5%) of the farmers. Majority (63.5%) of the farmers did not record the duration period for hatching



eggs. Storing eggs in the nest before incubation was practiced by majority (85.5%) of the farmers.

Most (61.5%) of the respondents culled their surplus chicken stock for sale. Majority (58%) of the respondents culled surplus males and females at the age of 6 to 7 months. The overall mean body weights recorded were  $32.06 \pm 0.26$ ,  $752.50 \pm 3.99$  and  $1082.48 \pm 6.27$  g respectively at 1st week, male grower at 5 months and adult at 10 months of age. The corresponding values for female grower and adults were  $637.15 \pm 2.87$  and  $899.75 \pm 4.09$  g respectively. There was no significant ( $P \leq 0.05$ ) difference in body weights among different districts. The overall mean age at first egg was  $6.45 \pm 0.06$  months. The overall mean number of laying cycle per hen per year was found to be  $3.30 \pm 0.04$ . The overall mean number of eggs laid in a laying cycle and overall mean annual egg production per hen were found to be  $15.91 \pm 0.17$  and  $51.40 \pm 0.91$  respectively. The overall mean weight was  $32.57 \pm 0.19$  g. The mean fertility and hatchability (On TES) were recorded as  $89.73 \pm 0.44$  and  $83.45 \pm 1.04$  respectively. There was no significant ( $P \leq 0.05$ ) difference in fertility and hatchability among different districts.

Majority (54.5%) of the farmers did not treat their sick birds, while some (18%) of them consulted with veterinarians for their ailing birds. Most (94.5%) of the farmers did not practice any vaccination programme. None of the farmers practiced deworming in the study areas. Greenish diarrhoea was noticed by most of the farmers as symptoms in any disease outbreak. Ranikhet disease was the most important disease that resulted in highest mortality in a flock as reported by majority (84.5%) of the farmers under study. The overall mean per cent mortality in indigenous chicken recorded as  $18.97 \pm 0.28$ ,  $10.00 \pm 0.46$  and  $5.38 \pm 0.17$  respectively during 0 to 9, 10 to 20 and above 20 weeks of age in the study areas. There was a significant ( $P \leq 0.05$ ) difference in mortality per cent at above 20 weeks of age between districts.

The total cost of production per bird up to 72 weeks of age was higher in Sivasagar (Rs. 395.62) than other district. However, the net income and B:C ratio were higher in Sonitpur district. The overall mean egg price was Rs.  $8.39 \pm 0.16$  and live chicken was Rs.  $340.90 \pm 3.25$ . The market price of live chicken significantly ( $P \leq 0.05$ ) varied from district to district. Four numbers of marketing channels each were identified for live chicken and egg.

Lack of veterinary services was the major problem and was ranked first with mean score of 67.91 among all the constraints, followed by disease outbreak (67.59), predator (62.79), damaging crops and vegetable (61.70), external parasites (44.83), improper housing (43.64), inferior productivity of local chicken, unorganized marketing and shortage of feed.

The overall mean per cent grains and by-product contents of both male and female crop ingesta were significantly ( $P \leq 0.05$ ) higher during post-monsoon season than other seasons. Further, the values recorded during winter season ( $43.29 \pm 0.81\%$ ) were

significantly ( $P \leq 0.05$ ) higher than pre-monsoon and monsoon seasons. There was no difference in per cent grains and by-product contents of both male and female crop ingesta between districts. The overall mean per cent kitchen wastes contents of male crop ingesta were significantly ( $P \leq 0.05$ ) higher during pre-monsoon ( $48.39 \pm 1.14\%$ ) than other seasons. However the values were comparable between monsoon ( $41.37 \pm 1.23$ ) and winter ( $40.91 \pm 1.21\%$ ) seasons. The male crop ingesta contained significantly ( $P \leq 0.05$ ) higher per cent kitchen wastes in Dhubri ( $42.80 \pm 1.82\%$ ) than Nagaon and Sonitpur districts. Similarly the mean per cent kitchen wastes contents of female crop ingesta were significantly ( $P \leq 0.05$ ) higher during pre-monsoon ( $41.02 \pm 1.21\%$ ) and monsoon ( $42.07 \pm 1.94\%$ ) than post-monsoon and winter seasons. The female crop ingesta contained significantly ( $P \leq 0.05$ ) higher kitchen wastes contents in Sivasagar than Nagaon and Sonitpur districts. The overall mean per cent green forage contents of male and female crop ingesta were significantly ( $P \leq 0.05$ ) higher during monsoon than other seasons. Further, per cent green forage contents were significantly ( $P \leq 0.05$ ) higher in Sonitpur and Nagaon districts in the case of male and female respectively. The overall mean insects and worms contents of male and female crop ingesta were significantly ( $P \leq 0.05$ ) higher during monsoon than other seasons. There was no significant ( $P \leq 0.05$ ) difference in insects and worms contents of male crop ingesta between districts; however, significantly ( $P \leq 0.05$ ) higher insect and worm contents were found in Sivasagar ( $3.11 \pm 0.38\%$ ) district than other district in female crop ingesta. The overall mean per cent indigestible miscellaneous particles present in male crop ingesta were significantly ( $P \leq 0.05$ ) higher monsoon ( $14.19 \pm 0.55\%$ ) than other seasons. The corresponding values were also significantly higher in Nagaon and Sivasagar districts for male and female crop ingesta respectively.

The crop ingesta of male and female chicken constituted significantly ( $P \leq 0.05$ ) higher per cent of DM during monsoon ( $51.41 \pm 0.52\%$ ) and post-monsoon ( $51.91 \pm 0.45\%$ ) seasons respectively. There was no significant difference of dry matter contents of crop ingesta between pre-monsoon and winter season in male chicken, however dry matter content was significantly higher during postmonsoon than pre-monsoon and winter seasons. The crude protein content (on DM basis) was significantly higher during post-monsoon and winter seasons than other seasons in males. The crude protein content was significantly ( $P \leq 0.05$ ) higher in Dhubri and Sonitpur than Sivasagar district. In females, there was no significant difference in crude protein contents of crop ingesta among different seasons. However, crude protein content in Dhubri was significantly ( $P \leq 0.05$ ) higher than other districts in males ( $10.86 \pm 0.30\%$ ) and females ( $10.83 \pm 0.30\%$ ) respectively. The ether extract content (on DM basis) of male crop ingesta was significantly ( $P \leq 0.05$ ) higher during winter season than any other seasons. The corresponding value was significantly ( $P \leq 0.05$ ) higher in Dhubri than Sivasagar, however it was comparable with Nagaon and Sonitpur districts. There was no significant difference in ether extract content of female crop ingesta between districts and between seasons. The crude fiber content (on DM basis) of male crop ingesta was significantly

( $P \leq 0.05$ ) higher during winter than monsoon and post-monsoon, however it was comparable with pre-monsoon season. There was no significant difference in crude fiber contents of male crop ingesta between districts. However, female crop ingesta constituted significantly ( $P \leq 0.05$ ) higher crude fiber contents during pre-monsoon and post-monsoon than monsoon and winter. In Sonitpur district, female crop ingesta contained significantly ( $P \leq 0.05$ ) lower crude fiber contents than other districts. The total ash content (on DM basis) of male crop ingesta was significantly ( $P \leq 0.05$ ) higher during pre-monsoon than any other seasons. Significantly ( $P \leq 0.05$ ) lower content of total ash was found in Nagaon than any other districts. In females, the crop ingesta contained significantly ( $P \leq 0.05$ ) lower total ash during monsoon than post-monsoon and winter; however the value was comparable with pre-monsoon season. There was no significance difference in total ash content of female crop ingesta between districts. The calcium content (on DM basis) of male crop ingesta was significantly ( $P \leq 0.05$ ) higher during pre-monsoon than monsoon and post-monsoon; however the values were comparable with winter season. The calcium content of male and female crop ingesta was significantly ( $P \leq 0.05$ ) higher in Dhubri than any other districts. In winter season, the female crop ingesta contained significantly higher calcium than any other seasons. The total phosphorous content of male and female crop ingesta did not differ significantly between seasons and districts. The pre-slaughter live weight (g), dressed yield (%) and thigh yield (%) of both males and females did not differ significantly ( $P \leq 0.05$ ) either between districts or between seasons. Similarly, wings yield (%), drumsticks yield (%), breast yield (%) and back yield (%) of male did not differ significantly between districts and seasons. The mean per cent giblet yield in both male ( $6.15 \pm 0.04\%$ ) and female ( $6.14 \pm 0.05\%$ ) were significantly ( $P \leq 0.05$ ) higher during monsoon than other seasons but the values were comparable with pre-monsoon season. The overall mean per cent giblet yield was significantly ( $P \leq 0.05$ ) higher in Sivasagar than other districts in both males and females. The overall mean per cent head yield was significantly ( $P \leq 0.05$ ) higher during premonsoon than other seasons; however it was comparable with post-monsoon season.

# **Effect of Drinking Water of Different Sources on The Performance of Commercial Broiler Chicken During Monsoon Season**

*Sanghamitra Kalita*

The present study was undertaken with a view to compare the effect of drinking water of different sources on the performance of commercial broiler chicken during monsoon season. A total of 450 day-old commercial broiler chicks (Cobb 400) having similar body weight from a single hatch were procured from a local hatchery of Guwahati city. The chicks were weighed and randomly divided into ten experimental groups namely, untreated group with ring well water, treated group with ring well water, untreated group with tube well water, treated group with tube well water, untreated group with bore well water, treated group with bore well water, untreated group with pond water, treated group with pond water, untreated group with rain water and treated group with rain water. Each group consisted of 45 chickens. Further each group was again subdivided in 3 replicates containing 15 chicks in each group. The chicks were wing banded and reared under deep litter system of management throughout the experimental period of 6 weeks following standard and uniform management practices. The birds were offered both untreated and treated drinking water of these five sources. The treatment of water was done with the combination of acidifier and sanitizer at the rate each of 0.05 ml per liter of drinking water. The water samples from all the untreated and treated groups were analysed for various physico-chemical and microbiological parameters. During the period of experiment, performance traits of broiler chicken comprising of daily water and feed intake, weekly water and feed consumption, weekly body weight and body weight gain, FCR, BPEI and economy of production were recorded. The carcass traits, certain haematological and biochemical parameter of broiler chicken offered different sources of water were also determined

The average value of pH and turbidity of both untreated and treated drinking water differed significantly ( $P < 0.01$ ) among the different sources of water. The pH value of different sources of water ranged from 6.45 to 7.35. However, after treatment of

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water the pH value of all the five sources of water decreased significantly ( $P < 0.05$ ). On the other hand, turbidity of ring well and rain water increased significantly ( $P < 0.05$ ). All the water samples of different sources were found to be colourless in untreated and treated drinking water throughout the study, except for untreated tube well water which was partially brown in colour.

The quantitative analysis of chemical impurities comprising of TDS, total hardness, iron, calcium, magnesium, sulphate, fluoride, chlorine, chloride and nitrate indicated that the mean value of chemical impurities differed significantly ( $P < 0.01$ ) among the different sources of both untreated and treated drinking water. The treatment of water significantly ( $P < 0.05$ ) increased the TDS and chloride content of all the sources of water under study. The total hardness of all the sources of water became nil after treatment. The iron content of untreated tube well water (1.97 ppm) was beyond the maximum permissible level and after treatment the level decreased significantly ( $P < 0.05$ ) to permissible level of 0.88 ppm. After treatment, the calcium content of tube well and bore well, magnesium content of tube well and pond, sulphate content of ring well, tube well, bore well and pond and nitrate content of pond water decreased significantly ( $P < 0.05$ ). The rain water was free from total hardness, iron, magnesium, sulphate, fluoride, chlorine and nitrate content.

Among the different sources of water, the total bacterial load was higher in pond water as compared to other sources of water. However, after treatment the microbiological qualities that included total viable count, total *E. coli* count and total coliform count of all the sources of water under study were found to be reduced. The rain water was free from *E. coli*.

The average total water consumption (l/bird) of broiler chicken offered untreated pond water was lowest (12.055) and it was highest for bore well water (14.560). However, after treatment of water the total water consumption per bird increased numerically for all the groups. The overall water/ feed consumption ratio of broiler chicken offered different sources of water ranged from 3.67-4.07 wherein, it was lowest for untreated pond water (3.67) and highest for untreated rain water (4.07).

The total feed consumption of broiler chicken offered both untreated and treated bore well water was numerically higher as compared to other groups of broiler chicken. The weekly body weight and body weight gain of broiler chicken offered both untreated and treated groups of different sources differed significantly ( $P < 0.05$ ) among the broiler chicken. The bore well water offered broiler chicken of both untreated and treated exhibited significantly ( $P < 0.05$ ) highest final body weight. The treatment of water showed significantly ( $P < 0.05$ ) increased body weight of broiler chicken offered bore well, pond and rain water.

The overall feed conversion ratio for untreated ring well, tube well, bore well, pond and rain water was 1.81, 1.77, 1.88, 1.77 and 1.79 respectively. The corresponding values for treated drinking sources were 1.75, 1.73, 1.71, 1.72 and 1.76 respectively.

Among the untreated sources of drinking water, the broiler chicken offered tube well and pond water exhibited the best FCR values of 1.77. In respect of treated sources best result (1.71) was found in bore well water offered group followed by pond water, tube well, ring well and rain water. The treatment of drinking water improved the FCR values numerically for all the five sources of water. Among the untreated and treated sources, highest BPEI values were shown by the broiler chicken offered rain and bore well water. The per cent livability of broiler chicken offered untreated ring well, tube well, bore well, pond and rain water were 91.11, 91.11, 88.89, 95.56 and 100.00 respectively. On the other hand, cent per cent livability was found to be the broiler chicken offered treated drinking water. Among the untreated sources, the cost of production per broiler was found to be highest in broiler chicken offered bore well water (₹ 179.24), whereas it was lowest for pond water (₹ 163.15) offered group. In respect of treated sources, the cost of production per broiler was highest (₹ 178.70) in bore well water offered group and it was lowest (₹ 170.12) in tube well water. Among the treated sources gross profit was highest (₹ 37.20) in broiler chicken offered bore well water.

The average carcass quality traits, per cent yield of cut up parts and per cent weights of relative organs of broiler chicken did not differ significantly ( $P < 0.05$ ) among the sources except the dressing percentage, per cent weights of kidneys and thymus (untreated). The treatment of bore well water showed significantly ( $P < 0.05$ ) increased dressed weight, dressing percentage, giblet weight and giblet yield. The abdominal fat content increased significantly ( $P < 0.05$ ) in broiler chicken offered treated ring well and tube well water. The per cent weight of heart increased significantly ( $P < 0.05$ ) in broiler chicken offered treated pond water offered group.

Among the haematological parameters studied, the mean values of haemoglobin and PCV levels did not differ significantly ( $P > 0.05$ ) among the broiler chicken offered different sources and treatment of water.

The biochemical parameters namely total serum protein and serum glucose were estimated for broiler chicken offered different sources and treatment of water. The total serum protein levels did not differ significantly ( $P > 0.05$ ) among the broiler chickens offered different sources and treatment of water. However, the serum glucose levels differed significantly ( $P < 0.05$ ) among the broiler chicken offered different sources and treatment of water. The treatment of water significantly ( $P < 0.05$ ) increased the total serum glucose levels of all the groups of broiler chicken offered different sources of water.

Thus, it is concluded that during monsoon season, all the physico-chemical and microbiological qualities of drinking water were found to be within the maximum permissible level after treatment with the combination of Acidifier and Sanitizer @0.01%. Hence, all the treated sources of water under study will be more useful for broiler chicken production during monsoon season.

## **Ph.D (Home Science)**

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- **Extension and Communication Management**
  - **Family Resource Management**
  - **Food Science and Nutrition**
- **Human Development and Family Studies**
  - **Textile and Apparel Designing**

## **Status of Sanitary and Hygienic Condition in Schools of Rural areas of Assam**

*Jitumoni Neog*

The study entitled “Status of Sanitation and Hygiene in Schools of Rural Areas of Assam” was undertaken with the following objectives: i) To study the existing sanitary facilities in the selected schools of rural areas of Assam. ii) To assess the existing knowledge and practices of students and MDM functionaries regarding sanitation and hygiene. iii) To identify the role played by the teachers and SMC members of schools in maintaining sanitation and hygiene. iv) To identify the problems faced by the students, teachers, SMC and MDM functionaries for maintenance of sanitary and hygienic condition of the school and their suggestive measures to overcome. v) To assess the impact of an intervention programme on sanitation and hygiene. The present study was carried out in three districts namely Jorhat, Nagaon and Nalbari representing upper Assam, central Assam and lower Assam respectively. Three educational blocks in Jorhat district, 5 educational blocks in Nagaon district and 2 educational blocks in Nalbari district i.e., total 10 educational blocks were selected under the study. Thus, there are 22 MV schools in 3 selected educational blocks of Jorhat district, 46 MV schools in 5 selected educational blocks of Nagaon district and 22 MV schools in 2 selected educational blocks of Nalbari district of Assam. From the lists, 30 per cent MV schools from each of the selected educational block of each district were selected randomly for the present study. Thus, total 28 MV schools were considered from selected 3 districts of Assam for the present study. From each selected school, five teachers were selected randomly as one of the respondents for the present study which comprised of total 140 teachers from 28 sampled schools. All the students present on the day of survey of the selected schools of class VI, VII and VIII were considered for the present study, thus, 96 from Jorhat district, 148 from Nagaon district and 56 students from Nalbari district, totaling 300 students of MV schools were the respondents, to assess the knowledge and practices of students regarding sanitation and hygiene. The Jorhat district was selected randomly for imparting the intervention programme on sanitation and hygiene. All the students of class VI to VIII from 7 MV schools of Jorhat district (96 students) were considered for the intervention programme

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**Abstract of Ph.D. Community Science**

**Department : Extension & Communication Management**

**Major Adviser: Dr. Juliana Sarmah**



in order to assess the gain in existing knowledge and practices regarding sanitation and hygiene. Each MV school consists of one cook and one helper under MDM programme. Thus, all the cooks of the selected 28 schools were considered for the present study. Thus, the total numbers of cooks under the study were 28. Each MV school of rural area consists of School Management Committee (SMC). In this study, members included were 1 ward member, 1 village headman, 1 health worker (ASHA), 1 Anganwadi Worker and 3 parents from each school. Thus, the total 196 members of SMC have been selected as the respondents under the present study. It can be observed that all the sampled schools had the provision of water facilities within the school. Also, it can be noted that not a single school had disable friendly toilets and the provision of disposal of sanitary pads. It is also very alarming to note that none of the sampled schools used dust free chalks for writing and good dusters for cleaning the black board. There was no provision for dusting of wooden furniture regularly. It can be concluded that though all the schools had the provision of water, toilet and urinal facilities, but the maintenance of these facilities was very poor in most of the schools. The provision of good water and sanitary facilities in the schools helps to create a good environment. It can be noticed from the findings that though most of the respondents from all the selected districts of three different regions had medium level of knowledge on sanitation and hygiene. The data also revealed that though most of the respondents belonging to moderate level of practice was higher in Nagaon (64.86 %). It can also be observed that though the role of the teachers were found satisfactory in maintaining sanitation and hygiene, but the role of SMC members need to be emphasized more for the betterment of the school. It can be identified from the findings that the students, teachers, SMC members as well as MDM functionaries had faced lots of problems in maintaining sanitation and hygiene. Therefore, suggestive measures were identified for consideration to overcome those problems so that the sanitary and hygienic condition of the school can be improved. Lastly, we have observed in the findings that there was change in knowledge and practice of the students through intervention programme.

# **Socio economic Empowerment of Rural Women Through Krishi Vigyan Kendra**

*Mayuri Bora*

The study on Socio economic empowerment of rural women through Krishi Vigyan Kendra was conducted with the objective (i) To find out the participation of women in different extension activities of KVKs, (ii) To study the extent of adoption of the technologies by the respondents and its impact, (iii) To identify the constraints faced by the respondents in adoption of technologies and (iv) To explore the factors affecting transfer of technology. The present study was conducted in Assam where twenty three Krishi Vigyan Kendras (KVKs) are functioning under administrative control of Assam Agricultural University, Jorhat. Seventeen KVKs out of 23 were selected to find out the participation of women in different extension activities of KVKs. To study the extent of adoption of the technologies by the respondents and its impact, 300 rural women were randomly selected from the operational villages of six selected KVKs, where 150 respondents were participants of the selected vocational trainings and equal numbers were nonparticipants. For studying the factors affecting transfer of technology, thirty SMSs were selected. The findings revealed that during 2012-2017 the selected seventeen KVKs conducted 5152 numbers of training programmes where number of participant was 1,38,809. In trainings under “Home science” and “Agricultural extension” discipline, percentage of women participant was found to be highest with 93.99 and 54.52 respectively. However in subjects like Horticulture, Fisheries science, Soil science, Plant protection and Agronomy, women participation was less than 20.00 per cent. The seventeen KVKs conducted 379 numbers of vocational trainings during the study period covering a total of 10,940 participants of which 53.55 per cent were men and 46.45 per cent were women. It was found that in some vocational training, all participants were women where as in some other trainings there was no women participant at all. Similarly the KVK wise analysis of data reflected a large variation among the KVKs. Three vocational trainings namely „Food processing and preservation“, Mushroom cultivation“ and „Vermicompost production“ were selected to study the extent of adoption of the technologies by the respondents and its impact on socio economic empowerment of rural women. The findings reflected a clear picture

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**Abstract of Ph.D. Community Science**

**Department : Extension & Communication Management**

**Major Adviser: Dr. Manoshi Baruah Deka**

that participation in the selected vocational trainings increased the level of knowledge of the respondents, increased inclination for adopting the technology by inculcating favourable attitude which led to adoption of technology. Highest percentage participant respondents had medium level of knowledge on the technology they learnt in the vocational trainings and highest percentage had moderately favourable attitude. Regarding extent of adoption, highest percentage (52.00%) respondents fall in medium level of adoption, followed by low adoption with 36.00 per cent and high with 12.00 per cent. Participant respondents had more knowledge, better level of adoption than the nonparticipant respondents. Data on change in level of empowerment reflects that after the selected period, highest percentage i.e. 52.00 per cent were in high level of empowerment whereas „before“ the highest percentage was in medium level of empowerment with 43.33 per cent. Significant difference in level of empowerment was observed among participant and nonparticipant respondents after the selected period. Data on constraints faced by the respondents in adoption of technologies reveals that highest percentage of respondents faced medium level of constraints. „Lack of financial resource for starting a new venture“ was reported as a major constraint with mean score 1.33 by the rural women. Regarding facilitating factors affecting transfer of technology, 70.00 per cent of the respondents (SMSs) had collaborative programmes with state and national level NGOs followed by line departments and district administration. „Electricity problem at field level“ was reported as a major constraint faced by the SMS while transferring technology. It is concluded that KVKs are playing vital role in transferring technology to the target groups including rural women which have significant impact on socioeconomic empowerment of rural women.

## **Promoting rural women for use of ICT in agriculture and allied areas**

*Pompy Malakar*

The present investigation on “Promoting rural women for use of ICT in agriculture and allied areas” was undertaken with the objectives (i) to analyse the situation of the rural women with regard to knowledge and use of ICT in agriculture and allied areas (ii) to build the capacity of the rural women on use of selected ICT application through intervention and (iii) to assess the impact of the intervention on use of selected ICT application by the rural women. The study was conducted in two agro-climatic zones of Assam. A multistage random sampling design was followed for selection of the sample. From each zone one district namely Jorhat from Upper Brahmaputra Valley Zone and Nagaon from Central Brahmaputra Valley Zone were selected randomly. Altogether 400 rural women were selected as the respondents for the present study. Data collection was done by using structured interview schedule. The findings revealed that majority (42.25 %) of the rural women were belonged to lower middle age group and are married (70.75%). Majority (39.75%) of respondents had education upto high school level. A high majority (83.75%) of respondents was from nuclear family and has small family size (54.00%) with farming as the main family occupation (82.50%). Majority have ICT tools like mobile phone (92.50%), television (86.25%), internet (28.00%) and radio (17.00%). A large majority (99.18%) of respondents use mobile phone for contacting their friends and 97.83 per cent for contacting different organized groups. Participation of respondents in training related to ICT was found to be very less (1.50 %). The findings indicated that majority (64.50%) of the respondents had medium level of knowledge on ICTs and have favourable attitude towards ICTs (77.00%). Among the various problems faced by the respondents in utilization of ICTs, “Lack of confidence in operating ICTs” was ranked I (0.96), followed by “ICT Services are costly”, ranked II (0.91) and “Erratic power supply”, was ranked III (0.89). Finding shows a significant association between knowledge on ICTs with age, size of family, organizational membership and extension contact. The finding also shows significant association between attitude towards ICTs with age, educational qualification, organizational membership and extension contact. Based on the existing

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knowledge of respondents on ICTs an intervention programme was organized. Before interventions mean score of their knowledge was 18.4 and after intervention immediate post knowledge scores was 41.26. Further it was found that before interventions mean score of their existing practices was 7.76 and after intervention immediate adoption of practices scores was 13.33. Impact of the intervention programme was found to be significant in terms of gain in knowledge and adoption of practices thus, leading to capacity building of the rural women.

# **Role of Self Help Groups (SHGs) in Rural Development with special reference to Jorhat district of Assam**

*Sadala Rajasri*

Women empowerment has become a meme in the global governance network. In this context, SHGs have emerged as the tools that wield power to create a socio-economic revolution in the rural areas of our country. SHGs set as the building blocks of organizing poor and disadvantaged households in the community. SHGs have not only produced tangible assets and improved living condition of members but also help in changing much of their outlook, world view and attitude.

The present study entitled Role of Self Help Groups (SHGs) in Rural Development with special reference to Jorhat district of Assam with the objectives: i) To study the organizational structure and functioning of the selected SHGs, ii) To find out the various sources of fund and their pattern of expenditure, iii) To study the impact of selected SHGs on socio-economic empowerment of rural women and iv) To explore suggestions for the effective functioning of SHGs in improving the socio-economic status of rural women.

A sample of 60 SHGs consisting of 300 members have taken to study the various aspects of the SHGs. A multistage purposive cum simple random sampling method was adopted. It was found that most of the SHGs (76.67 per cent) were promoted by Government organizations, established during the year 2000-2005 (50.00 per cent), had constitution for conducting their regular activities (93.33 per cent) and members belonged to residents of the same village where SHGs were located. Majority of the SHG groups (66.66 per cent) had 10-15 members. Nearly 50.00 per cent of the SHGs did not have any fixed tenure of service of office bearers. Higher percentage of respondents from SHGs were motivated for avail the loan (90.00 per cent). It was found that meetings were conducted on monthly basis. Majority of the SHGs (83.34 per cent) expressed of holding the meetings in the afternoon. 66.67 per cent SHGs reported that there is no fixed time of the duration of SHGs meetings. 93.34 per cent were conducting meetings at their office bearers residence. 58.33 per cent of SHGs were reported to

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**Major Adviser: Dr. Manju Dutta Das**

impose no fine for absenteeism followed by 33.33 per cent SHGs imposed penalty of Rs. 5 and 8.33 per cent of Rs.10 for absenteeism . 88.33 per cent of the SHGs were found to be regular in their contribution towards savings. Monthly interest rate was 2 % for 75 per cent of selected SHGs. 58.33 per cent charged 5% from outside group members. 90 per cent SHGs had kept records with respect to internal loan and interest (95.00 per cent). Majority of the SHGs (55.00 per cent) did not to have provision of verification of accounts for which misunderstanding among the members were seemed to be developed gradually. 50.00 per cent of SHGs received training on maintenance of records. Majority of the SHGs did not received any kind of training for proper function of SHGs. 73.33 per cent SHGs were found to raise their income mainly from government fund to implement some socio-economic activities, while, 70.00 per cent relied on its membership subscription. 73.33 per cent had spent their funds in travelling to collect important information, attending meetings, visiting banks etc. from different related organization/institutions. 54.66 per cent of the respondents belonged to middle aged (between 36-55 years). 50.33 per cent of rural women in SHGs were holding 1.0 acre-4 acres of land, educated upto HSLC (40.33%) followed by primary school( 41.00 %) Independent profession was the major occupation (47 per cent) of the members of SHGs. Majority (82.00 %) of the SHGs members belonged to nuclear family. Rural women moved from their house for social visit, attending bank, and block which were ranked as I, II, and III. After joining SHGs, all the respondents were empowered to take decision on marketing of prepared products (100%) and 49.33 per cent of members had medium level of risk bearing abilities. Job reservation for women and punishing wicked husband, compulsory family planning and inter caste marriage were ranked as I, and II and III which were strongly approved social issues by all rural women. Lack of awareness regarding functioning of SHG ranked (I) with mean score 1.98 followed by lack of adequate training provided by the linked agencies, and lack of vocational/skill development training ranked (II) with a mean score 1.96 are the major problems faced by members. Majority of the respondents increased decision making power within their household (66.00%). medium (62.00 per cent) level of self confidence, not interacting with officials (53.33%) whereas after joining in SHGs, 13.33 per cent and 33.33 per cent sometimes had interacted with outsiders followed by not faced any family violence in their respective household (50%). It was also revealed that the status of access to amenities were increased (37.05%) after joining SHGs. 68.67% respondents were encouraged to take loans from SHGs / Govt. fund after joining SHGs. 70.00 per cent SHG members have increased their asset value after joining SHGs. The awareness of members about selection of micro enterprises (rank 1), and organize need based intervention programmes were (rank II) suggested by Government, NGOs officials and knowledgeable persons.

# **Design requirements for ease of operation of consumer electronic products used for cooking**

*Moonty Baruah*

In the past few years there has been a tremendous change in the consumer electronic market with availability of wide ranges of products. Though the people possess these products and are dependent on it but still they are not satisfied since they face problems while using it, especially in case of products used for cooking activities. These problems are not related to the technical problems but with usability problems while using the user interface. User interface is the panel through which the users interact with the products. It may be due to incorporation of multiple functions in the products along with digitalization of user interface; in many cases the use of products is becoming complex. There is a gap between the intention of the manufacturers and the needs and understanding of the users while using these products. Solution lies in following a framework of guidelines on design requirements for ease of operation of the products, which can reduce these usability problems of user interface. These guidelines should be based on the opinion of users, their needs, etc. This will not only increase the usability of the product but will also try to capture the market in long run. Keeping these points in view the present study was undertaken with the following objectives (1) to study the Taxonomy of user Interfaces of Consumer Electronic Products used for cooking. (2) to identify the usability problems in use of selected products. (3) to generate design requirements for ease of operation of a selected product. The study was conducted in three phases. In the phase I, data on different consumer electronic products possessed by the respondents, dependency on the products, problems faced by the users, etc were collected through a survey. For the survey a total of 200 samples were selected randomly from Jorhat town by following purposive sampling procedure. In the Phase II, a user workshop was conducted to find out the design requirement of user interface. The information generated from the user workshop was used for developing mock up models/stimuli for further laboratory analyses. While developing the stimuli paired preference test was performed. Finally 32 stimuli were selected for the next phase of analyses in the laboratory. The user workshop was conducted with 40 numbers of respondents (20 per cent of sampled respondents). In Phase III of the study, design

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**Abstract of Ph.D. Thesis**

**Department : Family Resource Management**

**Major Advisor : Dr. Nandita Bhattacharyya**



requirements for user interface were generated for ease of operation of the selected product through usability study by using eye tracking experiment. The gathered data revealed that the respondents possess almost all types of electronic appliances and are dependent on it but still they are they have fear in using it. This fear is mostly because of the complicated user interfaces. In order to study the usability problems, the different aspects of dimensions of taxonomy of the user interface was studied in details. It was seen from the analyses of data that user interfaces of many of the consumer electronic products are not user friendly. Especially, in case of microwave oven the interface is problematic due to the presence of many functions. From the paired preference test few guidelines came into foreface. These guidelines were people mostly preferred font size of 7.5 point with black font in white background, regarding the position of user interface the respondents mostly prefer vertical down position. Buttons were more preferred than knobs. From the eye tracking experiment three aspects were tested and it was found that the respondents prefer to have the start/stop button at the middle of the panel. The number of buttons in the interface should be adequate, it should neither be too less nor too more for ease of operation and as regards to colour contrast the mostly preferred combination found was white font in black background.

## **Bioactivity of medicinal plants used in traditional rice beer starter cultures of Assam**

*Radali Duarah*

The present study entitled “Bioactivity of medicinal plants used in traditional rice beer starter cultures of Assam” was undertaken with the objectives of documentation of plant species used in the preparation of rice beer starter culture of Assam, analysis of phytochemicals and antioxidant capacity of selected plant sample and assay of antimicrobial activity of them against five human pathogenic bacteria. Six major communities of Assam were selected for the documentation of the plant materials used in the preparation of rice beer starter culture. The information was collected using a semi-structured questionnaire from experienced local men and women of three districts of Assam viz., Sibsagar, Nagaon, and Bongaigaon. A total of thirty-six plants were found to be used in the preparation of the starter culture by the *Mishing* community, twenty-seven plants by the *Ahom* community, thirteen plants by the *Deori* community, twenty plants by the *Tiwa* community and seven plants by *Bodo* and *Rabha* community for their respective starter cultures. A total of fifty-one plants were documented from the survey, many of which were commonly used by all the communities for preparation of rice beer starter culture as well as in their traditional health care system for curing many diseases. Twelve commonly used plants were screened out based on their importance in the preparation of rice beer among all the communities. These plants are *Curcuma longa*, *Sphaerostepheras unitus*, *Polygonum hydropiper*, *Drymaria cordata*, *Psidium guajava*, *Cinnamomum bejolghota*, *Zanthoxylum nitidium*, *Elsholtzia blanda*, *Rubus hexagonus*, *Vitex negundo*, *Justicia gendarussa* and *Scoparia dulcis*. Proximate analysis showed that the moisture content ranged between 4 to 10.5 (g/100g); ash content 6.09 to 16.61 (g/100g), crude fiber content 6.12 to 13.40 (g/100g); protein content 0.23±0.10 to 6.81±0.45 (g/100g); crude fat content 0.60 to 6.22±0.36 (g/100g) and lastly carbohydrate content 69.91 to 85.85±0.16 (g/100g) in the selected plants. The percentage yield of extracts in studied medicinal plants is found to be higher in the aqueous extracts than ethanolic extracts. The antioxidant activity of plant extracts was assessed by ABTS and DPPH method. For ABTS assay, the aqueous extract of *Psidium guajava* leaves showed the highest scavenging activity (77%) at 200 µg/mL with IC<sub>50</sub> value 74.05 µg/ml, whereas ethanolic extract of *Curcuma longa* showed the highest

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**Abstract of Ph.D. Community Science**

**Department : Food Science and Nutrition**

**Major Adviser: Dr. Mridula Saikia Barooah**

scavenging activity (87.4%) with IC<sub>50</sub> 68.52 µg/ml. Similarly for DPPH assay, the aqueous extract of *Psidium guajava* showed the highest scavenging activity (65.22%) with IC<sub>50</sub> 113.25 µg/ml. Ethanolic extract of *Curcuma longa* showed the highest scavenging activity (70.6%) with IC<sub>50</sub> 99.02 µg/ml. The qualitative phytochemical screening of selected plant extracts showed the presence of various components. The total flavonoid content for both aqueous and ethanolic extracts varies from 0.7 mg QE/g to 185.7 mg QE/g, and 12.14 mg QE/g±0.51 to 260±0.08 mg QE/g. Total phenol content was noticed to be in the range 1.96mg GAE/g to 153.7 mg GAE/g for aqueous extracts and 3.96±0.99 to 205.9 mg GAE/g for ethanolic extracts. Tannin ranged between 0.30 mg TAE/g to 1.58±0.03mg TAE/g for aqueous extracts and 0.73±0.03 to 1.61±0.05mg TAE/g for ethanolic extracts. Alkaloid content was found highest in *Polygonum hydropiper* in both aqueous (7.7g/100g) and ethanolic (13.26 g/100g) extracts. A significant correlation was observed between the antioxidant and phytochemicals like total phenols, flavonoids and tannin content however, did not show any correlation between antioxidant and alkaloid content of the selected plant extracts. By FTIR analysis the various functional groups observed in the samples indicate the presence of alcohol, total phenol, alkane, 1° amine, aromatic amine, conjugated alkene, aliphatic amines, ester, carboxylic acid etc. In the antimicrobial activity of the selected plants, the Zone of Inhibition (ZOI) against *Escherichia coli* was found highest in *Vitex Negundo* (15.5 mm) among aqueous extracts and *Curcuma longa* (25 mm) among the ethanolic extracts which can be compared with standard antibiotic ciprofloxacin showing ZOI 25 mm. Against *Listeria monocytogenes*, *Psidium guajava* leaves showed the highest ZOI among both aqueous (15 mm) and ethanolic extracts (20 mm). Against *Salmonella typhi*, *Drymaria cordata* showed the highest ZOI in both aqueous (13 mm) and ethanolic extracts (24 mm). In the case of *Serratia marcescens*, *Psidium guajava* showed the highest ZOI in both aqueous (12 mm) and ethanolic (19 mm) extracts. Many of the plants are found to be a good source of phytochemicals and possess antibacterial activity against all the selected pathogen except *Shigella*. This validates the use of these selected plants by different communities in the preparation of rice beer starter culture. Based on the present study it can be concluded that among all the selected plant samples used in the preparation of rice beer starter culture, most of the plant samples possess dose-dependent antioxidant ability in both aqueous and ethanolic crude extracts. The outcome of the present study can be recommended for in-depth analysis of the medicinal plants, and further, the rice beer prepared using the selected plants to find out the efficacy of the plants as therapeutic agent for prolonging longevity and attaining positive general health.

# **Adolescents' Aggression: a Mindfulness-Based Interventional Approach**

*Arifa Momtaz Begum*

Aggressive behaviour has become a topic of vital importance and a major concern in most of the societies. Identifying, controlling and managing highly aggressive behaviour and its ill effect of school going adolescents have not yet been a major focus of education system of India. Hence, the present study was undertaken to identify the aggression level of adolescents, its locus of control, develop and implement mindfulness-based intervention programme to manage aggression and to assess its efficacy. A total of 32 adolescents of the age group of 14-16 years were selected from two different schools of Sonitpur district of Assam. Sociometry was used to identify the aggressive students. A standardized questionnaire namely Direct & Indirect Aggression Scales developed by Bjorkqvist *et al.*(1992)was used to gather data from self, peers and teachers to assess the types and levels of aggression of respondents. For assessment of locus of control, the scale developed by Nowicki *et al.* (1973) was used. An intervention package was also developed to reduce the level of aggression of adolescents. Intervention programme was carried out for a period of one month. Data was collected once before the intervention and then again during the 3rd month and 5th month after implementing the intervention programme. The findings of the study revealed the prevalence of three types of aggression viz., physical, verbal and social aggression among adolescents. Verbal and social aggressions were much more prevalent than the physical aggression among the respondents. Barring two respondents, all of them were found to have external locus of control which has a positive correlation with their aggression. There were significant ( $P<0.01$ ) changes in the level of aggression of all the respondents in physical, verbal and social aggression after implementing the intervention programme. Significant increase in the percentage of respondents in low category of all three types of aggression revealed that a large section of respondents abate the level of aggression considerably after intervention. High social acceptability of the package is also an evidence to establish its effectiveness. Hence, this mindfulness based interventional activities can be a new start for bridging the gap of adolescents' emotional need and challenging behavior.

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**Abstarct of Ph.D. Community Science**

**Department : Human Development and Family studies**

**Major Adviser: Dr. Jinamoni Saikia**

# **Development of learning tool for promotion of spatial intelligence in children during concrete operational period**

*Tulika Borah*

Spatial intelligence, one of the nine types of intelligence proposed by Howard Gardner (1983) has been highlighted in recent years and regarded as an integral component of human cognition. Research studies have provided evidences of relation of spatial intelligence to achievement in science, technology, engineering and mathematics (STEM) streams. In the present study the investigator attempted to develop a learning tool for promotion of spatial intelligence in children during concrete operational period. An Embedded mixed method research design was adopted for the study. The sample of the study constituted of 120 children belonging to the age group of 8-11 years, who were selected randomly from three schools of Jorhat district, Assam. The young people's version of 'Multiple intelligence test' developed by Chislett and Chapman (2005) was used as quantitative technique to assess the type of intelligence found among children under the study. In addition to it, observation and interview methods were also used. The data collected from both quantitative and qualitative methods were analysed and the results were obtained after triangulation of quantitative and qualitative data. Seven types of intelligences were identified and inter-correlations between the types of intelligences were analysed. Positive inter-correlations found among different types of intelligence indicated that, spatial intelligence of children can be developed by administering spatial tasks to children, irrespective of the type of dominant intelligence they possess. The topological framework of spatial skills proposed by Uttal *et al.* (2013) was followed for preparation of spatial tasks, which consists of four dimensions i.e. intrinsic-static, intrinsic-dynamic, extrinsic-static and extrinsic-dynamic. Spatial tasks in all the four dimensions were prepared and difficulty level of each task was assessed. It was found from the study that, the task difficulties of dynamic tasks were more than static tasks. Moreover it was found that, the tasks under the dimension of extrinsic dynamic were more difficult as compared to other three dimensions. A 2 way ANOVA was conducted to analyse the main effects and interactive effect of types of intelligence

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**Abstract of Ph.D. Community Science**

**Department : Human Development and Family studies**

**Major Adviser: Dr. Juri Boruah**

and dimensions of spatial tasks on performance of children in spatial tasks. The two way ANOVA test indicated that maximum differences in the performance of children in spatial tasks were accounted by different dimensions of spatial tasks ( $\eta^2 = 0.516$ ) than the types of intelligence ( $\eta^2 = 0.219$ ). Based on the analysis carried out, finally a learning tool, consisting of forty numbers of spatial tasks covering all four dimensions, was developed for promotion of spatial intelligence in children, during concrete operational period.

**Key words:** Multiple intelligences, spatial intelligence, spatial tasks, task difficulty

## **Risk and Protective factors contributing towards Adolescents' Emotional Resilience**

*Zionvarzing Thiek*

Resilience is all about how an individual is able to bounce back after encountering an adversity. Many researchers have proved that adolescent's resilience is affected by various factors related to social and familial environment. A resilient adolescent is likely to enter adulthood with a better chance of adapting well even if he encountered negative events in life. The present study attempted to identify the risk and protective factors contributing toward adolescent's emotional resilience. The study was conducted in Dima Hasao District of Assam. A total of 360 adolescents belonging to the age group of 14-17 years from both private and government schools were selected through probability proportional sampling. A self-developed general information schedule was used to collect the background information of respondents. A checklist consisting of 20 statements of negative events was prepared and used to identify the negative life events among the adolescents. The Resilient Quotient developed by Jeffrey and Linda Russell in the year 2009 was used to assess the level of emotional resilience of adolescents. To assess the personal attributes of the adolescents, The Big Five Inventory developed by John and Srivastava (1999) was used. The attachment of parent-adolescent was studied by using an inventory of Parent and Peer Attachment by Greenberg and Armsden (1987). To study the family related factors such as cohesion, family conflict, control and independence, A Family Environment Scale (FES) by Harpeet Bhatia and Chadha (1993) was used. The most reported negative events by the adolescents were class work load, obtaining low grade than expected, getting pressure from parents, restrictions at home, financial problems and rebuke by parents. Gender difference was found to be statistically significant in the three negative life events namely experiencing arguments between parents, pressure from parents and having to repeat the same grade. The highest serious negative life events experienced by the adolescents was death of the family member and natural calamities. There was no significant relationship between the NLEs and emotional resilience of adolescents. This implies that NLEs neither act as protective factor nor as risk factor towards adolescent's emotional resilience. The relationship between the demographic variables and resilience

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**Department : Human Development and Family studies**

**Major Adviser: Dr. Juri Baruah**

of adolescents was also seen and was found that, the age of the respondents, types of family and birth order showed statistically significant relationship with the emotional resilience level. Statistically significant difference was also found between the gender, types of school and adolescents' resilience. The personal attributes (extraversion, agreeableness, conscientiousness and openness) were identified as protective factors and neuroticism as a risk factor. The family factors such as cohesion and parental attachment were identified as protective factors and the factors such as family conflict and family independence act as a risk factors of emotional resilience of adolescents.



# **Application of copper nanoparticles generated on plant extract for antimicrobial finish on cotton fabric**

*Gitanjali Boruah*

The present study deals with the application of copper nanoparticles synthesized by plants for antimicrobial finishing on cotton fabric. Based on a pre antimicrobial test against selected microbes such as *Staphylococcus aureus*, *Escherichia coli*, *Candida albican*, and *Aspergillus niger*, three plants were selected out of twenty eight plants for green synthesis of copper nanoparticles. Plant extracts selected for the present experiment were namely, *Emblica officinalis* (amla), *Phyllanthus fraternus* (Bhumi amla), and *Syzygium cumini* (Jamun). Methanolic extract of plant extracts showed the presence of various phytochemicals such as alkaloids, flavonoids, phenols, tannins, and resins compounds, etc. In case of aqueous extract, most of the phytochemicals were found to be absent. TPC and TFC showed specific contents in each extract. Antioxidants activities of plant extracts possess potent antioxidant and reduction power. After these preliminary tests, plant extracts were used for reducing copper nanoparticles. The resulting copper nanoparticles were characterized by UV-Vis spectroscopy around 416.00nm, 415.00 nm, and 420.50 nm for E.CuNPs, P.CuNPs, and S.CuNPs respectively. FTIR analysis of CuNPs confirms the surrounding of these organic molecules such as polyphenols, alkaloids, and terpenoids, involved in the synthesis of CuNPs. XRD and SAED pattern indicates the crystallinity of the nanoparticle. DLS exhibited the average particle size around 142.01-203.65 nm whereas TEM micrograph indicated the shape and size of the nanoparticles, which were polydispersed and predominantly round, spherical, and cubical or square with particle size in the nano range between 24-38nm. Pharmaceutical analysis exhibited the anti-inflammatory and non-toxicity of the plant extracts and CuNPs. It was found that synthesized CuNPs showed effective antimicrobial activity than plant extracts. SEM micrograph indicated that the surface of CuNPs treated fabrics were coated with minute particles, certain particles are found to be agglomerated. The presence of CuNPs in the fabric is supported by the EDS analysis. After finishing treatment with the CuNPs and plant extracts, CuNPs treated fabrics retain more antimicrobial properties than the plant extracted

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**Abstarct of Ph.D. Community Science**

**Department : Human Development and Family studies**

**Major Adviser: Dr. Ava Rani Phukan**

treated fabric against test organisms. Furthermore, nanocoated fabrics enhance some of the physical properties, for instance, tensile strength and elongation, crease recovery, cloth weight as well as breathability don't exhibit any significant difference compared to the untreated fabric. Unlike *E. officinalis*, the total color value (K/S) of all the treated samples increased in comparison to the untreated fabric. Hence, it can be suitable for technical applications viz., medical textile, intimate clothing, sports textiles as well as it can use in dyeing purposes also.

## **Master of Science (Agriculture)**

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- **Agricultural Biochemistry**
- **Agriculture Biotechnology**
- **Agricultural Economics and Farm Management**
  - **Agronomy**
  - **Agrometereology**
  - **Crop Physiology**
    - **Entomology**
  - **Extension Education**
    - **Horticulture**
    - **Nematology**
- **Plant Breeding and Genetics**
  - **Plant Pathology**
    - **Sericulture**
    - **Soil Science**
- **Tea Husbandry and Technology**

## **Nutritional composition and antinutritional factors of Millets of Assam**

*Debanjal Borah*

Millets are a group of small-grained, gluten-free cereal food crops belonging to the Poaceae family. Millets are characterised by a higher content of protein, dietary fibre, crude fat, carbohydrates, minerals, micronutrients and phytochemicals. Millets nowadays have become more relevant because of its health-promoting benefits along with its ability to thrive in extreme climatic conditions, low fertiliser, and pesticide requirement.

In the present investigation, eight millet germplasms from Regional Agricultural Research Station (RARS), Gossaingaon were evaluated and compared for biochemical constituents of quality significance and antinutritional effects with Mahsuri (Aijong) variety of rice, popular in Assam. Millet germplasms were found varying significantly in their proximate composition with moisture content ranging from 9.59 - 12.24 %, crude fat from 1.64 - 3.49 %, crude protein 6.67 - 12.04 %, crude fibre 3.85 - 7.58 % and ash content from 2.07 - 3.27 % on a dry weight basis. Starch and amylose content were found to be in the range 63.38 - 72.87 % and 20.99 - 32.76 % dry weight, respectively. Total phenol content and antioxidant activity of millet germplasms ranged from 190.58 - 280.89 mg GAE/100 g and 163.07 - 335.73 µg/ml respectively. Millet contained calcium and iron in the range from 23.62 - 291.87 mg/100 g and 3.83 - 6.52 mg/100 g dry weight, respectively. The antinutritional factors in millets like tannin, phytate P and oxalate were found in the range from 53.48 - 136.13 mg/100 g, 193.83 - 663.81 mg/100 g and 4.84 - 13.74 mg/100 g dry weight, respectively. Rice exhibited less crude fat, crude protein, crude fibre, ash, minerals, phenol and antioxidant activity as well as low levels of tannin, phytate P, oxalate compared to the millet germplasms. Of the eight millet germplasms used in the study, released genotypes VR-1117, KMR-652 and local genotypes Red, Local appeared to be superior over the others in terms of nutritional quality.

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**Abstract of M.Sc. thesis**

**Department: Agriculture Biochemistry**

**Major Adviser: Dr. Samindra Baishya**

## Studies on metabolism of iron in rice

*Madhusmita Baruah*

Rice, though rich in carbohydrates and proteins, lacks micronutrients like iron and zinc. Considering several disadvantages of fortification of iron in food, emphasis is given on biofortification of iron in plants, including rice grains. Though, there exists threat of iron toxicity in some of the rice varieties grown in lowland acid soils of this region, the present study was conducted to know the effect of two different levels of soil iron content on some biochemical parameters including grain iron content of rice plant.

Three rice varieties, including two popular varieties of Assam, *Ranjit* and *Mahsuri*, and one traditional pigmented variety *Kajoli chakua* were cultivated in pots at two different levels of iron: marked as control and treated; in which DTPA extractable iron content of soil were 159.40 mg/kg and 182.35 mg/kg, respectively.

Within the range of soil DTPA extractable iron content (159.40 mg/kg - 182.35 mg/kg), iron toxicity was not observed. The analysis revealed that the iron content, chlorophyll content of leaves and the activities of antioxidative enzymes *viz.* peroxidase, superoxide dismutase and catalase varied significantly at different growth stages. Among the three rice varieties, uptake of iron in rice leaves and grains were found in the order *Ranjit* > *Kajoli chakua* > *Mahsuri*. The iron content of brown rice significantly differed according to its position on the rachis, the order being: top primary rachis > top secondary rachis > middle primary rachis > middle secondary rachis > bottom primary rachis > bottom secondary rachis. The iron content of brown rice of all the three varieties increased significantly (more than 100 % than that of control) in plants grown in soils of higher iron content. Specific activity of all the three enzymes showed that higher the iron content, more the specific activity.

Considering initial iron status of the soil, application of iron solution of suitable concentration may be advocated for increasing grain iron content of these three rice varieties.

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**Abstract of M.Sc. thesis**

**Department: Agriculture Biochemistry**

**Major Adviser: Dr. Priyanka Das**

## **Nutrient composition and total antioxidant activity in selected eggplant (*Solanum melongena* L.) germplasms**

*Minakshi Dutta*

Eggplant, also known as brinjal is one of the most popular vegetable across the world. It ranked as one of the top ten vegetable amongst 120 different vegetables having antioxidant capacity. It contains powerful antioxidants like ascorbic acid and phenolic along with other nutrients like protein, carbohydrate and dietary fibre.

In the present investigation, Matured fruits of six selected eggplant germplasm collected from Horticultural Experimental Farm, AAU, Jorhat were evaluated for their nutrient composition and antioxidant properties. Germplasm were found varying significantly in their proximate composition with moisture content ranging from 88.140-91.327% on fresh weight basis, ash content (6.576-9.5%), total soluble sugar content (4.559-6.827%), reducing sugar content (0.575-3.383%), crude protein content (0.783-2.736%), crude fibre content (1.410-3.420 %) and crude fat content (0.940-1.813%) on dry weight basis. Antioxidant properties like ascorbic acid content found in the range of 12.486-31.78 mg/100g on fresh weight basis. Total phenol content, chlorogenic acid content and flavonoid content from 604.920-1007.006 mg GAE/100g, 150.820-342.650mg/100g and 10.729-22.192 mg/100g respectively on dry weight basis. Anthocyanin content was found in the range of 5.156-14.5174 mg/100g on fresh weight basis. DPPH radical scavenging activity was found in the range of 88.860-205.070 µg/ml IC50 value on fresh weight basis. Of six eggplant germplasm used in the study JC1 was found superior over other varieties in terms of nutritional quality having highest amount of crude protein, reducing sugar, ascorbic acid and chlorogenic acid content and SM-6-7 was found superior in terms of antioxidant properties having highest content of total phenol and highest antioxidant properties. The germplasm found superior in terms of nutritional and antioxidant properties among the others can be recommended for consumption and can be used as starting material for different breeding purposes. Also they can be used for evaluating other factors like glycoalkaloids which gives an off-flavour for determining a superior variety in terms of both the aspect of nutrition and flavour.

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**Abstract of M.Sc. thesis**

**Department: Agriculture Biochemistry**

**Major Adviser: Dr. Sunayana Rathi**

# **Extraction and characterization of natural colourants from indigenous plant species for use in food industry**

*Simanta Das*

Color appearance of food products is one of the major concerns of food industry. Pigments from natural sources may display a wide range of colors and are usually safe compared with synthetic derivatives. Among different pigments widespread in nature, anthocyanins play a crucial role when dealing with natural colourants. Anthocyanins comprise a group of naturally occurring pigments which are responsible for the blue, red, purple, violet and magenta coloration of most species in the plant kingdom.

The present investigation was intended to study the phytochemical composition as well as characterization and stability analysis of anthocyanin extracted from selected plant samples for use as food colourants. Selected plant samples *viz.* *S. cumini* L., *S. cumini* L. (wild), *Basella alba* L., *Basella rubra* L., *R. indica* L., *R. damascena* Mill. and *R. bracteata* J.C. Wendl. were collected from different places of Jorhat district. The morphological data were taken from the mature plant samples. The selected plant samples were found to contain varying amounts of percent moisture content, total phenolics, total flavonoids, total alkaloid, total terpenoid, total soluble protein, ascorbic acid, total ash content and minerals like phosphorous, sodium, calcium, potassium and iron. Total phenolics content was found highest in *Rosa indica* L. (1516.52 mg GAE/100g) and the flowers of *Rosa damascena* Mill. was found with higher total flavonoids content of 262.88 mg QE/100g followed by other selected plant samples. The anthocyanin content was found highest in *S. cumini* L. (124.87 mg/100g) followed by *R. indica* L.(115.26 mg/100g) and *S. cumini* L. (wild) (91.41 mg/100 g).UHPLC analysis of the extracted colourant showed that pelargonidin-3-glucoside was the major anthocyanin followed by delphinidin-3-glucoside in extracted colourant of both *S. cumini* L. and *S. cumini* L. (wild) fruits. On the other hand, delphinidin-3-glucoside was the major anthocyanin followed by pelargonidin-3-glucoside in *R. indica* L. The anthocyanin pigments was found to be stable at an acidic pH (up to pH 5) and below 40°

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**Abstract of M.Sc. thesis**

**Department: Agriculture Biochemistry**

**Major Adviser: Dr. Ranjan Kandali**

C temperature. The percent pigment retention of *S. cumini* L., *S. cumini* L. (wild) and *R. indica* L. at 40° C were 72.72, 68.79 and 77.31 %, respectively. Moreover, the light stability study showed that the colourant illuminated with 2,500 lux for 6 hour could retain the activity of anthocyanin.

A new food product was developed by immobilizing the extracted colourant on *Colocasia esculenta* (var *Ahina*) powder. The final food product contained total phenol content of 71.83 mg GAE/100g (Colourant from *S. cumini* L.). The anthocyanin content increased to 44.76 mg/100g. The change in starch content was also found very less after one month of storage period. Also, heating the final food product at 100°C for half an hour resulted in marginal decrease in total anthocyanin content.

Juice extracted from selected plant samples were analyzed to study color hue, color intensity, juice pH, percentage of juice content, total soluble solid content, ascorbic acid content and titrable acidity.

Assam Lemon (*Citrus limon*) beverage enriched with extracted colourant was also prepared. The nutritional analysis such as total soluble solid, pH, acidity, total soluble sugars, vitamin C, total ash and minerals (iron and phosphorous) of Assam Lemon (*Citrus limon*) pulp were analyzed. Assam Lemon (*Citrus limon*) added with colourant showed total anthocyanin content varying from 87.48 mg/100g (*S. cumini* L., wild) to 119.91 mg/100g (*S. cumini* L.).

Further studies will be required for assessing the other nutritional parameters of carrier materials mixed with colourants. The antioxidant activity as well as anti nutritional factors of final food product are required for better development of food colourants. The study further suggested that besides anthocyanins the selected plant samples may contain other pigments which have the potentiality to act as a substitute for synthetic food colourants.



# Identification and Validation of drought-responsive genes in the upland rice cultivar ‘Banglami’

*Akankshita Borah*

Drought is one of the most important and highly unpredictable abiotic stresses causing drastic reductions in yield under rainfed rice environments, affecting 20% of the total rice-growing area in Asia (Pandey and Bhandari, 2008). Assam has diverse germplasm of rice which includes Banglami, a traditional drought-tolerant Ahu rice cultivar found locally in the state. Since 2013, crossing has been carried out between this drought-tolerant cultivar and Ranjit, a high yielding but drought-susceptible elite cultivar. Many drought-related QTLs were identified and reported from this cross-population. For the current study, twenty QTLs identified in the F4 population were selected for mapping on the parental genome. The results revealed that 17 of the 20 QTLs were present on the parent genomes where 11 of the 20 QTLs (*qEBT3.1*, *qEBT6.2*, *qNOT6.1*, *qNOT2.1*, *qPL1.1*, *qPL1.2*, *qPL9.1*, *qPL9.2*, *qPL1.1*, *qNOG9.1*, *qNOG12.1*) were found common to both the cultivars. From these, two of the QTLs (*qGY1.1*, *qGY7.1*) were found to be exclusively contributed by Banglami while four of the QTLs (*qRLWC9.1*, *qRLWC9.2*, *qPH7.1*, *qDTF12.2*) were found to be contributed by Ranjit to the cross-population. Genes associated with the QTLs were identified from whole-genome sequence data of both the cultivars. In total, 2454 genes were located in the 13 QTLs found in Banglami while 1585 genes were found in Ranjit in the 15 QTLs. The differential expression of the candidate genes in water-stress and irrigated conditions were calculated with the help of available RNA-seq data. Differential gene expression was calculated for each of the candidate genes under drought and control. Fifty DEGs in Banglami and seventy-two DEGs in Ranjit having a Log<sub>2</sub> Fold change greater than  $\pm 2.5$  up to  $\pm$  infinity were considered significant. Few of the differentially expressed genes having a significant Log<sub>2</sub>Fold change as revealed by the sequencing data, were confirmed experimentally under drought situation using qRT-PCR. Stress-responsive candidate genes involved in nitrate uptake, DNA repair, ubiquitination, enzymatic activities, cell cycle activities, etc. which can play a significant role in conferring drought tolerance were identified in the drought-related QTLs. The

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**Department: Agriculture Biotechnology**

**Major Adviser: Dr. M. K. Modi**

expression pattern of the candidate genes in qRT-PCR was found similar to transcriptome studies, signifying important role of the candidate genes in drought tolerance mechanism in rice.

# **Genetic diversity analysis of mild insect resistant wild and cultivated chickpea (*Cicer arietinum* L.) genotypes**

*Ankur Mahanta*

Chickpea (*Cicer arietinum* L.) is one of the most important pulse crop grown all over the world and India is the major producer. Despite being the largest producer, India still imports chickpea from other countries because of its low productivity. In Assam, the chickpea growers suffer as the cultivars available in the state are susceptible to various insect pests which appear to be the most important reasons for low productivity. In order to enhance the genetic potential of cultivated chickpea one has to assess the extent and the pattern of real diversity available in the existing cultivated and wild accessions (Croser and Ahmad *et al.* 2003). In the present study, we have characterized 18 chickpea genotypes belonging to *C. arietinum*, *C. reticulatum* & *C. judaicum*, based on morphological traits and molecular data of 48 SSR markers to analyze their genetic diversity and phylogenetic relationship. Morphological diversity analysis showed a significant variation for seed yield/plant, growth habit and flower colour. Considerable diversity was recorded from the SSR data analysis with a polymorphic information content ranging from 0.12 to 0.47 with a mean of 0.31. Most of the diversity was confined to the *C. judaicum* genotypes with respect to its average Jaccard's similarity coefficient (0.246) and average Euclidean distance (9.098). The dendrogram generated for both morphological & SSR data reflects similarities between the cultivated and *C. reticulatum* genotypes while genotypes of *C. judaicum* were diverse and distinctly unique from the other genotypes. A better understanding of the diversity and relationships within and among the genotypes will contribute to identification and utilization in breeding program to widen the genetic base of this cultivated species, for the development of elite lines with superior yield and improved adaptation to diverse environments.

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**Abstract of M.Sc. thesis**

**Department: Agriculture Biotechnology**

**Major Adviser: Dr. B. K. Sarma**

## **Genomic studies for aroma in Joha rice of Assam**

*Kingsuk Das*

The *badh2* locus for aroma in Basmati and Jasmine rice has been extensively studied and the present study was intended to target the functional marker for aroma, *badh2* to determine the fidelity of the marker and validate the same to group the joha rice of Assam in particular. A total of 90 small-grained rice cultivars including 60 joha rice was included in the study. All the fieldwork and laboratory work were carried out at the ICR farm and in the Department of Agricultural Biotechnology, AAU, respectively. The study revealed that the majority of the joha cultivars (44) and 22 non-joha types including four chakhaw, three jeera rice were detected with the aroma allele for *badh2*. The cultivars could be grouped into three based on the results of marker profile using the primer pairs for *badh2* (Group I: cultivars possessing aromatic *badh2* allele, Group II: cultivars with non-aromatic *badh2* allele and Group III: Heterozygous for *badh2*). The cultivars were genotyped further using 23 markers linked to aroma (other than *badh2*), and those loci (mostly minor) were mapped previously flanking the regions of *badh2*. The markers used in the study detected 43.47% polymorphism, and only those polymorphic marker loci were analysed for allelic composition among the three groups of cultivars. The number of marker alleles ranged from 2-4 with a mean of 3.11. Except for 10L03, RM223, RM282, the rest of the markers showed higher homozygosity, indicating that high resolution of allelic difference among the groups of cultivars would be possible. The cultivars of Group I, i.e., with aromatic *badh2* are distinctly unique from the other two groups, suggesting the allelic composition within the Group I was intact (share the same allele most of the time) and could be different from Groups II and III at many times. The Group I was detected a significantly higher number of expected alleles as compared to the other two groups except for RM 282, indicating the determinant of aroma might be governed by *badh2* along with some other minor loci in the case of Group I. The present study could throw some light that in joha rice cultivars, the involvement of *badh2* along with few other minor loci is mainly responsible for the aroma.

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**Abstract of M.Sc. thesis**

**Department: Agriculture Biotechnology**

**Major Adviser: Dr. A. R. Baruah**

# **Validation of drought responsive miRNA in a drought tolerant rice cultivar**

*Oindrila Debsarma*

Drought like situation in non-irrigated agriculture system often limits rice production, necessitating introduction of drought tolerance trait into the cultivar of interest. In Assam, effect of dry spells on varieties cultivated on low lands was reported to be reduced up to 43.07%. miRNAs, a class of abundant small noncoding RNAs, have been identified as important regulators of gene expression in both plants and animals and are involved in many aspects of plant development, including the modulation of plant response to stress. Despite technical hurdles to miRNA functional analysis, there is a growing body of evidence that alteration of miRNA accumulation plays an important role in reprogramming plant responses to biotic and abiotic stresses.

Assam having a diverse germplasm of rice, might have evolved an unique response to various stress. ARC-10372, a proven drought tolerant landrace may be a good source of drought related miRNAs and can provide insight into the role of miRNA in drought stress. In a previous effort in the Dept. to identify novel variety specific miRNA, small RNA sequencing had been employed to systematically investigate the tissue specific miRNAs responsible to drought stress, which are understudied in rice. The study revealed few novel miRNA in addition to known under drought stress. Differentially expressed miRNA as revealed by sequencing data are confirmed experimentally under drought situation using qRT-PCR. Out of 31 miRNAs, 7 known and 5 novel miRNAs were found to respond to drought stress. The identified target for these miRNAs revealed several conserved miRNAs targeting transcription factors like homeodomain-leucine zipper, MADS box family protein, zinc finger protein and Myb, well known for their importance in drought tolerance in plants. Drastic decrease in abundance of a few of the members of the novel miRNA ( nmiR4, nmiR25, nmiR32, nmiR84 & nmiR86) might suggests important role of these miRNAs in drought tolerance. Further work on revealing its confirmatory role shall yield more information in this regard.

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**Abstract of M.Sc. thesis**

**Department: Agriculture Biotechnology**

**Major Adviser: Dr. Priyabrata Sen**

## ***Agrobacterium* mediated genetic transformation of *Citrus reticulata* cv. Khasi mandarin**

*Sangeeta Bhandari*

*Citrus* is number one fruit of the world on accounts of its high nutritional value. India is the fourth largest producer of *Citrus* in the world. The north-eastern region of India is a rich treasure of various *Citrus* species. Khasi mandarin is the most economically important one and plays a vital role in the socio-economic development of the people in this region. Khasi mandarins are declining at a very high rate due to its vulnerability to different pathogen and insect/ pest. Conventional breeding for overcoming these problems are limited in *Citrus* and are directly associated with the reproductive biology of *Citrus*. Recent advances in genetic engineering have made it possible to incorporate desirable genes from elite genotype mainly through *Agrobacterium*-mediated genetic transformation. *Citrus* species showed varied response to *in vitro* regeneration and genetic transformation. Cultivar specific optimization of *in vitro* regeneration and transformation protocol is very important. In the present investigation, *in vitro* regeneration and *Agrobacterium* mediated genetic transformation protocol for Khasi Mandarin was optimized using different explants like epicotyl, hypocotyl, nodal and inter nodal segment obtained from six-week-old *in vitro* grown zygotic seedling. Explants were transformed with *Agrobacterium* strain LBA4404, harbouring plasmid pBI121-AtSUC-GUS containing *nptII* as a selectable marker and *gus* as a reporter gene. Hypocotyl was found to be the best explants for khasi mandarin transformation and regeneration. MS medium supplemented with BAP (2mg/L), NAA (0.5 mg/L), 2, 4-D (1mg/L), MES (0.5g/L), sucrose (30g/L) and acetosyringone (100µM) was found to be best medium for co-cultivation. Modified MS medium containing BAP (4mg/L), MES (0.5g/L), sucrose (30g/L), phytigel (4g/L), kanamycin (50mg/L) and timentin (150mg/L) showed highest regeneration efficiency (18%). Modified MS medium containing BAP (4mg/L), GA3 (0.5mg/L), MES (0.5g/L), sucrose (30g/L), phytigel (4g/L), kanamycin (50mg/L) and timentin (150mg/L) showed highest multiple shoot induction (6%). *In vitro* regenerated shoots that survived up to 3<sup>rd</sup> selection cycle were subjected to GUS assay for confirmation of *GUS* expression in the phloem tissues. Present investigation is a preliminary study for optimization of an *in vitro* regeneration and genetic transformation protocol in Khasi Mandarin.

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**Abstract of M.Sc. thesis**

**Department: Agriculture Biotechnology**

**Major Adviser: Dr. S. Singh**

## **Molecular characterization of the gut microbes of greater wax moth (*Galleria mellonella*)**

*Silpi Shikha Saikia*

Greater wax moth (GWM), *Galleria mellonella* (Lepidoptera: Pyralidae) is a notorious honey-bee pest found throughout the world. The moth is very destructive to the honeycomb, lays eggs and their larva grows up eating beewax. Beewax is a natural polymer, mainly composed of saturated/ unsaturated, linear/ complex monoesters, hydrocarbons etc. The most frequent hydrocarbon bond in beewax is the CH<sub>2</sub>-CH<sub>2</sub> which is found in polyethylene (PE). Meanwhile, biodegradation of PE by gut microbes of Indian meal moth, *Plodia interpunctella* and lesser wax moth (a close species of GWM) was reported. As wax-digestion is not a common character of animals, we hypothesized to encounter some microbes in GWM-gut, which could also be responsible for the PE degradation. Therefore, we aimed this investigation to isolate and identify the gut-microbes from GWM following culture-dependant approach. We had characterized several bacterial and fungal species based on culture characteristics, Gram-staining and several biochemical tests such as carbohydrate utilization test, catalase test, citrate utilization test, MR-VP test, motility test etc. Using 16S-rDNA sequencing with conserved primer-sets from representative types, thirteen bacteria and one microalgae were obtained from the digestive tract of *G. mellonella*. These species includes Gram-positive *Exiguobacterium aestuarii*, *Bacillus circulans*, *Microbacterium zaea*, *Microbacterium paraoxydans*, *Enterococcus faecalis* and Gram-negative *Agrobacterium* sp., *Sphingomonas pseudosanguinis*, *Sphingobium yanoikuyae*, *Acinetobacter radioresistens*, as well as a microalgae (*Picochlorum oklahomensis*). Several of these species/ isolates have been reported to degrade polycyclic aromatic hydrocarbon, low density polyethylene, 2-methylphenanthrene etc. Interestingly, *P. oklahomensis* is a marine microalgae; it steals genes from bacteria and adapt themselves to abiotic stress. Further investigation will be required to find out more precise details about plastic degrading candidate microbes and their biotechnological applications.

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**Abstract of M.Sc. thesis**

**Department: Agriculture Biotechnology**

**Major Adviser: Dr. Basanta K. Borah**

# **Isolation and characterization for pesticide tolerant bacteria and their application in remediation of pesticides contaminated soil**

*Subangshi Borah*

Application of agrochemicals to reduce the infestation of pests and disease, a major constrain in improving crop yields has become a worldwide practice in the intensive agricultural production system. Although agrochemicals have no doubt helped in reducing crop damage and increasing food production, their indiscriminate use has led to several negative impacts on the environment including human health. Many of the pesticides are slow degrading and are retained in the soil long after their application which leads to entry into ecosystems and in turn may show lethal effects on the living system. Microbial degradation is an attractive alternative method to remove the pollution created by the use of pesticides. Many soil microorganisms have the ability to degrade many pesticides by converting them into non-toxic compounds. Therefore, the present study was undertaken to isolate and identify imidacloprid-degrading microbes from pesticide-contaminated soil and to test their utility in field conditions. Soil samples were collected from three different plots with and without history of pesticide application and enumerated for bacterial diversity and also screened for pesticide tolerant/degrading bacteria by plating in minimal media agar plates containing four different pesticides viz., Deltamethrin, Quinalphos, Glyphosate and Imidacloprid at a concentration of 25 ppm each. Bacterial abundance was observed in media plates containing imidacloprid as a sole carbon source indicating the presence of pesticides degrading bacteria. Imidacloprid, a neonicotinoid group of pesticide used in tea gardens to control aphids, mites, spiders and whitefly was thus taken for study. The bacterial isolates were exposed up to a range of concentration (25 ppm -25,000 ppm) of Imidacloprid to test the tolerance ability of the bacterial isolates. Among the 30 bacterial isolates, four isolates (MBSB-1, MBSB-9, MBSB-11 and MBSB-12) were able to grow in 25,000 ppm of imidacloprid. The isolate MBSB-12 was able to grow and survive for a longer period in culture containing 25,000 ppm imidacloprid and thus taken for further study and identified as *Pseudomonas plecoglossicida* (Accession number MW091028)

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**Abstract of M.Sc. thesis**

**Department: Agriculture Biotechnology**

**Major Adviser: Dr. M. Barooah**



on the basis of its cultural and 16S rDNA sequence homology. The High Performance Liquid Chromatography (HPLC) analysis of samples drawn from *in-vitro* experiment liquid culture and soil revealed *Pseudomonas plecoglossicida*. MBSB-12 to decrease 94% and 87% imidacloprid in 7 days and 90 days respectively. The imidacloprid degraded products were identified through High Resolution Mass Spectrometry (HRMS) analysis as two non-toxic compounds *viz.*, imidacloprid guanidine olefin and imidacloprid urea. A greenhouse experiment conducted to evaluate the imidacloprid degradation efficiency of *Pseudomonas plecoglossicida*. in pots sown with *Solanum melongena* (variety-COBH.1) was set up. The soils in the pots were inoculated with 10<sup>6</sup> CFU per gram of soil and sprayed with 100 ppm imidacloprid on infestation with whitefly/aphids. However, no pesticide residue was detected in the soil which may be due to single dose of imidacloprid application. This study revealed the successful degradation of imidacloprid to non-toxic compounds by a native bacterial isolate. Further study to understand the conditions that influences pesticide degradation in soil (pH, temperature, soil moisture) along with identification of the genes involved in the catabolic pathway will open new vista to improve the biodegrading ability of the isolate.

# Development of CAO-1 mutant in rice using CRISPR/Cpf1 technology

*Suprava Priyadarsini Nayak*

CRISPR (Clustered Regularly Interspaced Short Palindromic Repeats) is originally a bacterial immune system against virus based on RNA guided bacterial defence mechanisms designed to recognize and eliminate foreign DNA of invading bacteriophage and plasmid. Although the most successful genome editing tool used at present is CRISPR/Cas9 (Jaganathan *et al.*, 2018), the newly developed CRISPR/cpf1 (CRISPR from *Prevotella* and *Francisella 1*) is a single RNA guided endonuclease of a class-II CRISPR-Cas system that has several advantages over CRISPR/Cas9 (Zetsche *et al.*, 2015). Cpf1 needs single guiding RNA (*sgRNA*) while Cas9 requires two guide RNAs (*crRNA* and *tracrRNA*). While Cas9 make a blunt end cut of the DNA molecule after recognizing a PAM sequence NGG (Moon *et al.*, 2018), the Cpf1 endonuclease makes a staggered cut of the DNA after recognizing a PAM sequence *viz.* NTTT, offering researchers more option when selecting an editing site. The current study employed CRISPR/Cpf1 construct *pSS09* harbouring *sgRNA* of *CAO1* gene of rice that was developed at Prof. Okita's Lab, Institute of Biological Chemistry, Washington State University, Pullman, USA. The main objective of the present study was to validate the efficacy of CRISPR/Cpf1 system in rice. Chlorophyllide-*a*-oxygenase (*CAO1*) is an enzyme that converts chlorophyll *a* to chlorophyll *b*. Knockout of the gene using CRISPR technology is expected to produce "pale yellow" leaf phenotype. We introduced CRISPR/Cpf1 binary vector harbouring *sgRNA* of *CAO1* gene into *Japonica* rice *cv.* Kitaake through *Agrobacterium* genetic transformation. Embryogenic calli were induced from mature seed with efficiency of 96.3% and regeneration efficiency of embryogenic calli was observed as 63.3%. 43 putative transformed lines were generated in the current study. Out of 43 transformed lines, 20 lines were selected based on varied level of pale green colour of the leaves and subjected to PCR analysis using gene specific primers for the targeted sequence of *CAO1* gene. Transformed lines number 8, 9 and 13 showed mutations in the *CAO1* gene with 9 bp, 12 bp and 25 bp deletions, respectively. We observed fairly high efficiency of mutation rate (2.22%) with CRISPR/Cpf1 system and the mutations occurred at very near the targeted *sgRNA* sequence of *CAO1* gene.

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**Abstract of M.Sc. thesis**

**Department: Agriculture Biotechnology**

**Major Adviser: Dr. Salvinder Singh**

## **Regional Variation of Rice Production in Kerala**

*Anagha V. Gopal*

Rice is the most important food crop grown in Kerala. It occupies 7.46 % of the total cropped area of the state. The agriculture in Kerala has undergone significant structural changes in the form of a decline in the share of Gross State Domestic Product and commercialization of agriculture. However, a large share of the rural population is still dependent on agriculture for employment and livelihood. In this present study, an attempt has been made to examine the trends of area, production, and yield of different types of rice crops in three different geographical regions as well as in the state of Kerala. For the trend analysis of the area, production and yield of autumn, winter, summer, and total rice in different geographical regions, the three different models viz. linear, quadratic, and exponential have been fitted. The functional form having the highest coefficient of determination ( $R^2$ ) and lowest Mean Square Error (MSE) has been selected for fitting the trend of area, production, and yield of autumn, winter, summer, and total rice in all the three geographical regions of Kerala. The region wise Compound Growth Rate (C.G.R) and Coefficient of Variation (C.V) have been computed to study the region wise instability of rice production. A multivariate linear discriminant function and associated Mahalanobis  $D^2$  statistics have been carried out by considering eleven variables viz. area and yield of respective rice, area under HYV, irrigation, and fertilizer consumption for estimating the potential index of rice production in each district of Kerala. The study reveals a decreasing trend of area and production for all the types of rice in three geographical zones as well as in the state. But in the case of yield, it has shown an increasing trend in all the geographical zones and also in the State of Kerala. The empirical estimate of growth rates shows that area and production are having negative growth while yield is having a positive growth rate and even though all are significant. The multivariate discriminant analysis with zero misclassification shows that relatively good performing districts have a larger discriminant score than that of the districts having relatively poor performance in yield.

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**Abstract of M.Sc. thesis**

**Department: Agricultural Statistics**

**Major Adviser: Dr. R. P. Paswan**

# **Classifying the States of India Through Rice, Wheat, and Groundnut using Statistical Graphics**

*Stanley Tornam Tsigbey*

India's economy is mainly contingent on agriculture which accounts for 17-18 percent of India's gross domestic product (GDP) and provides sufficient **employment** to 50-60% of the total population. The India position in terms of rice, wheat, and groundnut production all over the world call for vital information on area, production, and productivity as well as agricultural states of India.

In this study an effort has been made to classify the agriculture states of India using statistical graphics i.e. regression analysis and tri linear plot of the three selected major crops; rice, wheat, and groundnut. And in order to do that the 50 years data (1966-2016) trend of area, production, and productivity of the various crops are converted into index number. Thereafter a scatter plot is depicted considering 'area index' as an independent variable and 'productivity index' as a dependent variable and then a linear regression line is being fitted along with confidence band for classification of the states. Tri-linear plot was considered as one of the graphics in classifying the states where the indices values of the three variables (area, production, productivity) were first brought within the range 0 to 1. Afterwards percentage contributions of each of the three variables are taken where the total of the three variables sum to unity (100%) and are represented as one point on a triangular diagram.

The study reveals that some states recorded less productivity despite of being adequate increasing area trend and some states also shown productivity increased with decreased area.

The classification of Indian states is to provide essential information to the planners and policymakers responsible for designing efficient agricultural policies, and for making significant decisions concerning resources allocation for the development of agricultural sector in the various states.

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**Abstract of M.Sc. thesis**

**Department: Agricultural Statistics**

**Major Adviser: Dr. Hemanta Saikia**

# **Structural Break Analysis of Rapeseed and Mustard Production in Jorhat District of Assam**

*Sujata Baruah*

Oilseed crops play a vital role in the Indian agricultural economy and so does in any parts of Assam in terms of area and production. Rapeseed and mustard production in Jorhat have increased from 7817 tonnes in 2012-13 to 9118 tonnes in 2013-14 and then decreased to 8129 tonnes in 2014-15. This reflects the structural change in the economy of the district. The present study is performed to determine the exact time of the structural break in the rapeseed and mustard production, followed by the identification of the factors affecting the crop's production and finally by examining the presence of cointegration between the crop productivity and the various variables under investigation. The data collected for the study pertained to the annual time series of area, production, productivity, maximum temperature, minimum temperature, total rainfall, bright sunshine hours, and wind speed for the periods 1988-89 to 2014-2015. The results of the structural break analysis reveal that the variables for the crop are non-stationary at levels, indicating the existence of structural breaks. The production of rapeseed and mustard is found to have breaks in the years 1995-96 and 1996-97. Amongst all the factors under investigation, the area is found to have a significant effect on the production of the crop in Jorhat district of Assam. This implies that increasing the land area in the study location may increase the production of the crop in the same place. Johansen's cointegration test was used to check for the presence of the cointegration between the variables under the crop. It is concluded that the variables in the model are cointegrated. This is followed by the employment of the Vector Equilibrium Correction Model, finally proving the presence of a long-run relationship between the variables. It is found that minimum temperature has a negative relationship with the productivity of the crop whereas area and total rainfall have positive and significant short-run effects on the productivity of rapeseed and mustard crop in the study location.

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**Abstract of M.Sc. thesis**

**Department: Agricultural Statistics**

**Major Adviser: Dr. Dr. R. P. Paswan**

# **Land Use Pattern of Rice Farmer with Special Reference to Nalbari district of Assam**

*Anindita Devi*

Land is the fundamental resource for all agricultural activities. Proper utilization of land directly contributes to the economic and agricultural development of a region. The economy of the state of Assam is agrarian in nature. Assam occupies a geographical area of 78438 sq. km out of which net cropped area is 28.27 lakh hectares. The average cropping intensity of the state is 145.9 percent. One of the main reasons for low cropping intensity is that the area under Rice cultivations are mostly kept as fallow land after harvesting of the crop. The state is more or less self sufficient in rice production. But, in case of pulses, oilseed and other crops the state is dependent on other parts of the country and it is very essential to increase the total production of all these crops to feed the growing population. Despite of the effort of both the state and central Govt. to develop agricultural sector over the time yet there is no significant improvement in case of cropping intensity. So, the present study was undertaken to explore the factors responsible for monocropping of Rice.

The study was conducted in the three blocks *viz.*, Pub Nalbari, Pachim Nalbari and Borbhag blocks in Nalbari district of Assam. Primary data was collected using multistage stratified random sampling technique. A total of 135 farmers were selected as the final sample.

The study revealed that the average size of the operational holding of the rice farmer was found to be 1.648 hectares per farm. Land use pattern of the study area did not follow any particular trend. However, the highest percentage of fallow land was found in medium-sized farm while homestead land and net sown area was found to be the highest for large size farm and small sized farm. On an average all the sample Rice farmer kept 63.78 percent of the net sown area as fallow land after harvesting of Sali rice. Land used for single cropping of Rice was the highest for small sized farm (71.6 percent). Mostly five Rice based cropping sequence was followed in the study area namely Rice-Fallow, Rice-Toria, Rice-Potato, Rice-Black gram and Rice-Pumpkin. Sali rice mono crop shared the highest percentage (55.15 percent) of the total gross cropped area with 1.07 hectares of land per farm. Rice-Pumpkin was found to be the most

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profitable cropping sequence amongst all four cropping sequences. Regarding the cost and income per hectare of different crop cultivation, not much difference was observed across the farm sizes. However, medium-sized farm was found to generate more income from all the cropping sequences except for Rice-Pumpkin. In case of Rice-Pumpkin, large sized farm gained more net income per hectare of land. Availability of irrigation facility, availing of institutional credit and commercialized nature of cultivation were the major factors affecting the choice of cropping pattern. Study also revealed that the problem of stray cattle and unavailability of proper irrigation was the major constraints in multiple cropping patterns. To promote multiple cropping sequences, community cultivation of crops should be popularized as well as timely supply of irrigation water should be provided.

# **Characterization and economic appraisal of farming systems in Kamrup (Metropolitan) district of Assam**

*Arindita Bishaya*

In the present agricultural scenario of Assam, diversification of farms is one of the most potential ways of raising and stabilizing productivity and profitability levels of farm income, augmenting farm employment, risk reduction, maintaining food security, managing environmental pollution and supporting sustainable agriculture by optimum utilization of land, labour and other resources. Due to the availability of limited land resource in the rural areas of Kamrup (M) district on account of increasing population, land fragmentation and other associated factors in the current times, farming system and integrated farming system approach is gaining popularity in the region. The study undertaken is an attempt to investigate the prevalent farming systems, their types and patterns of diversification, estimate the economics of the identified farming systems and analyze the major constraints faced by the sample farmers practicing the farming systems. The study was conducted in two blocks, viz. Chandrapur Development Block and Dimoria Development Block of Kamrup (M) district of Assam following the multistage stratified random sampling design. A total of 100 farmers were selected as the ultimate sample in the ratio 4 marginal: 3 small: 2 medium: 1 large for the purpose of study. The study pertaining to land utilization and characterization of farming systems revealed that total area of operational holding in the entire sample was 48.91 hectares, of which 82.78 per cent was utilized for cultivation of field crops and 5.64 per cent for allied agricultural enterprises. Crop alone (40 per cent), Crop + Dairy (25 per cent), Crop + Dairy + Poultry (19 per cent) and Crop + Dairy + Poultry + Duckery (10 per cent) constituted the major identified farming systems. Highest gross cropped area (2.35 hectares) and net sown area (1.97 hectares) was found in crop + dairy + poultry + duckery farming system, while, highest cropping intensity of 122.09 per cent was found in crop + dairy + poultry farming system. The study on economics of the farming systems revealed that in crop farming system, average total cost (Cost C<sub>2</sub>) incurred and average total income gained per hectare of operational holding were Rs. 66748.74 (Rs.

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221539.06 per farm) and Rs. 92341.55 (Rs. 306481.60 per farm) respectively. Sali rice had the highest contribution (47.28 per cent) to the total income while boro rice was the most profitable crop with B:C ratio of 1.49. In crop + dairy farming system, the average total cost incurred per farm was Rs. 358289.17 and average total income gained per farm was 6 Rs. 500261.84 from the entire system. Both crop and dairy enterprise showed a B:C ratio of 1.4 each. On the other hand, in crop + dairy + poultry farming system, the average total cost incurred and average total income earned per farm was Rs. 337392.82 and Rs. 473846.27 respectively. Both crop and dairy enterprises were equally more profitable in the system (B:C ratio 1.41 each) than the poultry enterprise (B:C ratio 1.3). In crop + dairy + poultry + duckery farming system, the average total cost incurred per farm was Rs. 462682.80 and average total income gained per farm was Rs. 332029.33. The duckery component was the most profitable enterprise (B:C ratio 1.46), followed by dairy (B:C ratio 1.4), crop (B:C ratio 1.39) and poultry (B:C ratio 1.27) enterprises. No particular trend was observed across the size classes in the sample in regard to the total cost (Cost C2) of the farming systems while the net income mostly exhibited a positive trend alongwith the increase in size of farms. The crop component was the dominant enterprise in all the farming systems contributing more than 85 per cent to the total income. Both crop + dairy and crop + dairy + poultry were the most profitable farming systems in the sample displaying a B:C ratio 1.4 each, followed by crop + dairy + poultry + duckery (B:C ratio 1.39) and crop (B:C ratio 1.38) farming system. The study on the main constraints encountered by the sample respondents brought to light that high cost of inputs was the major constraint identified in the crop enterprise, while inadequate knowledge of disease prevention and control, and, vulnerability to diseases were the highest ranked constraints in the dairy and, poultry and duckery enterprises respectively.

## **Production and Marketing of Mushroom in Sivasagar district of Assam**

*Bidisha Buragohain*

Mushroom is fleshy, spore bearing fruiting body of a fungus, typically produced above ground on soil or on its food source. Mushroom cultivation is labour intensive, indoor activity where high profitability provides employment to small farmers, landless labourers, women and unemployed youth in rural areas. Mushrooms have nutritive and medicinal importance. In Assam, mushrooms are greatly desired item of food. The study was performed in undivided SIVASAGAR district of Assam. In Sivasagar district of Assam, oyster mushroom is cultivated by the growers due to its easy and cost effective cultivation.

The study pertains to the year 2019-2020. There were three crop cycles in a year in the survey area. The sample size was 120. The sampling design followed for the survey was Simple Random Sampling. Primary data were used for the study. Primary data was collected from the sample mushroom growers through questionnaire by face to face interview method. The sample mushroom growers were stratified into 4 size groups on the basis of number of mushroom bags prepared, by the cumulative frequency distribution method. The stratification was as follows: Group I prepared 1-50 bags, Group II prepared 51- 150 bags, Group III prepared 151- 300 bags and Group IV prepared 301 and above bags. The objectives of the study were: to study the resource utilization pattern in mushroom cultivation, to examine the economic feasibility of mushroom cultivation, to estimate the marketing efficiency of mushroom, to analyse the constraints faced by the mushroom growers. Results of the present study revealed that per grower utilization of variable resources increased from group I to group IV but per bag utilization decreased from group I to group IV except straw and rope. This may be due to the tendency of small growers to use more quantity of resources to minimize risk. Paddy straw and spawn were the major inputs in mushroom cultivation because of their highest values among the items of variable resources. Highest labours required for cutting of straw followed by harvesting and transferring the bags to cropping room. Most of the growers used only family labours in the study area. In utilization of equipments, per grower utilization increased from Group I to IV and per bag utilization

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decreased from Group I to IV. Production per grower increased from group I to IV but per bag production decreased from group I to IV. Mushroom production was financially profitable due to its high value of benefit cost ratio based on variable cost and total cost. Breakeven price and production were much lower than the average price and production which indicated economic feasibility of mushroom production in the study area. Marketing efficiency was highest in group I and II because of lack of involvement of middlemen. Lack of local market for fresh and dried mushroom, lack of regular market, non-availability of spawn in time were the major constraints faced by the sample mushroom growers.

# **Impact of Tenancy System on Resource Use and Production of Major Crops in Karbi-Anglong District of Assam**

*Brota Sing Bey*

Agricultural productivity and production of Assam is less in compare to other state of the country. Increasing the productivity per unit of cultivable land has been the main priority of all concerned. Since the population growth rate of the state has been increasing at a faster rate than in compare to Agricultural production. So, the agricultural production could not keep up with the increasing population growth rate. Consequently, the state agriculture faced the problem of how to increase the productivity per unit of input use. Consequently, efforts have been made for accomplish efficiency in resource use. Though, the productivity and resource use of tenancy are affected by various elements such as the size of the holdings, tenancy system, tenurial status of land, etc. it was observed that apart from own farm operating system, tenancy system also exists in the Karbi Anglong district of Assam because the land owners do not cultivate all of their available land due to lack of family labour and some other reasons. The present paper attempts to study the nature and extent of existing tenancy systems, examine the production and resource use efficiency of major crops in owned and tenant farms and to identify the problems faced by owned and tenant farmers. The study was conducted in Karbi Anglong district of Assam with 84 respondents. The primary data were collected by personal interview method. Most of the respondents were between the age group of 15 to 60 years with most of them having primary level of education. From the study It was found that 62 percent of the sample tenant farmers had rented less than 50 percent of their own land which was considered to be the tenant group I and 38 percent of the sample tenant farmers has rented more than 50 percent of their own land which was considered to be tenant group II. The cropping intensity was found to be higher in the tenant farmers than in compare to the owned farmers and the cropping intensity of tenant group I was found to be higher in compare to the tenant group II. There was a difference in resource use in rice cultivation under Total tenant and owned, Tenant's leased in and Tenant's own land and Tenant group I and Tenant

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group II which was supported by t-test. Similarly, there was a difference in resource use in sugarcane and tomato cultivation under Total tenant and Owned and Tenant group I and Tenant group II, respectively. The change in some inputs like seed, fertilizers etc were found to be significant and positive. In the resource use efficiency of rice, the return to scale was found to be higher in tenant farmers compared to Owned farmers. In the resource use efficiency of sugarcane, the return to scale was found to be higher in Owned farmers than in compare to the Total tenant. Similarly, In the resource use efficiency of tomato, the return to scale was found to be higher in owned farmers than in compare to the Total tenant. The gross return obtained from rice by Total tenant and owned farms were ₹ 56855.24 and ₹ 45544.00, respectively. Similarly, for Sugarcane and Tomato, the gross return for Total tenant and Owned farms was found to be ₹ 583128.16 and ₹ 628011.63 and ₹ 176146.84 and ₹ 173706.04, respectively. It was found that the lack of irrigation facility and the hired labour charges and lack of proper knowledge about the disease and pest management was found to be the common problems in both the tenant and owned farmers. The study concluded that There is still scope for the farmers to increase the quantity of input use where the resource use has been under-utilized and the scope to decrease the quantity of input use where there is over-utilization of the resources by the farmers. The recommendation for advisory services and training on various insect, pest and disease management issue for better management practice by the farmers in the major crops.

## **Interzonal variation of agriculture in Brahmaputra valley zones of Assam**

*Dhiman Hazarika*

The present study was conducted in the four agroclimatic zones of the Brahmaputra Valley viz., Upper Brahmaputra Valley Zone, Central Brahmaputra Valley Zone, Lower Brahmaputra Valley Zone and North Bank Plains Zone with the objective of finding the zonal variation in agriculture. The main objectives included identification of the major farming systems in the study area, finding the interzonal variation in resource use, finding the variation of farm income across the zones according to the farming systems and finally identification of the constraint faced by the farmers. The study employed multistage random sampling technique and a total number of 200 sample farmers were selected for the study from the 20 ADO circles in the four agroclimatic zones. The findings revealed that there were numerous farming systems practised by the farmers in the study area. However, only three of them emerged to be the major ones. The three most adopted farming systems were „crop“, „crop+dairy“ and „crop+dairy+poultry“. Between the three, crop farming system was the most popular and was adopted by 34.50 percent of the sample farmers. It was followed by crop+dairy+poultry farming system adopted by 19.5 percent sample farmers and finally, crop+dairy farming system adopted by 18.5 percent of the sample farmers in the Brahmaputra Valley. The resource use pattern was found out for the three major farming systems and it revealed that there was considerable variation in level of resource utilization across the agroclimatic zones with some zones using more inputs in crop, dairy and poultry than the rest. On examining the income variation across the agroclimatic zones it was found that crop enterprises contributed the most to farm income. It was followed by dairy and poultry enterprises respectively. Also, farm income increased with the incorporation of dairy and poultry enterprises in their farming system. Upper Brahmaputra Valley zone reported the highest net income per farm out of all the four zones in the Brahmaputra Valley. Finally, the constraints faced by the farmers in the study area were found out and evaluated. Major constraint faced under crop cultivation was lack of finance which meant that farmers lacked the required capital to efficiently perform agricultural activity. Most dairy farmers faced a shortage of skilled labourers in their farms. Under poultry farming early chick mortality was the most common problem to be identified across the zones.

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# **Dynamics of Hill Agriculture with special reference to Shifting Cultivation in Dima Hasao District of Assam**

*Hamjana Hojai*

The present study was undertaken in Dima Hasao, one of the hilly districts in the state of Assam. In an attempt to understand the dynamics of hill agriculture in the district, it was found that the availability of operational holding per holder had decreased by 77.32 percent from the year 1970 to 2000. Another decrease of 36.23 percent was observed from the year 2000 to 2010 with the availability of 0.69 ha per holder in 2010. Cropping Intensity (C.I.) showed an increasing trend between 1999-00 (C.I. value of 129 percent) till 2010-11 (C.I. value of 200.50 percent), with a steep increase between the year 2008-09 and 2009-10. This could be attributed to the success of a few projects going on under the National Watershed Development Project for Rainfed Areas (NWDPR) during the time. This increase was followed by a decreasing trend between 2011-12 (C.I. value of 192.46 percent) and 2018-19 (C.I. value of 132.63 percent). A significant increase was observed in the area covered under cereals, pulses, oilseeds, fruits, vegetables, condiments and spices, sugar and rubber from 1999-00 to 2018-19. Also, there was significant growth in fertiliser (total) consumption with Compound Growth Rate (CGR) of 20.08 percent and a very high Co-efficient of Variation (CV) of 227.58 percent. Shifting cultivation is a dominant land use practice in Dima Hasao and in an attempt to identify the existing crop mix in the study area, it was found that they could be divided into four crop mix groups based on the crops grown under shifting cultivation. Out of them, Crop Mix III (Cereals + Vegetables + Spices + Oilseeds + Tubers) had the highest occurrence with 58.75 percent of respondents following it. The analysis of the resource use pattern under shifting cultivation revealed that human labour (owned) was the most extensively used resource, contributing up to 70.84 percent (Crop mix III) to the total cost of production. Seed costs contributed up to 33.37 percent, farm tools contributed up to 6.66 percent (Crop mix IV) and farm hut contributed only up to 0.75 percent (Crop mix I) to the total cost of production. The ratio of return over variable costs in shifting cultivation ranged from 1.78 to 2.03 in the

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four crop mix groups with the highest ratio (2.03) in Crop mix IV (Vegetables + Spices). Employment generation in shifting cultivation (year-round) ranged from 183.06 to 224.63 mandays (per ha) with an average of 205.19 mandays (per ha) while the average annual net income from shifting cultivation in Dima Hasao was found to be Rs. 31,193.13 per ha.



## **Organizational structure and management of Dream Dragon Fruit Farm of Nagaland**

*Pithunglo L Kiron*

Dragon Fruit is a climbing cacti and needs support for growth and development. It is a new introduction in India and also known as “The wondrous fruit of the 21st Century” due to its nutraceutical properties. The study was conducted in Dream Dragon Fruit Farm located at Shitovi village of Dimapur district in Nagaland state of India. A total of 15 wholesalers, 20 retailers and 45 consumers were interviewed randomly to fulfill the objectives of the study.

The farm has been commercially established in 5 ha land area and it has six (6) varieties of dragon fruit, i.e. white fleshed dragon fruit (*Hylocereus undatus*), pink/purple fleshed dragon fruit (*Physical graffiti*), red fleshed dragon fruit (*Hylocereus costaricensis*), yellow skin dragon fruit (*Hylocereus megalanthus*), orange skin dragon fruit and Opuntia variety. The organizational structure of Dream Dragon fruit farm is characterized by the proprietor who is the head of the organization, followed by three departments: Website Manager who is assisted by Assistant Website Manager, Farm Manager/ Caretaker who is assisted by 3 assistants and 4 labours, and Accountant cum marketing supervisor.

In order to estimate the economics of Dream Dragon Fruit Farm investment feasibility analysis was performed. The Net Present Value was found positive (Rs. 2,08,29,478.00), which indicates worthy investment of the proprietor. Benefit Cost Ratio was also greater than 1 (2.04), which also favours the investment. Internal Rate of Return of 11.78 clearly indicates a sound financial position of Dream Dragon Fruit Farm and hence the liabilities of the farm could be met easily during any unexpected closure in future. Value addition of dragon fruit in the form of wine preparation has started recently in 2019; a total of Rs. 2,23,000.00 was spend in wine preparation and the farm had earned a profit of Rs. 77,000.00 by selling the finished product.

Three prominent marketing channels viz. channel I (Producer – Consumer), channel II (Producer – Wholesaler– Consumer), channel III (Producer – Wholesaler - Retailer – Consumer) were identified for marketing of dragon fruits, out of which channel I was found to be most preferred channel.

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Higher initial investment and high labour requirement during monsoon season were the main production problems faced by the farm. Problem of storage facility, perishable nature of the fruit and high labour costs are the major marketing problems faced by the channel players. Lack of modernized processing industry and high cost of processing were the severe problems associated with value addition of dragon fruit. Government intervention in establishment of cold storage and processing industry will surely enhance the prospect of dragon fruit farming in the North Eastern region.

# Economics of Cashew Nut Production in West Garo Hills District of Meghalaya

*Saddam Hussain*

Cashew nut is an important plantation crop in wasteland development programme due to its utility in soil water conservation and to build up balanced ecosystem. Due to improvement in health consciousness of people, cashew nuts getting importance not only in domestic markets but also in international markets. The present study is an attempt to examine the cost, returns and resource use efficiencies of Cashew nut cultivation by different categories of farmers. The sampling design consists of four stages. In the first stage, the West Garo Hills district of Meghalaya was selected. In the second stage two blocks namely Dadenggre and Selsella were selected purposively. In the third stage, eight villages, namely. Aningokgre, Addinggre, Chibonggre, Daljagre, Dabakgre, Mronggre, Rongramgre and Makbilkolgre from the two blocks were selected purposively. In the final stage, proportionate number of farmers from each village were selected randomly to constitute a total sample of 120 farmers. The selected farmers were categorized as small (1 - 2 ha), medium (2-4 ha) and large (> 4 ha). The findings revealed that majority of the cashew nut growers were literate (78.62 per cent) with the educational status of (35.92 per cent) up to primary school. (25.77 per cent) up to secondary and (18.00 per cent) up to higher secondary level of education. The remaining (21.31 per cent) of cashew nut growers were observed to be illiterate. The average size of the family cashew nut growers was 6.11 members and land holding of the farmer was 3.10 hectares, out of which 2.97 hectares was operational and remaining 0.13 hectare was under permanent fallow. Out of operational land, the area under irrigation was 1.92 per cent and remaining area was unirrigated (98.08 per cent). The study further revealed that the per hectare establishment cost of cashew nut on a small, medium and large farm in the year 2020 were ₹ 11151.50, ₹ 10573.84 and ₹ 11475.96 respectively. The net returns were ₹ 13610.19, ₹ 13712.29, ₹ 13785.73, ₹ 13879.76, ₹ 13595.78, ₹ 14107.61, ₹ 14294.84, and ₹ 14189.20 in 8", 11", 14" and 17" year respectively. Benefit-Cost ratios were calculated as 2.44, 2.42 and 2.38 for the small, medium and large farms. It

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is observed that the Benefit-Cost ratio is more than unity, so it is feasible and economically viable. The factors that found significant in cashew nut production were hired human labour, family labour, manures and fertilizers in DJI size of farms. But age of the farmers was not significant. It showed that hired human labour, family labour, manures and fertilizers have a positive impact towards the income from cashew nut. The ratio of MVP to MC was positive and greater than unity and it is significant in case of inputs like labour, manures and fertilizers. Its significance indicated the possibility of additional use of these inputs to achieve the optimum level. The adjusted  $R^2$  for the estimated regression model were 0.8463, 0.7541 and 0.8677 for the small, medium and large farm respectively. The present study serve as a useful reference guide to the people involved in the cultivation and resource uses to the crop as well as a guideline for similar studies that may be undertaken in other parts of the country.

# **Estimation of Risk Frontiers in Rice Cultivation under Flood Prone Situation of North Bank Plain Zone of Assam**

*Shivangee Acharya*

The present study was carried out in the North Bank Plain Zone (NBPZ) of Assam during February- March 2020. The mentioned zone was purposively selected to study the effect of risk rising from chronic flood hazards in the region. As the occurrence of flood in the production process was unavoidable, the use of modern inputs was also dramatically low. The perceived risk inherent in the production process was the primary reason for hesitance in use of fertilizers, HYV seeds, modern practices, etc. That gradually led to low production and low productivity of rice in the study region. Rice was predominant in the region as the prevalent climate and hydrology did not provide favourable situation for cultivation of other crops in a commercial basis.

A multistage random sampling technique was used for the selection of sample farms. The sample farms were the core units of observation in the study. A sample of 90 farmers were randomly selected for primary data collection in the present investigation. The sampled farms were then grouped into small, marginal, semi-medium and large based on operational landholding and into group A and B depending on the percentage of crop area affected by flood.

Demographic situation was analyzed through tabular method. As the traditional production function fails to capture the risk considerations of the production process and also does not imply the nature of risk associated with a certain factor, i.e. if it is increasing or decreasing, hence, estimation was done through the Just and Pope (1979) model to analyze the product-factor relationship under uncertainty environment. The effect of factors on the yield was studied through the Cobb-Douglas production function. To study the inefficiency effects, the stochastic production frontier function developed upon by Battese and Coelli (1995) was used. The analysis was carried out through the FRONTIER 4.1 software.

The study area was predominant with marginal and small farms characterized by a low literacy rate. The youth of the area was primarily involved in agriculture directly or indirectly. The use of modern inputs was low; fertilizer had insignificant

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effect on the yield of marginal farms, but affected the yield of small and semi-medium farms in a significant way which indicated that by increasing the amount of fertilizer used, the yield could be increased too. Fertilizer also had a risk decreasing effect on the yield, which showed that it reduced the variability in the rice yield of the 8 farmers. Abundance of labour in the farms lead to overuse of the same. This implied that there existed disguised unemployment amongst the youth of the region. Most of the young population was involved in rice cultivation directly or indirectly. Literacy was found to be important in reducing risk in agriculture in an uncertain environment, and significantly reduced the variability of yield and risk in the production process.

A number of risk management strategies were developed by the farmers to reduce the loss arising from the flood hazard or for minimization of risk under such condition. These strategies were either *ex-ante*, *ex-post* or executed in the period of flood occurrence. Percentage analysis was carried out to determine which strategy was the most prevalent in the area amongst the farmers. The present study showed that risk played a major role in use or non-use of modern inputs and adoption of modern cultivation practices. The production of rice in the region could be improved by structuring effective policies, constructing proper planning for flood loss mitigation and developing practices and inputs that are in line with safeguarding the interests of the farmers in flood affected regions.

# **An economic analysis of production and marketing of orange in Kamrup Metro district of Assam**

*Sunil Pator*

Orange is commercially the most important sub-tropical fruit and one of the most widely cultivated fruit crops. The present study is an attempt to analyse the cost of cultivation of orange farmers, the economics of orange cultivation vis-à-vis competing crop and the marketing channel of orange in Kamrup Metro district of Assam. It will serve as a useful reference guide to the people involved in the cultivation and marketing of this crop as well as a guideline for similar studies that may be undertaken in other parts of the country. The present study is carried out with the following specific objectives: Find out the cost of cultivation of orange in study area; Study the economics of orange cultivation vis-à-vis competing crop; Study marketing of orange in study area. The sampling design consisted of four stages. In the first stage, the Kamrup Metro district of Assam was selected purposively. In the second stage two revenue circles namely Sonapur and Chandrapur were selected purposively. In the third stage, a total of six villages namely Kalangpur N.C, Dondoral N.C, Barkashrong N.C, Chandrapur Bagicha, Niz Panbari, Hingimari Bagicha from the two blocks were selected purposively. In the final stage, 32, 19, 25, 14, 15 and 15 farmers from Kalangpur N.C, Dondoral N.C, Barkashrong N.C, Chandrapur Bagicha, Niz Panbari, Hingimari Bagicha villages were selected randomly to constitute a total sample of 120 farmers. The selected farmers were categorized as small (those having less than 2 ha), medium (those having 2-4 ha) and large (those having more than 4 ha).

The findings revealed that the per hectare establishment cost of orange on a small, medium and a large farm in the year 2019 were ₹129357.60, ₹137160.60 and ₹139772.60, respectively. The average maintenance per hectare cost of small farm was estimated to be ₹55265.75, ₹55622.92, ₹57530.97, ₹64107.23 in medium farms ₹64528.75, ₹65050.25, ₹66645.25, ₹66882.75, large farms ₹73058.75, ₹73966.75, ₹75866.95, ₹76987.08 in 10th, 15th, 20th and 22nd year respectively. Benefit-cost ratios were calculated as 1.38, 1.45 and 1.50 for the small, medium and large farms. The

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average cost per hectare cost for arecanut farm was found to be ₹ 22555.93, ₹ 22297.81, ₹ 22429.49, and ₹ 24992.51 on 8th, 10th, 12th, and 13th year age plants. The net present value and benefit-cost ratio were found to be ₹ 261218.20 and 3.32, respectively. The study of marketing of orange revealed that orange producers sold their products through three marketing channels viz., Channel-I (Producer – Pre-harvest contractor – Retailer – Consumer), Channel-II (Producer- Village Trader – Retailer - Consumer) and Channel-III (Producer- Retailer – Consumer). Among these channels, channel-III was found the most important channel in the study area. The market efficiency was 4.58 in channel-III.



# **Assessment of women participation in Assam Agriculture**

*Trishna Chutia*

Indian women play a focal role in different agricultural activities along with their day-to-day household activities. The present study is an attempt to assess the level of women participation in agriculture, the women involvement in farm decision making along with estimation of women contribution to agricultural income in the state of Assam. The study also tried to identify the factors affecting women's participation in agriculture. The study area was in two districts of Assam viz., Golaghat and Nagaon. A multi-stage random sampling technique was used to select the sample unit. A sample of 180 households was selected from Golaghat, and Sarupothar block of Golaghat district and Kothiatoli and Barhumpur block of Nagaon district.

Various activities performed in different crops were considered to study the women participation. The most important activities of rice cultivation, in which women actively participated were transplanting and harvesting in both the districts of the state. Similarly, for other crops viz., sugarcane, mustard, potato, tomato and pumpkin, the most important activities that showed women participation were inter-culture activities, harvesting and post-harvest management

Decision making by women under organizational decisions was highest in leasing in & out of land (12.86%) in Golaghat district while decision making by women was highest in purchasing and selling of land (6.82%) in Nagaon district. With respect to production decision, highest decision by Women was for decision on area to put under different crop in both Golaghat (8.29%) and Nagaon (5.56%) districts. Storage of crop produce involved solo decision making by women in both Golaghat (49.14%) and Nagaon (31.06%).

The most profitable crop for both the district was pumpkin followed by tomato and sugarcane. The least profitable crop was found to be mustard for both the district with least return over cost. Contribution of women to net income was 36.84 per cent and 20.74 per cent in Golaghat and Nagaon district, respectively.

Among different factors, poor economic status (48.89%) and lack of alternative employment avenue (58.89%) were the most influencing factor while preference for job

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(24.45%) and lack of training (40%) were equally the most hindering factor in Golaghat and Nagaon district, respectively

The study revealed that women played an important role in different activities of important crops. However, women face some constraints while participating in agriculture. Intensive extension services, training, focus on income generating activities like off-season vegetable farming, nursery management and impetus on proper planning on women empowerment approaches etc. would help to increase their participation.

# Value Chain Management of Naga King Chilli of Nagaland

*Tumei Konyak*

Agro-climatic condition of India gives scope for growing 63 different spices, making India the “Land of spices” (with 48% India’s share in world trade of spices). Naga King chilli (*Capsicum chinense* sacq) also known as ‘Raja Merja’ or ‘Raja Mircha’ is one of the world’s hottest chilli (has also entering in "Guinness book of world records") and is widely known for its distinct taste, aroma and its pungency, widely grown Northeast part of India. Nagaland having favorable topography and climatic condition, has about 7739 million tons of production of Naga king chilli in 1385 hectare area (GON, 2015-16) and has also obtained G.I rights for Naga king chilli in 2008 from G.O.N under Registration and Protection Act, 1999. So, Present Study on “value chain management of Naga king chilli in Nagaland” was carried out to identify and map the different value chain of Naga king chilli, to analyze the resource management in different value chains of Naga king chilli and to examine the problems faced by value chain players in the region. The study was executed in Mon district of Nagaland during the year of 2020 and Tizit block was selected for the study, under which two villages (*viz.* Nokyan village and Loakho Village) were studied and the data’s collected were from both primary and secondary means. A total of 100 respondents were selected randomly for the study, comprising of 50 farmers, 20 Intermediaries and 30 customers.

The value chain players identified from the study area were Naga king chilli growers (all small farmers), Wholesalers (Local & Distant), Retailer/vendors (Local & Distant) and customers. Data’s related to perception and attitude of end users were collected from Customers of Tizit block, also four market channels were identified in the study area. The growers practiced organic cultivation and profit earned by chain players per kg of NK Chillies is comparatively higher than other normal Chillies in the study area. The total number of working days required for production & cultivation of NK chilli was 183 days/ha/year, respectively. And the total number of labors required were 90/ha/annually. Some precautionary measures for picking, grading, washing and cleaning of Chillies, use of Indigenous Technical Knowledge (ITK) and packaging are used by the channel players to improve the shelf life of the chilli. Pest attack and Wide

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fluctuation in price were the major problems faced by farmers for production and marketing of Naga King Chillies, respectively. Major problems faced by other value chain players in the study region were Wide fluctuation in price, Availability/ Supply Shortage, Handling and storage problems, Perishable nature of Chilli, etc. Some of the policies suggested were, Contract agreement between farmers and buyers to sustain the supply flow. Initiating post-harvest handling practices for the tribal farmer, Proper/scientific storages, Forming Cooperatives/FPO's, Trainings could be initiated through KVK, NGO'S, state departments, etc. Hence, this study was undertaken to understand the value chain management in Naga king chilli in the region.

# **Performance of Agri-Supply Chains: A study on Fresh Vegetable Distribution System in Jorhat district of Assam**

*Allah Mohammad Riaz*

Supply chain is the network of organizations that are involved, through upstream and downstream linkages, in different processes and activities that produce value in the form of products and services in the hand of ultimate customer. Supply chain management (SCM) of vegetable is complex as compared to other SCMs due to the perishable nature of the produce, and high fluctuations in demand and prices. A total of 150 samples comprising of 45 vegetable farmers, 30 assemblers, 30 wholesalers and 45 retailers were randomly selected from Jorhat district of Assam for the study. Different marketing activities such as cleaning and washing, grading, storing and packing were by and large followed by most of the respondents. All the traders, except the farmers, were lacking awareness on pesticides and chemical use standards set by the government. Precautionary measures such as washing, use of Indigenous Technical Knowledge (ITK), organic treatment and packaging were used by the channel players to improve the shelf life of fresh vegetables. Majority of the channel players were satisfied with the services offered by the transport operators in shipping of fresh vegetables. Most of the time, the fresh vegetables were damaged during transit due to long waiting time of loading and unloading. Prolonged storage time, poor storage facilities, inferior quality, and rough handling of vegetables were the main reasons for quality loss of vegetables in the marketing channels. Vegetable prices were mainly determined by the demand-supply forces. On an average, the respondent farmers had spent Rs. 64,404.00/farm/year and in return had earned Rs. 1,77,996.00/farm/year, which help them in earning a profit of Rs. 1,13,592.00/farm/year. Profit earned by farmers per kg of brinjal, ridge gourd, spine gourd, pointed gourd, broccoli etc. were comparatively more than the other vegetables. Four prominent marketing channels viz. channel I (Producer – Assembler – Wholesaler – Retailer – Consumer), channel II (Producer – Wholesaler – Retailer – Consumer), channel III (Producer – Retailer – Consumer) and channel IV (Producer – Consumer) were identified for marketing of vegetables in Jorhat district, out

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of which channel IV was the most efficient channel. Fluctuating price of vegetables, transportation difficulties, storage problem and non availability of market information were the common problems faced by majority of the respondents of all groups.

# **Impact of the Celebrity Endorsement on the Buying Behaviour of the Consumers in Jorhat District of Assam**

*Balaganesh T*

The modern-day markets are very attractive in terms of the purchasing power and as well as equally competitive. The existence of a product is directly proportional to how far it reached and created awareness about the product to the consumers. So, the modern marketing strategy of the most business relies heavily on the advertising that can easily promote the products in a short period. Advertisement is a persuasive tool to convey a brand's message to target audience with an aim to persuade them towards buying that brand or product. It is the most influencing tool in the hands of the marketer to market his product. Meanwhile, the buying behaviour of the consumers decides the running of the business in the market. In this era, product endorsement from an authoritative figure is a key element in business advertising and marketing campaigns.

India is one of the places where the celebrities are idolized and they enjoy demigod status. Peoples admire the celebrity and hold them in high esteem. Celebrity endorsement has become a popular method of advertising in this era. In simple words, using the fame of celebrity to promote a product or service. McKinsey Global Institute (MGI), reported that the consumer market in India is developing at a speedy rate and prospective tempo, and the country's consumer market is the fifth largest in the world by 2025 which is currently valued at US\$ 511 billion.

The present study was an attempt to examine the impact of the celebrity endorsement on the buying behaviour of the consumers and conducted in Jorhat district of Assam. Data was collected through a questionnaire from 150 persons. The results showed that the celebrity endorsement had a positive impact on bringing awareness about the product but their influence on buying behaviour was minimal. The effective media for advertising was internet or social media which is becoming more popular in the modern era. The gender of the celebrity, beauty of the celebrity, physical attractiveness of the celebrity had no impact or they had a very minimal impact on influencing the consumers. The consumers had a positive attitude towards a celebrity endorsed product at the same time they expect them to be of good quality.

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**Major Adviser: Dr. N. Bothakur**

# **An Economic Perspective of Farmer Producer Company (FPC) — The Case of Satbhani Potato Producer Company Ltd**

*Imran Hussain*

Farmer Producer Companies (FPCs) are the institutions that can be geared up towards protecting small farmers from the ill-effects of liberalization and to incentivize them to participate in modern competitive markets. The producer company aims to empower and improve the bargaining power as well as the quality of life of small and marginal farmers. The present study entitled “An Economic Perspective of Farmer Producer Company (FPC) - The Case of Satbhani Potato Producer Company Ltd.” was conducted under Biswanath district of Assam. The study intended to examine the structure, organisational pattern, and performance of Satbhani Potato Producer Company Ltd. The study compared the economics of potato production for both FPC and non-FPC farmers of the study area. Further, the factors influencing the performance of FPC farmers were examined under the study by employing multiple linear regression. The study reveals that the Satbhani Potato Producer Company Ltd. was found functioning as per the structure provided by the Department of agriculture and cooperation, Government of India under policy and process guidelines for farmer producer organisations. The various financial test ratio *viz.*, current ratio, net capital ratio, return on asset, return on equity and debt-equity ratio were calculated for Satbhani Potato Producer Company Ltd. for the financial year 2017-18 and 2018-19. The current ratio, net capital ratio, return on asset, return on equity and debt-equity ratio for the year 2017-18 were 2.21, 2.69, 0.05, 0.09, 0.59 respectively, while the ratios for the same for the year 2018-19 were 1.86, 3.13, 0.10, 0.14, 0.46 respectively indicating the satisfactory performance of the Satbhani Potato Producer Company Ltd. The costs and returns were examined to study the economics of potato production. The findings of the study revealed that FPC farmers were incurring relatively lower costs per hectare of potato production than non-FPC farmers. The per hectare cost of potato production was worked out as ₹ 181312.96 for FPC farmers and ₹ 195293.22 for non-FPC farmers on overall farm basis. For both FPC and non-FPC farms, the total cost of production per hectare was found to be increasing with the increase in the size of the farms. The overall

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productivity of potato was found higher in the case of FPC farmers (235.82 quintals/ha) as compared to non-FPC farmers (215.54 quintals/ha). In the case of FPC farmers, the productivity of small farmers was recorded as highest (248 quintals/ha) and it was lowest in the large farmer's category. In the case of non-FPC farmers, the highest productivity was found in medium farmers (226.05 quintals/ha) and lowest in large farmers (215.54 quintals/ha). The price received per quintal of potato was more in FPC farmers (₹ 1400) as compared to non-FPC farmers (₹ 1250). As a result, the overall gross income and net income per hectare were found higher in FPC farmers than those of non-FPC farmers. The overall gross income per hectare was ₹ 330166.66 and ₹261895.80 for FPC and non-FPC farmers respectively, while the overall net income was worked out as ₹148854.32 for FPC farmers and ₹ 66602.56 for non-FPC farmers. The overall benefit-cost ratio of FPC farmers was found higher (1.82) as compared to non-FPC farmers (1.38). The factors that were found significant in influencing the performance of FPC farmers were level of education, family labour, hired labour, family size, adoption of recommended production practices, and farm training attended during past years. The R<sup>2</sup> and adjusted R<sup>2</sup> for the estimated regression model were 0.8873 and 0.8709 respectively.

# **Study on Marketing Efficacy Of Mukta-Bio product of Brahmaputra Velly Fertilizer Corporation Ltd.**

*Tabarak Hussain*

This study will be helpful to provide an understanding about the marketing Efficacy of Mukta-Bio product of BVFCL, Namrup and also the impact of marketing & promotional strategies through marketing surveys. This project will act as a comprehensive elementary guide to increase the intergration of marketing mix, marketing management, expansion and improvedment of sales and awareness of the products in the consumers.

**Objective:**

1. To study the organizational structure of the BVFCL
2. To Examine the strategic management of 4 P s marketing mix of Mukta-Bio product
3. To study the marketing channel, channel wise marketing cost of Mukta-Bio prosuct
4. To study the customer behaviour about the awareness of mukta\_ Bio product

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**Abstract of M.Sc. thesis**

**Department: Agri-Business, MBA**

**Major Adviser: Mr. A. Talukdae**

## **A study on economics of *khuti* systems of buffalo rearing in eastern districts of Assam**

*Lochan Jyoti Dutta*

*Khuti* system of buffalo rearing is a traditional technique of Assam. Buffaloes are allowed to graze freely in open wetland areas or forest fields from morning till evening and taken back to the temporary camps. The present study entitled “To study the economics of *khuti* system of buffalo rearing in eastern districts of Assam” intended to study the extent of seasonality of production of milk. The present further worked out the cost and returns of *khuti* system of buffalo rearing and the problems faced by the buffalo rearers in production of milk.

From the findings of the study it was found that milk production is not uniform throughout the year due to certain factors like temperature and relative humidity. Farming activities of the *khuti* becomes difficult during the rainy seasons (from June to September) due to flooding in their low land areas. The milk yield was found to be highest in April and December. Minimum milk production per *khuti* was found during the month of July.

The cost of *khuti* has a positive relationship with the herd-size. The total cost per *khuti* of large rearers was found to be ₹286080.00 followed by medium (₹148998.47) and small rearers (₹90340.69). For overall sample, total cost per *khuti* was ₹169865.10.

Returns from all the sources per *khuti* were found to be highest for large rearers followed by medium and small rearers which were ₹754733.33, ₹207472.00 and ₹168050.00, respectively, and for the overall sample it was ₹257071.00. The net income per *khuti* for all the categories were ₹468653.33, ₹58473.53 and ₹77712.88 for large, medium and small rearers, respectively. For the overall sample, it was recorded as ₹87205.91. The cost-benefit ratio of small, medium and large categories of buffalo rearers were 1:1.86, 1:1.39 and 1:2.63, respectively, and it was 1:1.51 for the overall sample.

Major problems faced by the buffalo rearers in the study area were low productivity of the Assamese buffalo, lack of technical knowledge of milk production, lack of proper feed especially during rainy seasons due to flood in low land areas near

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river banks, the interference of middlemen for the marketing of buffalo milk, disease infestation especially during rainy seasons and seasonal hazard. Besides these, other problems faced by the rearers were – the high price of medicine and veterinary charges, lack in good storage facilities and lack of credit facilities.

# **Consumer Preference towards Online Shopping in Jorhat District of Assam**

*Rahmatullah Shahin*

Online shopping is a modern way of marketing a product or service. In India it was first started in 1999-2000. However, due to ease, simplicity, convenience, security etc in trading and delivery system, it has been gaining tremendous popularity among all categories of stake holders. Diversity in taste, security, perceived privacy, perceived after-sales service, perceived marketing mix, perceived reputation and consumer's attitude affect the adoption of online shopping. But, the marketers faces problem in getting response from the customers as there is no face to face interaction between buyers and sellers in case of online shopping. This study was taken up to understand the background of online shopping, consumer preference towards online shopping, impact of online shopping on traditional retailer and the problems of online shopping perceived by the consumers in Jorhat district of Assam. The sample for the present investigation was selected using random sampling procedure.

E-commerce was introduced about 40 years ago in its earliest form. Boston Computer Exchange, which was launched in 1982, became the world's first ecommerce company. Presently numerous agencies like Flipkart, Amazon, Myntra, Snapdeal, Paytm, e-Bay, Zivame, ZopNow, Jabong, Shop Clues, Rediff, Nykaa and many others are performing online marketing all over the world.

Under the present study, 72 percent of respondents were found to involve in online shopping. More than 85 percent of user respondent reported that they preferred online shopping because it was easy to get product through online marketing while 74.07 percent of respondents viewed that they preferred online shopping as they could shop at any time through online marketing. Highest proportion of online customer (83.33 %) were found in the age group of 'above 20 years to 30 years'. There was not much difference in likings and involvement in online shopping over the gender of the customers. Literate people were found more involved in online shopping. Students were most prominent online users for shopping different goods and services. More than 88 per cent of students were found to perform online shopping. The least prominent group was wage earner group. Maximum number (73.15%) of online customers used online

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shopping for purchasing of cloths. The least preferred items through online was baby products followed by medical items. The major services provided online were flight ticketing followed by bus and railway ticketing. The most popular platforms in the study area are Flipkart, Amazon, Myntra, Snapdeal, Zomato, Swiggy, Nykaa and Cluvia. More than 98.00 per cent of online customers used smart phone for online shopping. The use of internet café for online marketing was very less because of security reason. The most frequently used payment mode was cash on delivery followed by debit card. Majority of customers in the study area did not write the review about the product or services they have purchased. The frequency of online shopping was highly varied from customer to customer. More than 50 percent of the online buyers spent less than Rs. 1000.00 in single online purchase.

The major problems faced by the customers during online marketing were difference between displayed product and actual product, time consuming and complicated registration, delay in delivery of product, selling of inferior quality product, missing of personal observation, feel and touch on product before purchasing, etc. which acted as hindrance of online marketing.

Presently, though there is no significance impact of online marketing on the business and income of traditional retailers, but looking at the growing popularity of online marketing, it is not unwise to predict the negative effect of online marketing on the sales and profit of traditional retailing business. Hence, rational policy measures are needed for the development of on line marketing as well as protecting of the interest of traditional retailers. Traditional retailers also must equip their retailing business to compete with online mode of marketing.

## **Investment Analysis of Dairy Farming in Assam**

*Raj Kallol Dutta*

India being a major agrarian economy has a deep connection with dairy farming since Vedic era. Dairy farming is an important secondary source of income that provides employment and nutritive food for millions of families. The project work was carried out in the state of Assam as the state's economy continues to be an agrarian economy and the dairy sector plays a major role in the income generation for both the rural and semi-urban population. Out of all the variable costs under the study it shows that the cost incurred for cattle feed and labour were the main capital intensive costs. The farms under study have also proven to be all viable and profitable in terms of their production and the existing price of production. Returns on dairy farming across various groups prove to be all positive, and among all the farm enterprise, the farms rearing jersey breed cattle proves to be the most cost effective. The results have also clarified that problems faced by the dairy farmers mainly consist of problems such as lack of veterinary health aid, water scarcity and low price of milk, unavailability of local feed retailers, inadequate infrastructure and high price of feed. Lack of knowledge, extension works and management skills are still much needed among the farmers and given the right attention to these extension work and management skills, dairy farming may go long way in enhancing the income of the dairy farmers.

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**Abstract of M.Sc. thesis**

**Department: Agri-Business, MBA**

**Major Adviser: Dr. R.A. Halim**

# **A Study on Financial Management of Muktai Dairy Farm**

*Vishal Kacharu Kahandal*

Muktai Dairy Plant was established in 7th February, 2007 just as chilling centre with a capacity of 10000 liters/day. At present they are processing and packing around 18000 liters of milk per day with the plant capacity of 30000 liters per day. The organizational structure of dairy farm had four departments which are Processing, Finance, Marketing and Human Resource departments. Processing department was considered as the prime department of the farm which involves Manager, Operator/Supervisor and plant workers. The farm processes a number of milk and milk products which are very popular at different parts of Maharashtra. Shivneri milk is the main product of the farm with 34.66 lakh liters of production with a product share of 69.45 per cent. Shivneri chass has the lowest share (0.06%) due to seasonal demand and nature of production. Ghee, paneer and curd are the other products manufactured at the farm. Among the various investments, the investment on buying machinery and equipment was the maximum, having share of 71.21 per cent, with total amount of Rs. 363.10 lakhs. The other fixed expenses were incurred for acquisition of land, construction of building, vehicle, generator, fencing, furniture, water supply structure, license fee and lab equipments. Amount paid to the permanent workers of the farm was Rs.13.20 lakhs per year. Casual workers were mostly hired on the basis of daily wages as per the workforce requirement and the amount spent on casual workers was Rs.13.02 lakhs per year. The total variable cost worked out was Rs. 1469.94 lakhs, out of which the cost of purchasing of raw material was the prime cost accounting for Rs. 1231.68 lakhs. The processing costs for Shivneri milk, Muktai milk, Shivneri Ghee, Shivneri Paneer, Shivneri Curd and Shivneri Chass were accounted for Rs. 30.34/lit, Rs. 30.34/lit, Rs. 257.85/kg, Rs. 160.10/kg, Rs. 31.96/kg and Rs. 11.32/lit., respectively. The average productions of Shivneri milk, Muktai milk, Ghee, Paneer, Curd and Chass in the farm were 3466.13K lit, 1152.71K lit, 39.35K Kg, 3.08K Kg, 19.20K Kg and 9.66K lit. per year. Total net income of Muktai dairy farm was Rs. 274.58 lakhs per year. Similarly, total processing cost and gross income were found as Rs. 1514.75 lakhs

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and Rs. 1789.33 lakhs per year, respectively. Net Present Worth, Benefit-Cost Ratio and Internal Rate of Return were found as Rs. 28,13,42,191.70, 1.15 and 112.97 per cent, respectively. This clearly indicates a sound financial position of Muktai Dairy Farm and hence the liabilities of the farm could be met easily during any unexpected closure in future.

# **Study on Vishaka Dairy Products and Consumers' Perception in North Coastal Districts of Andhra Pradesh**

*Yedla Divya Dinkar*

The project work was carried out for a period of three months from March-May, 2019 in the State of Andhra Pradesh to in connection with the “Study on Vishaka Dairy Products and Consumers’ Perception in North Coastal Districts of Andhra Pradesh”.

For this study, a total of 100 numbers of consumers were drawn from the selected territory of North Coastal Districts of Andhra Pradesh, representing an equal number of samples from each region *viz.*, Srikakulam, Vizianagaram, Visakhapatnam, and East Godavari. The simple random sampling design was followed for the study. Data relating to the perception of the consumer were collected from consumers with the help of a structured pre-tested schedule and questionnaire through personal interview method and secondary data were collected from the record books and reports of the milk Union. The milk products produced by the Union were smart milk, cream, ghee, plain curd, sweet curd, and paneer. The consumers' perception towards different products of the union was found good during the study and it significantly differed from all the other brands available in the territory under consideration and well-received among the masses, indicating higher potential in coming years because of the trending brand loyalty.

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**Abstract of M.Sc. thesis**

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**Major Adviser: Dr. A.K. Das**

## **Growth and yield of tomato crop under modified microclimatic condition in Jorhat**

*Amlanika Kalita*

The present investigation was carried out during *rabi*, 2019-20 at the Experimental Farm, Dept. of Horticulture, Assam Agricultural University, Jorhat to study the effect of modified microclimates on growth, development and yield of tomato. The variety – *Arka Rakshak* was grown in split plot design with 4 dates of planting (P1 - 25th October, P2 - 14<sup>th</sup> Nov , P3 - 3rd December and P4 - 8th January) in main plots and three mulching treatments (M0 - non mulch, M1 – rice straw mulch and M2 - black polythene) in sub-plots, following recommended agronomic practices . Microclimatic parameters like daily soil temperature (5 cm and 10 cm depth) and soil moisture content at 15 days interval from two depths (0 - 15cm and 15 - 30 cm) and different components of photo-synthetically active radiation (PAR), *viz.*, incident (IPAR), reflected (RPAR) and transmitted (TPAR) were recorded at 10 days interval starting from 30 days after planting (DAP) using line quantum sensor (Model LQM-70-10) at local noon time (11:30 AM). Crop growth parameters *viz.*, plant height, leaf area index and dry matter accumulation, phenological observations and yield attributing characters and fruit yield were recorded. Agro-climatic indices *viz.*, growing degree day (GDD), heliothermal unit (HTU) and phenothermal index (PTI) were computed for attaining different phenological events and heat use efficiency (HUE) were estimated for both biomass and grain yield of the varieties sown on different dates. The range for weekly mean maximum and minimum temperature throughout the crop growing period was found within 21.7 to 31.7°C and 8.4°C to 20.8°C with their respective averages of 26.7°C and 14.5°C. Thus, the daily maximum temperature never exceeded 34.6°C, but increasing daily maximum temperature above 30°C after mid March (11 SMW) was detrimental to the crop as the optimum temp is for the crop is 18 to 24°C. Similarly, the lower average daily minimum temperature (<10°C) during 49th to 5th SMW affected growth of the crop. The average soil moisture content in upper 30 cm soil profile in experimental plots recorded up to mid March, 2020 was highest in the second date of planting (80.81 mm), followed by first (79.7 mm), third (76.44 mm) and fourth (72.15 mm) dates of planting. As compared to non mulch treatment, the increase in weekly morning and evening soil

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**Major Adviser: Dr. Prasanta Neog**

temperatures under black polythene was up to 1.63 and 2.47 °C, respectively, while under rice straw mulch the increase in the soil temperature was to some extent lower. Incident PAR (iPAR) during the crop growth season varied from 531 to 1431  $\mu\text{mol s}^{-1}\text{ m}^{-2}$  with the mean value of 1140.4  $\mu\text{mol s}^{-1}\text{ m}^{-2}$ . The reflected PAR varied from 41 (P1M2) to 285 (P1M2)  $\mu\text{mol m}^{-2}\text{ sec}^{-1}$  in different planting dates and mulching treatments. In all dates of planting and mulching treatments, the lowest transmitted PAR was recorded at 90 to 100 DAP (in case of P1 to P3) when the crop was with full canopy coverage, thereafter it increased with the advancement of the age of the crop. The crop took 36 to 57, 45 to 71, 87 to 115 and 120 to 180 days for attaining first flower appearance, first fruiting, first fruit maturity and end of fruit harvest, respectively under different planting dates and mulching treatments. The plant height of crop varied from 63.4 to 102.5 cm, irrespective of dates of planting and mulching treatments. The maximum leaf area index recorded were significantly affected by both planting dates and mulching treatments, which ranged from 1.85 to 3.26 irrespective of planting dates and mulching treatments. The biomass production at maturity was the highest in the second date of planting (284.7 g/plant) and it decreased gradually with delay in planting. The total biomass production was highest under black polythene mulch (263 g/plant), followed by rice straw mulch (28.1 g/plant) and non-mulched treatment (149.9 g/plant). The fruit yield of tomato cultivar planted under different planting dates and mulching treatments ranged between 76.6 and 392.6 q ha<sup>-1</sup> with an overall mean of 234.9 q ha<sup>-1</sup>. The crop planted on 14th November was found to be the most suitable planting date because it facilitated optimum weather conditions with improved soil hydrothermal and radiation (PAR) regimes during the crop season. Mulching with black polythene was found to be more suitable compared to non mulched condition for crop growth and fruit yield due to increase of soil temperature particularly during 49th to 5th SMW by up to 1.84 under black polythene. Irrespective of mulching treatments and planting dates, the GDD accumulation to attain end of the fruit harvest was reduced from 2140 to 1463 °C day, when planting was delayed from 25th October to 3rd December, but it again increased to 1687 °C day when planting was further delayed to 8th January. Regardless of dates of planting and mulching treatments, Heliothermal units (HTU) and Day temperature accumulated to attain end of the harvest stage varied from 7152 to 12300°C hr and 2502 to 3526°C, respectively. The PTI at different phenological stages varied from 9.61 to 17.25°C day<sup>-1</sup> in regardless of planting dates and mulching treatments. The HUE for total biomass production and fruit yield ranged from 2.9 to 4.6 kg ha<sup>-1</sup>°C<sup>-1</sup> and 1.3 to 5.2 kg ha<sup>-1</sup>°C<sup>-1</sup>, respectively. The RUE under different dates of planting and mulching treatment varied from 0.48 to 1.64 g MJ<sup>-1</sup> and 0.30 to 1.10 g MJ<sup>-1</sup> with the mean value of 1.04 and 0.68 g MJ<sup>-1</sup> for total biomass production and fruit yield, respectively. Regression studies showed that there were linear significant relationships between total biomass, fruit yield and max LAI with iPAR and RUE in the tomato variety. Correlation studies between fruit yield, and thermal indices (Thermal time, HTU, Day temperature, HUE and PTI) confirmed the existence of significant and positive correlation between them. The regression model developed indicated that fruit

yield can be predicted with high determining factor ( $R^2 = 0.99$ ) from thermal time accumulation during planting to first flower appearance, HTU from the first maturity to end of harvest and heat use efficiency for biomass production.

# **Crop Planning based on Rainfall Analysis and Moisture Availability Index (MAI) in the Central Brahmaputra Valley Zone (CBVZ) of Assam**

*Jyotishman Goswami*

The present research work was carried out for two districts viz., Nagaon and Morigaon under central Brahmaputra valley zone of Assam (CBVZ) to find out the probabilities of occurrence of dry and wet spells, onset and withdrawal of rainy season and moisture availability index (MAI) to suggest suitable crop planning in the region. Long term rainfall and temperature data were collected from Department of Agrometeorology, AAU, Jorhat and IMD, Pune for both the districts. The probability analysis for occurrence of dry and wet spell was carried out by using Markov chain model which calculates the initial, conditional and consecutive probability. The onset and withdrawal of rainy season were determined by using forward and backward accumulation method and the MAI was calculated using Thornthwaite's formula (1948). Rainfall analysis revealed that mean annual rainfall along with CV and SD of Nagaon is moderately higher than the rainfall of Morigaon. Seasonal rainfall analysis indicated that monsoon season receives the highest amount of rainfall with least CV and the winter records the lowest rainfall with higher CV in both the districts. Rainfall analysis revealed that monsoon season is very much ideal for agricultural enterprises in the region. From the result of initial probability, it was found that probability of occurrence of wet spell of minimum 10 mm of threshold limit was high from 13 th SMW (26 th March – 1 st April) to 41 st SMW (8 th – 14 th Oct) in both the districts. The consecutive probability of occurrence of wet spell of two weeks is more than 50% from 15 th SMW (9 th April – 15 th April) onwards in both Nagaon and Morigaon districts. There was a higher chance of getting wet spell of three consecutive weeks of more than 40 mm rainfall in Nagaon (26 th – 29 th SMW) and Morigaon (26 th SMW) which may lead to flood like condition in the districts. So, harvesting of the excess moisture as well as provision of drainage in the crop field is suggested during the aforesaid period. The probabilities of occurrence of dry spell were higher before 12 th SMW and after 42<sup>nd</sup> SMW, but during monsoon season it was found to be very less which indicates that

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kharif crops can be grown without any supplemental irrigation. From the result of forward accumulation from 9 th SMW it was found that there was accumulation of 75 mm rainfall within 17 th SMW and 200 mm rainfall within 19 th and 20 th SMW in Nagaon and Morigaon respectively, which indicates that sowing of summer crops can be started within these weeks. Considering forward accumulation from 22 nd SMW it was found that within 23 rd – 24 th SMW there would be accumulation of 75 mm rainfall and 200 mm rainfall within 26 th SMW in the districts. The mean week for withdrawal of rainy season was found to be within 31 st SMW for 500 mm, 35 th – 36 th SMW for 300 mm and 39 th SMW for 100 mm rainfall for both the districts. MAI value increases from 0.4 and reaches 1 in 26 th SMW in all types of soil for both the districts. In Nagaon MAI remains continuously 1 up to 34 th SMW in sandy and silt loam soil and up to 38 th SMW in clayey loam soil. In case of Morigaon the weekly MAI remain 1 till 38 th SMW all types of soil. Sowing of summer crops such as greengram, blackgram, ahu rice were suggested from 13 th SMW onwards for both the districts. Sowing of maize and sesame were suggested to complete within 12 th SMW. For sowing of jute pre sowing irrigation is recommended. Nursery bed preparation for sali rice can be started from 20 th SMW in both the districts and transplanting can be done during 25 th – 30 th SMW. Sowing of kharif greengram and blackgram could be started from 36 th SMW. Sowing of rabi crops such as rabi maize, potato, peas, french bean, rapeseed and mustard, linseed can be started from 40 th SMW. Wheat crop is suggested to grow if probability of continuous dry spell is high.

## **Simulation modelling of Winter Rice (*Oryza sativa* L) using DSSAT model in Agroclimatic condition of Jorhat**

*Nikhil Shrishail Paschapur*

The Field experiment was conducted at the Instructional-Cum-Research (ICR) farm of Assam Agricultural University, Jorhat during *Kharif*, 2019 to calibrate and validate the CERES-Rice model for winter rice (*Sali* rice) and to estimate its yield variability under changing climatic scenario at Jorhat. The experiment consisted of three different micro-climatic environments *viz.*, D1 (26th June), D2 (11th July) and D3 (26th July) with three varieties *viz.*, Mahsuri, Swarna sub-1 and TTB-404 following split plot (in number) design with four replications. Biometric observation, *viz.* total biomass production, leaf area index, plant height, number of effective tillers, number of grains per panicle, grain yield and straw yield were recorded phenophase wise. Early transplanted (D1) crop took more number of days from transplanting to maturity as compared to late transplanting (D2 and D3). The overall days required to maturity were relatively highest in D1 in all the three varieties *i.e.*, 122, 126 and 121 and lowest in the D3 *i.e.*, 116, 121 and 117 for Mahsuri, Swarna Sub-1 and TTB-404, respectively. Total dry matter production (TDM) differed significantly in both varieties and growing environments irrespective of crop stages. Highest TDM was found in D1 and lowest in D3, the dry matter production per plant was found at-par in Swarna Sub-1 (48.6 g) and TTB-404 (48.5g) and minimum in Mahsuri (43.8 g). Further, Leaf Area Index (LAI) was observed maximum during panicle emergence to 50% flowering stage and statistically significant variation in maximum LAI exists among three varieties and microclimatic regimes. Additionally, grain yield was significantly influenced by different growing environments and varieties. Among the three microclimatic regimes, D1 was significantly different from D2 and D3 with CD value 17.38. The highest grain yield was recorded in Swarna Sub-1 (3912kg/ha) followed by TTB-404 (3866kg/ha) and lowest in Mahsuri (3782kg/ha). The interaction between microclimatic regimes and varieties were found significant for grain yield with CD value 10.01kg/ha. The interaction between varieties and microclimatic regimes also showed significant

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differences for straw yield with CD value 144.08kg/ha. Correlation between grain yield and phasic mean meteorological parameters showed substantial impact of weather parameters on grain yield of *Sali* rice. Among the three different models involving phasic mean meteorological parameters, the best model for grain yield prediction comprises rainfall during PE to 50% flowering stage as the most important variable with R<sup>2</sup> of 0.88.

# **Crop suitability mapping using GIS for the upper Brahmaputra valley zone of Assam**

*Saranga Bordoloi*

A GIS based suitability analysis was conducted in the upper Brahmaputra valley zone (UBVZ) of Assam to find out the agroclimatic fitness of the zone for cultivation of winter rice, potato, and rapeseed & mustard. First, the rainfall and temperature data along with soil data of the zone were characterized and spatially mapped. The amount of rainfall and its distribution (number of rainy days) during each month of the crop growing period along with the mean temperature during various phenophases of the crops were considered for suitability analysis. The soil features viz. pH, texture, cation exchange capacity (CEC) and organic carbon (OC) were considered in the analysis along with slope for topography. As the suitability analysis for crops in a GIS context was conducted mainly based on soil parameters, in this study, an attempt has been to find out crop suitability by taking into consideration of crop's climatic requirements along with the soil factors and topographic features to delineate the agroclimatic suitability for winter rice, potato and rapeseed & mustard cultivation. Daily rainfall data and temperature (maximum and minimum) data from IMD gridded dataset, soil data from NBSS&LUP and slope data from SRTM-DEM were collected for the study. The gridded rainfall data were extracted using MATLAB to characterize its annual, seasonal, monthly and weekly features. The probabilities of receiving weekly rainfall at different levels were computed using incomplete gamma distribution model. The mean annual total rainfall in the UBVZ of Assam varied from 1720.5 mm (Golaghat) to 2345.9 mm (Tinsukia) during 1989-2018. The annual total number of rainy days was also less (128 days) in Golaghat and comparatively high (143 days) in Tinsukia. The contribution of pre-monsoon, monsoon, post-monsoon and winter season rainfall to total annual rainfall varies between 26-29%, 61-64%, 5-6% and 3-4%, respectively. Probability of getting rainfall of more than 25 mm per week increased gradually from 22nd SMW (Jun 25-Jul 01) onwards until 35th SMW (Sep 27- Aug 02) at 90% level in all the districts. In Golaghat (19th to 37th SMW), Jorhat (20th to 37th SMW), Sivasagar (18th to 39th SMW), Dibrugarh (17th to 39th SMW) and Tinsukia (17th to 40th SMW), the weekly rainfall probability at 75% level was above 20 mm reaching peaks in between 60-80 mm during peak monsoon season (26th to 33rd SMW). After 34th SMW, the rainfall amount

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decreased gradually at all probability levels. The annual mean maximum temperature and minimum temperature in the valley was found to be 28.9°C and 18.6°C respectively, with a mean of 23.8°C. The average maximum temperature was highest in the month of July (33.0°C) and lowest in the month of January (23.3°C). On the other hand, the average minimum temperature was lowest in January (9.6°C) and highest in July (24.8°C). During pre-monsoon, monsoon, postmonsoon and winter seasons mean temperature ranged between 15.7°C and 22.2°C, 23.4°C and 25.1°C, 21.5°C and 26.2°C and 16.4°C and 19.4°C, respectively. The soil data were derived from published data of NBSS&LUP, Jorhat and imported into ArcGIS. The data was used to digitize and generate a continuous raster layer using kriging interpolation technique which can interpolate missing spatial data from sampled discrete data to create thematic maps of soil characteristics of UBZ to show the spatial variation of parameters considered in the study. The slope data from digital elevation model (DEM) was clipped from global dataset to acquire the slope map of the UBZ zone. Slope of the zone was observed to be mostly between 0-4% with 2 some small areas near Nagaland border having steeper slopes. Soil pH in UBZ zone was found to be mostly acidic with range between 4.5 and 8.0. The CEC concentration was between 3 and 21 meq/100g. Soil texture was mostly homogenous in UBZ zone with sandy clay, silty clay loam and sandy loam type. The soil OC was found to vary between 0-3%. After generation of each criteria layer, the different thematic maps were imported into ArcGIS software and range of values of each layers were standardized to a common suitability category according to FAO guidelines as highly suitable (S1), moderately suitable (S2), marginally suitable (S3) and unsuitable (N). For calculating the weight of each criterion for suitability analysis, multi criteria decision analysis (MCDA) procedure using analytical hierarchy process (AHP) was used. In AHP, each parameter is paired and ranked with each other using a 1 to 9 scale where 1 indicates equal importance and 9 means extremely important. Considering only one pair at a time, each criterion was ranked, and the score was derived to find out the final weight of each criterion. By running AHP, the weight of criteria were calculated as 30% for rainfall followed by number of rainy days (25%), mean temperature (14%), soil texture (10%), pH (8%), slope (5%), CEC (4%) and OC (4%). After generation of weights, the criteria were overlaid to calculate the monthly agroclimatic suitability maps for each month of the crop growing period. For winter rice, monthly suitability maps from June to November, potato from October to February and rapeseed & mustard from November to February were generated to study the influence of the meteorological parameters on monthly variability of agroclimate. To find out the overall agroclimatic suitability of the crop during crop growing period, each of the monthly thematic suitability maps were overlaid upon each other using weighted overlay analysis but with equal weight given to each month. The agroclimatic suitability for winter rice in the UBZ was found to be under highly suitable (S1) category for all districts except some patches towards western part of Golaghat district due to inadequate rainfall during vegetative phase. The agroclimatic suitability for growing potato was found to be highly suitable (S1) from October to February in the entire zone

except some small pockets in Golaghat, Jorhat and Sivasagar districts which were moderately suitable (S2) due to soil constraints. The agroclimate for rapeseed & mustard during growing season indicated that the UBV zone was moderately suitable (S2) due to inadequate amount of rainfall during the study period. Determination of fitness of agroclimatic parameters will help in identifying suitable areas to grow winter rice, potato and rapeseed & mustard in the study area besides selection of appropriate varieties, irrigation scheduling and other management practices for optimum yield.

## **Quantification of thermal and radiation regimes on growth and yield of aromatic rice in Jorhat district of Assam**

*Silpa Rajkhowa*

A field experiment was carried out during *Kharif*, 2019 in the Instructional-cum-Research (ICR) Farm of Assam Agricultural University for quantification of thermal and radiation regimes on growth and yield of aromatic *Joha* rice under different microclimates. The experiment was laid out in factorial RBD with four dates of sowings (D1-30th May, D2-15th June, D3-30th June and D4-15th July) and two varieties *viz.*, *Keteki Joha* and *Kola kon Joha* grown following recommended agronomic practices. Occurrences of different phenological events of both the cultivars were recorded. Crop growth parameters *viz.*, leaf area index (LAI) and biomass production, grain yield and yield attributing characters were recorded. Incident Photosynthetically Active Radiation (IPAR), reflected PAR (RPAR) and transmitted PAR (TPAR) were recorded at seven days interval from 30 DAT, while intercepted PAR (iPAR) and radiation use efficiency (RUE) for both the varieties were estimated from those data. Moreover, diurnal variation of IPAR, RPAR and TPAR were recorded at one-hour interval during maximum tillering and 50% flowering stages of the crop sown on different dates. Agro-climatic indices *viz.*, growing degree day (GDD), heliothermal unit (HTU) and phenothermal index (PTI) were computed for attaining different phenological events and heat use efficiency (HUE) were estimated for both biomass and grain yield of the varieties sown on different dates. During a day, iPAR formed a parabolic shape with the maximum interception at 11:30 am in both maximum tillering and 50% flowering stages. The incident PAR recorded during the crop growing period varied from 1267 to 1622  $\mu$  mol sec<sup>-1</sup> m<sup>-2</sup> and 1271 to 1644  $\mu$  mol sec<sup>-1</sup> m<sup>-2</sup>, in *Keteki Joha* and *Kola kon Joha*, respectively. RPAR and TPAR showed variation for different dates and varieties. The higher RPAR (82  $\mu$  mol sec<sup>-1</sup> m<sup>-2</sup>) and TPAR (588  $\mu$  mol sec<sup>-1</sup> m<sup>-2</sup>) was recorded in *Kola kon Joha* compared to *Keteki Joha* with RPAR and TPAR of 68 and 513  $\mu$ molsec<sup>-1</sup>m<sup>-2</sup>, respectively. The higher iPAR was recorded in *Keteki Joha* (61.49%) as compared to *Kola kon Joha* (55.64%). Period of vegetative growth in both the cultivars was influenced by sowing dates and the highest vegetative period was

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recorded in the first date of sowing, which reduced gradually with successive delay in sowings. Irrespective of varieties and sowing dates, the crop attained maximum tillering (panicle initiation) and 50% flowering stage when it was exposed to the day length of around 12 and 11 hours, respectively. The maximum LAI was recorded highest in the first sowing and it reduced successively in delayed sowings in both the varieties. Irrespective of dates of sowing higher LAI was recorded in *Keteki Joha* (2.58) as compared to *Kola kon Joha* (2.20). The above ground biomass production was found highest at first dates of sowing (D1) compared to the last date of sowing (D4). Like LAI, *Keteki Joha* produced higher biomass (21.65 g hill<sup>-1</sup>) compared to *Kola kon Joha* (16.66 g hill<sup>-1</sup>). Grain yield in *Keteki Joha* and *Kola kon Joha* ranged from 1.45 to 2.90 t ha<sup>-1</sup> and 0.90 to 2.02 t ha<sup>-1</sup>, respectively. The significant reduction in grain yield in later sowing dates (D3 and D4) attributed due to lower LAI, iPAR, biomass production and biomass partitioning to the grain as compared to the early sown dates. Thermal time accumulation at physiological maturity was relatively higher in *Keteki Joha* (2176.05 oC day) than in *Kola kon Joha* (2077.15 oC day). The accumulated GDD for attaining any phenological events decreased in both the varieties as sowing was delayed. Similar to GDD, HTU accumulation at physiological maturity was found be higher in *Keteki Joha* (11138.41oC hr). The mean value of PTI computed for different phenological stages showed a decreasing trend from transplanting to physiological maturity which varied from 12.66 to 19.10 oC day<sup>-1</sup> (*Keteki Joha*) and 13.22 to 19.47 oC day<sup>-1</sup> (*Kola kon Joha*) under different dates of sowing. The HUE for biomass and grain was found to be highest at second date of sowing in both the varieties compared to other dates of sowing and between the varieties *Keteki Joha* computed the highest as compared to *Kola kon Joha* for both biomass 2.47 kg ha<sup>-1</sup> oC<sup>-1</sup> and 1.97 kg ha<sup>-1</sup> oC<sup>-1</sup>, respectively and grain yield 1.00 kg ha<sup>-1</sup> oC<sup>-1</sup> and 0.70 kg ha<sup>-1</sup> oC<sup>-1</sup>, respectively. RUE for biomass and grain yield were computed, which was found to be highest in the second date of sowing in both the varieties. Between the varieties, *Keteki Joha* recorded the higher RUE than the *Kola kon Joha* for both biomass (0.75 g MJ<sup>-1</sup> for *Keteki Joha* and 0.69 g MJ<sup>-1</sup> for *Kola kon Joha*) and grain yield (0.30 g MJ<sup>-1</sup> for *Keteki Joha* and 0.22 g MJ<sup>-1</sup> for *Kola kon Joha*). The correlation study showed that grain yield had a significant correlation with biomass, LAI, and different meteorological parameters, PAR interception (both average and maximum), RUE and thermal indices like GDD, HTU, PTI and HUE. The predictive model for grain yield using meteorological parameters, radiation indices and thermal indices explain the relationship with a high coefficient of determination (R<sup>2</sup>) with values more than 86.

## **Effect of varying drip irrigation level and N K fertigation on direct seeded autumn rice (*Oryza sativa* L.)**

*Abhinandan Chetia*

A field experiment was conducted at Instructional cum Research (ICR) Farm, Assam Agricultural University, Jorhat during autumn season of 2019 to study the “Effect of varying drip irrigation level and N K fertigation on direct seeded autumn rice (*Oryza sativa* L.)”. The experiment consisted of four irrigation levels viz., I1 :1.20 ETc (drip at 120% ETc), I2 : 1.00ETc (drip at 100% ETc), I3 :0.8 ETc (drip at 80% ETc) and I4 :0.60% ETc(drip at 60% ETc) and four fertilizer levels viz. F1 :100% recommended dose of N and K through drip, F2 :75% recommended dose of N and K through drip, F3 :50%recommended dose of N and K through drip and F4 : No fertilizer. The experiment was laid out in Randomised Block Design with three replications. The soil of the experimental site was sandy loam in texture with available N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O and OC of 299.3 kg/ha, 20.03 kg/ha,120.39 kg/ha and 0.71% respectively with pH 5.9. The rice variety Inglongkiri was sown on 20th March, 2019 and harvested on 7th July, 2019.

The results revealed that irrigation level I1 :120% Etc (drip at 120% ETc) recorded significantly maximum plant height at PI and maturity stages ; and I2 :100% ETc (drip at 100% ETc) recorded the highest dry matter accumulation and plant population at tillering, PI and maturity. The maximum values with respect to yield attributing characters, grain and straw yields, harvest index, plant water content; N, P, K uptake and irrigation water use were recorded under irrigation level I1 followed by I2. Different fertilizer levels brought about significant differences in dry matter accumulation at PI and maturity, grain yield, straw yield and in N, P, K uptake. The highest values for these parameters were recorded under application of 100% N and K through drip (F1) followed by at par results with F2 (75% N and K). The treatment F2 recorded slightly better result with respects to RWC and soil moisture content at all the growth stages, NPK content in grain.

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With regard to combined effect of treatments I1F1 recorded the highest grain and straw yields of 35.93 q/ha and 80.95 q/ha respectively. This combination of treatment also recorded the highest nutrient uptake of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O.

In terms of economics, the treatment combination I1F1 (drip at 120% ET<sub>c</sub> and 100% N K fertigation) was the best with respects to gross return (Rs 71,961.00), net return (Rs 21,747.00) and B:C (1.43 ) followed by the treatment combination of I1F2 (drip at 120% ET<sub>c</sub> and 75% recommended dose of N K).



## **Zinc fortification in maize *Zea mays* through soil and foliar application**

*Anupriya Yadav*

A field experiment entitled “Zinc fortification in maize (*Zea mays*) through soil and foliar application” was conducted at the Instructional-cum-Research (ICR) Farm, Assam Agricultural University, Jorhat during the *summer* season of 2019 to find out the effect of zinc on growth, yield and uptake of zinc through soil and foliar application. The experiment consisted of nine treatments *viz.*, 0 kg/ha ZnSO<sub>4</sub> (Control), 10 kg/ha ZnSO<sub>4</sub> soil application, 20 kg/ha ZnSO<sub>4</sub> soil application, 0.5% ZnSO<sub>4</sub> foliar spray at 25 DAS, 0.5% ZnSO<sub>4</sub> foliar spray at 25 DAS and 45 DAS, 10 kg/ha ZnSO<sub>4</sub> soil application + 0.5% ZnSO<sub>4</sub> foliar spray at 25 DAS, 10 kg/ha ZnSO<sub>4</sub> soil application + 0.5% ZnSO<sub>4</sub> foliar spray at 25 DAS and 45 DAS, 20 kg/ha ZnSO<sub>4</sub> soil application + 0.5% ZnSO<sub>4</sub> foliar spray at 25 DAS and 20 kg/ha ZnSO<sub>4</sub> soil application + 0.5% ZnSO<sub>4</sub> foliar spray at 25 DAS and 45 DAS. The treatments were laid out in Randomized Block Design (RBD) and replicated thrice. The soil of the experimental site was sandy loam in texture, acidic in reaction (pH 5.4), medium in organic carbon (0.64%), low in available N (198.04 kg/ha), medium in available P<sub>2</sub>O<sub>5</sub> (24.98kg/ha), low in available K<sub>2</sub>O (187.30 kg/ha) and low in available zinc (0.56 mg/kg).

The highest plant height was recorded in the combined application of 20 kg/ha ZnSO<sub>4</sub> soil application + 0.5% ZnSO<sub>4</sub> foliar spray at 25 DAS and 45 DAS. The Leaf Area Index (LAI) and yield attributing characters like weight and length of the cob with and without husk, girth of cob, number of grain rows per cob, number of grains per row, number of grains per cob and grain weight per cob as well as grain yield (43.05 q/ha), cob yield (64.49 q/ha) and stover yield (88.99 q/ha) were recorded the highest in the combined application of 20 kg/ha ZnSO<sub>4</sub> soil application + 0.5% ZnSO<sub>4</sub> foliar spray at 25 DAS and 45 DAS which was at par with the combined application of 20 kg/ha ZnSO<sub>4</sub> soil application + 0.5% ZnSO<sub>4</sub> foliar spray at 25 DAS. The highest N, K and Zn content and uptake were obtained in the combined application of 20 kg/ha ZnSO<sub>4</sub> soil application + 0.5% ZnSO<sub>4</sub> foliar spray at 25 DAS and 45 DAS. The P content in grain and stover were found to be non significant owing to different treatments but combined application of 20 kg/ha ZnSO<sub>4</sub> soil application + 0.5% ZnSO<sub>4</sub> foliar spray at 25 DAS

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and 45 DAS recorded higher P uptake than control. Significantly higher available N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O (kg/ha) in the soil after harvest were recorded under 0 kg/ha ZnSO<sub>4</sub> (Control) over rest of the treatments. The combined application of 20 kg/ha ZnSO<sub>4</sub> soil application + 0.5% ZnSO<sub>4</sub> foliar spray at 25 DAS and 45 DAS recorded highest available Zn which was at par with combined application of 20 kg/ha ZnSO<sub>4</sub> soil application + 0.5% ZnSO<sub>4</sub> foliar spray at 25 DAS and 20 kg/ha ZnSO<sub>4</sub> soil application . The highest gross return (Rs.117680), net return (Rs.88128) and B: C ratio (2.98) was obtained with the combined application of 20 kg/ha ZnSO<sub>4</sub> in soil + 0.5% ZnSO<sub>4</sub> as foliar spray at 25 DAS and 45 DAS.

## **Nutrient and weed management in buckwheat (*Fagopyrum esculentum*) after *sali* rice**

*Bamon Timung*

An experiment entitled “Nutrient and weed management in buckwheat (*Fagopyrum esculentum*) after *sali* rice” was conducted at Instructional-cum-Research farm, Assam Agricultural University, Jorhat during the *rabi* season of 2018-19 to study the effect of nutrient and weed management practices on buckwheat after *sali* rice harvest. The experiment was laid out in factorial randomized block design with three replications. The treatment consisted of four nutrient management practices *viz.*, control, application of 20-10-10 kg/ha N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O, respectively, application of 20-10-10 kg/ha N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O, respectively + 1.25t/ha vermicompost and application of 20-10-10 kg/ha N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O, respectively + 2.5t/ha vermicompost and three weed management treatments *viz.*, control, pre-emergence application of pendimethalin @ 0.75 kg/ha and pre-emergence application of pendimethalin @ 0.75 kg/ha + dryland weeder at 40 DAS. The soil of the experiment site was sandy loam in texture, acidic in reaction (pH: 5.6) medium in organic C (0.58 %), available N (259.56 kg/ha), P<sub>2</sub>O<sub>5</sub> (20.40 kg/ha) and available K<sub>2</sub>O (161.23 kg/ha). The weeds of the experimental field were *Eleusine indica*, *Panicum repens*, *Paspalum compressus*, *Digitaria setigera*, *Cynodon dactylon* among the grasses; *Cyperus rotundus* among the sedge; and *Ageratum houstonianum*, *Commelina benghalensis*, *Polygonum plebeium*, *Mimosa pudica* and *Acmella ciliata* among the broad leaved.

The density and dry weight of weeds in rainfed buckwheat were found to be significantly lesser with application of 20-10-10 kg/ha N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O, respectively + 2.5t/ha vermicompost compared to other treatments. As a result, the uptake of N, P and K by weeds was found to be significantly lesser with N<sub>3</sub>. The growth parameters like plant height, number of primary branches/plant and yield attributing characters *viz.*, number of cyme/plant, number of seeds/cyme were found to be significantly higher in N<sub>3</sub>. The highest seed yield (1249.99 kg/ha), stover yield (2046.76 kg/ha) was thus recorded with this treatment.

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In respect of weed management, pre-emergence application of pendimethalin @ 0.75 kg/ha + dryland weeder operation at 40 DAS was found to significantly lower the density and dry weight, N, P and K content and uptake of weeds in rainfed buckwheat. Thus, the growth and yield attributing characters of rainfed buckwheat improved with this treatment which recorded the highest seed (1080.55 kg/ha) and stover (1824.02 kg/ha) yields.

The nutrient as well as weed management interacted significantly and the combination of the two above-mentioned treatments was the best treatment combination with the seed yield of 1333.32 kg/ha and stover yield of 2079.16 kg/ha. This treatment combination was also found to be the best with a gross return of Rs. 47,705.72, net return of Rs. 26,032.58 and B: C ratio of 1.20.

## **Performance of quality protein maize (*Zea mays* L.) under different crop management practices**

*Gargi Kashyap*

An agronomic experiment entitled “*Performance of quality protein maize (Zea mays L.) under different crop management practices*” was conducted at the Instructional-cum-Research (ICR) Farm, Assam Agricultural University, Jorhat during the *rabi* season of 2018 to find out the performance of QPM under different dates and a suitable row spacing for QPM cultivation in Assam condition. The experiment consisted of three different dates *viz.*, 15th November (D1), 25th November (D2) and 5th December (D3) and four different row spacings *viz.*, 50cm x 25cm (S1), 55cm x 25cm (S2), 60cm x 25cm (S3) and 65cm x 25cm (S4). The treatments were laid out in split plot design and replicated thrice with different dates in the main plots and row spacings in the sub-plots. The soil of the experimental site was sandy loam in texture, acidic in reaction (pH 5.10), medium in organic carbon (0.64%), low in available N (227.72 kg/ha), low in available P<sub>2</sub>O<sub>5</sub> (21.07kg/ha) and medium in K<sub>2</sub>O (198.51 kg/ha). Experimental findings revealed that among the three different dates allotted, 15th November (D1) sown crop recorded highest plant height, total number of functional leaves, LAI and CGR values and less GDD than late sown other two dates and less days recorded in terms of total days for tasseling, silking and harvesting. Yield attributing characters were also recorded highest under 15th November crop *viz.*, number of cobs/plant(1.07), cob weight with husk (230.36g) and without husk (190.38g), cob length with husk (24.56 cm) and without husk (15.40 cm), cob girth (16.72 cm), number of rows/cob (16.72), number of grains/rows (31.53) and weight of 1000 grains (313.43g). The highest grain yield (45.01q/ha), stover yield (78.03q/ha) and harvest index (36.68%) were found under 15th November. The highest nutrient content in grains, stover and protein content in grains were recorded and also found highest under 15th November crop. Different row spacings showed significant effect on plant height, which was recorded the highest under 60cm x 25cm (S3). The number of functional leaves, LAI and CGR as well as yield attributing characters like number of cobs/plant, length and weight of the cob with and without husk, cob girth, number of rows/cob, number of grains/row and 1000 grain weight as well as grain yield (44.41q/ha) and

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stover yield (79.23q/ha) were recorded the highest with the spacing of 60cm x 25cm (S3). The highest nutrient content and nutrient drained from soil was obtained under row spacing of 60cm x 25cm (S3). In terms of economics, the highest gross returns (Rs. 1,16,158.14), net return (Rs. 91,742.89) and highest B:C ratio (3.76) was obtained from 15th November sown crop. Among the different row spacings 60cm x 25cm (S3) resulted in the highest gross return (Rs. 1,20,419.56) and net return (Rs. 96,052.56) and highest B: C ratio (3.94).

## **Agronomic bio-fortification of fodder maize (*Zea mays* L.) with boron and zinc**

*Himangshu Deka*

A field experiment entitled “Agronomic bio-fortification of fodder maize (*Zea mays* L.) with boron and zinc” was conducted during the *summer* season of 2019 at the ICR farm of Assam Agricultural University, Jorhat, with a view to evaluate the response of fodder maize to boron and zinc bio-fortification. The experiment was laid out in a randomized block design with 10 treatments and replicated thrice. The treatments consisted of soil and foliar applications of zinc and boron *viz.*, Absolute control [T1], Recommended dose of fertilizers [T2], RDF + Zn (10 kg/ha) [T3], RDF+ Zn (20 kg/ha) [T4], RDF + B (1% Borax as foliar application) [T5], RDF + B (1.5% Borax as foliar application) [T6], RDF + Zn (10 kg/ha) + B (1% Borax as foliar application) [T7], RDF + Zn (10 kg/ha) + B (1.5% Borax as foliar application) [T8], RDF+ Zn (20 kg/ha) + B (1% Borax as foliar application) [T9], RDF + Zn (20 kg/ha)+ B (1.5% Borax as foliar application) [T10]. The soil of the experimental site was sandy loam in texture, acidic in reaction (pH: 5.9), medium in OC (0.64%), low in available N (196.26 kg/ha), medium in available P<sub>2</sub>O<sub>5</sub> (25.34 kg/ha) and available K<sub>2</sub>O (155.23 kg/ha) and low in available zinc (0.62 mg/kg) and boron (0.56 mg/kg).

The results revealed that the growth and yield attributing characters, quality parameters and NPK content and uptake by the fodder maize were significantly higher with the application of RDF + Zn (20 kg/ha) + B (1.5% Borax as foliar application) [T10]. The green fodder yield and dry fodder yield were significantly influenced by the application of zinc and boron. The highest value (287.23 q/ha) was recorded with the treatment T10 [RDF + Zn (20 kg/ha) + B (1.5% Borax as foliar application)]. Among the different treatments, application of RDF+ Zn (20 kg/ha) [T4] recorded the highest Zn content (39.12 mg/kg) and the lowest one (18.67 q/ha) was recorded with the treatment T1 [Absolute control]. Similarly, the highest B content (47.34 mg/kg) was recorded with the application of RDF + B (1.5% Borax as foliar application) [T6]. In case of zinc and boron uptake by the plant, the highest value was observed with the application of RDF + Zn (20 kg/ha) + B (1.5% Borax as foliar application) [T10].

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Among different treatments higher monetary return (Rs.45956.80) was realized with the application of RDF + Zn (20 kg/ha) + B (1.5% Borax as foliar application) [T10] whereas, the B: C (2.11) ratio was highest with the application of Recommended dose of fertilizer (RDF) [T2].



## **Effect of Phosphate Solubilising Bacteria (PSB) on fodder productivity of cowpea in acid soil**

*Jishnu Pratim Mudoi*

A field experiment entitled “Effect of Phosphate Solubilizing Bacteria (PSB) on fodder productivity of cowpea in acid soil” was carried out during the *kharif* season of 2018-19 at the Instructional-cum-Research Farm, Assam Agricultural University, Jorhat to find out the performance of PSB on growth, productivity and quality of fodder cowpea. The experiment consisted of twelve treatments *viz.*, control (T1), application of recommended dose of fertilizers according to all India trial which were 20:60:30 kg/ha of N:P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O (T2) respectively, application of PSB (12PF-1) + N and K full (T3), application of PSB (47PF-1) + N and K full (T4), application of PSB (48PF-3) + N and K full (T5), application of PSB (48PF-4) + N and K full (T6), application of PSB (131PF-1) + N and K full (T7), application of PSB (99PF-1) + N and K full (T8), application of PSB (26PB-2) + N and K full (T9), application of PSB (68PB-3) + N and K full (T10), application of PSB (103PB-1) + N and K full (T11) and application of PSB (136PB-1) + N and K full (T12) and along with it, from 3rd treatment onwards, only half of the required phosphorus was supplied through inorganic fertilizer. The name of cowpea variety was „BL-2” (Bundel Lobia -2). This variety was developed in IGFRI, Jhansi through single plant selection from IL-978. The treatments were laid out in Randomized Block Design (RBD) and replicated thrice. The soil of the experimental site was clayey loam in texture, acidic in reaction (pH 5.1), medium in organic carbon (0.51%), low in available N (239.12 kg/ha), medium in available P<sub>2</sub>O<sub>5</sub> (18.4kg/ha), medium in available K<sub>2</sub>O (158.23 kg/ha). Experimental findings revealed that in case of the growth parameters such as highest plant height, no. of leaves per plant, length of root per plant and Leaf Area Index (LAI), significant results were found at 40 DAS, 60 DAS and at harvest compared to the other treatments with treatment T11 [application of PSB (103PB-1) + N and K full] recording highest values and being at par with application of PSB (136PB-1) + N and K full. Root weight per plant was significantly affected at all the stages of observation, i.e., at 20 DAS, 40 DAS, 60 DAS and at harvest with the highest recorded data observed in case of application of PSB (103PB-1) + N and K full (T11) which was at par with treatment T12 [application of PSB (136PB-1) +

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N and K full] . No. of root nodules and their weight per plant showed significant affect at 20 DAS, 40 DAS and at 60 DAS with the highest data being recorded in case of treatment T11 [PSB (103PB-1) + N and K full] followed by treatment T12 [application of PSB (136PB-1) + N and K full] with which it was statistically at par. CGR values increased at an increasing rate from 20-40 DAS to 40-60 DAS and thereafter the rate decreased from 40- 60 DAS to 60-Harvest with highest CGR values being observed in treatment T11 [application of PSB (103PB-1) + N and K full]. RGR values were highest between 20 DAS to 40 DAS and thereafter declined till harvest with highest data being recorded with application of PSB (103PB-1) + N and K full (T11). Green forage yield and dry matter yield were also significantly affected by the application of PSB with highest data being recorded in treatment T11 [application of PSB (103PB-1) + N and K full] which were 35.2 t/ha and 8.28 t/ha respectively and it was followed by treatment T12 [application of PSB (136PB-1) + N and K full] with which it was statistically at par . Crude protein yield was also influenced significantly and treatment T11 [application of PSB (103PB-1) + N and K full] recorded highest data (1.13 t/ha) which was at par with application of PSB (136PB-1) + N and K full (T12). The uptakes of N& P and were found to be significantly affected as well with treatment T11 recording highest N-uptake (23.56 kg/ha) as well as P – uptake (11.32 kg/ha). The primary nutrient status of the soil also increased after the harvest of the crop with significant results seen in case of available N and available P<sub>2</sub>O<sub>5</sub> in soil. Treatment T11 recorded highest available N (254.35 kg/ha) and available P<sub>2</sub>O<sub>5</sub> (29.94 kg/ha) of the soil which were at par with treatment T12 [application of PSB (136PB-1) + N and K full]. Among different treatments, higher gross return (₹ 70400.00), net return (₹ 49102) and B: C ratio (₹ 2.31) were realized with the application of [PSB (103PB-1) + N and K full [T11].

## **Effect of varieties and integrated nutrient management practices in rapeseed and mustard under rice fallow situation**

*Keisham Dony Devi*

A field experiment entitled “Effect of varieties and integrated nutrient management practices in rapeseed and mustard under rice fallow situation” was conducted during the *rabi* season of 2019-20 at the research farm of Assam Agricultural University, Jorhat, with a view to evaluate the performance of early maturing mustard varieties and the effect of integrated nutrient management in rapeseed and mustard in rice fallow situation. The experiment was laid out in a split-plot design with four (4) rapeseed and mustard varieties in the main plot and five (5) integrated nutrient management (INM) practices in the sub-plots and replicated thrice. The varieties (V) viz., PM 26 (V1), PM 27 (V2), NRCHB-101 (V3) and TS-36 (V4) and INM practices viz., control (No N-P-K) (F1), 50% of the recommended dose (RD) of NPK + vermicompost mixture @ 1t/ha (incubated with Azotobacter and PSB @ 0.2% w/w for 15 days) in equal splits applied at basal and 30 DAS (F2), vermicompost @ 2t/ha enriched with biofertilizers (Azotobacter + PSB) incubated @ 0.2% w/w for 15 days (F3), FYM @ 2t/ha (incubated with Azotobacter and PSB @ 0.2% w/w for 15 days) + quick lime @ 20 kg/ha + ash @ 2kg/ha at basal and 30 DAS (1000:10:1) (F4) and recommended NPK @ 40-35-15 kg/ha (F5) was sown on 23rd Nov 2019 and harvested on 24th Feb 2020 for *toria* and 6th March 2020 for mustard. The soil of the experimental site was sandy loam in texture, acidic in reaction (pH: 5.99), high in OC (0.98%), low in available N (219.17 kg/ha) and available P<sub>2</sub>O<sub>5</sub> (17.47 kg/ha) and medium in available K<sub>2</sub>O (281.8 kg/ha). The field capacity of the soil was 21.26 %.

The results revealed that the growth and yield attributing characters, the seed oil content (40.31%), oil yield (475.65 kg/ha) and NPK content of seed and stover as well as uptake by the crop were significantly higher in PM 27 (V2). Among four varieties, the highest seed and stover yield was produced by mustard variety PM 27 (V2) and it was *at par* with NRCHB 101 (V3). Application of recommended NPK @ 40-35-15 kg/ha (F5) was significantly superior over all other treatments and *at par* with 50% RD

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of NPK + VC @ 1t/ha incubated with biofertilizer in equal splits as basal and at 30 DAS (F2) in terms of the growth and yield attributing characters, seed and stover yield and NPK content and uptake. The highest oil content (40.15%) and oil yield (483.86 kg/ha) and available N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O in soil after harvest was recorded in application of recommended NPK @ 40-35-15 kg/ha (F5).

The highest Agronomic efficiency (AE) (kg/kg), Nutrient use efficiency (NUE) (kg/kg), Physiological efficiency (PE) (kg/kg) and Apparent recovery efficiency (ARE) (%) of rapeseed and mustard was obtained in INM treatment of FYM @ 2t/ha (incubated with Azotobacter and PSB @ 0.2% w/w for 15 days) + quick lime @ 20 kg/ha + ash @ 2kg/ha at basal and 30 DAS (1000:10:1) (F4).

Among the varieties, PM 27 (V2) produced the highest net returns of ₹ 40,965.11/ha with a B:C ratio of 2.34 followed by NRCHB101(V3) which produced a net returns of ₹ 38644.91/ha and B:C ratio of 2.22. In INM practice, a net returns of ₹ 45,325.00/ha with the highest B:C ratio of 2.74 could be recorded in recommended NPK @ 40-35-15 kg/ha (F5) followed by application of FYM @ 2t/ha (incubated with Azotobacter and PSB @ 0.2% w/w for 15 days) + quick lime @ 20kg/ha + ash @ 2kg/ha at basal and 30 DAS (1000:10:1) (F4) producing a B:C ratio of 2.59 with net returns of ₹ 39,629.63/ha.

From the interaction effect of variety and INM practice, it may be concluded that after the harvest of *kharif* rice in Assam, the sowing of mustard variety PM 27 or NRC HB 101 with recommended NPK @ 40-35-15 kg/ha may be followed. At the same time, considering the importance of INM practice, instead of chemical fertilizer alone, the best INM practice (50% RD of NPK + VC @ 1t/ha incubated with biofertilizers in equal splits as basal and at 30 DAS) may be applied in mustard cultivation for better results under rice fallow situation.

## **Irrigation scheduling in rapeseed using Can evaporimeter**

*Krishna Bharadwaj*

A field experiment entitled “Irrigation scheduling in rapeseed using Can evaporimeter” was carried out at Instructional-cum-Research (ICR) Farm, Assam Agricultural University, Jorhat during the *rabi* season of 2018-19 to determine the suitable depth and schedule of irrigation in rapeseed (toria) based on Can evaporimeter and to find out the water requirement of rapeseed by scheduling irrigation with Can evaporimeter. The experiment was laid out in factorial randomized block design and replicated thrice. The treatments consisted of 3 depths of irrigation *viz.*, irrigation of 4 cm depth (I1), irrigation of 5 cm depth (I2) and irrigation of 6 cm depth (I3) and 3 irrigation schedules *viz.* irrigation at 4 cm evaporation from Can evaporimeter (D1), irrigation at 5 cm evaporation from Can evaporimeter (D2) and irrigation at 6 cm evaporation from Can evaporimeter (D3). The soil of the experimental site was sandy loam in texture, acidic in reaction (pH 5.2), medium in organic carbon (0.70%), low in alkaline KMnO<sub>4</sub> extractable N (243.7kg/ha), medium in Bray I P<sub>2</sub>O<sub>5</sub> (24.9kg/ha) and low in 1 N ammonium acetate extractable K<sub>2</sub>O (151.6kg/ha). The toria variety “TS-38” was sown on 15th October, 2018 and harvested on 16th January, 2019. The total amount of rainfall received during the crop growth period was 69.8 mm.

Experimental findings revealed that irrigation of 6 cm depth (I3) recorded the highest values for all growth characters in terms of plant height, dry matter accumulation, Leaf Area Index (LAI), Specific Leaf Area (SLA) and Crop Growth Rate (CGR) and Relative Growth Rate (RGR). Similarly, the yield attributing characters *viz.*, branches/plant, number of siliquae/plant, number of seeds/siliqua and nutrient (NPK) uptake of rapeseed was observed to be highest under irrigation of 6 cm depth (I3). However, 6 cm irrigation (I3) recorded lower Specific Leaf Weight (SLW). The highest seed and stover yield (1104 kg/ha and 2052 kg/ha, respectively) was found under irrigation of 6 cm depth (I3) which was statistically at par with irrigation of 5 cm depth (I2) [1042 kg/ha and 1942 kg/ha, respectively]. On the other hand, the test weight and harvest index (HI) were found to be non-significant under different treatment combinations. Likewise, irrigation of 6 cm depth (I3) also recorded the highest oil yield

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(465.9 kg/ha), highest water use (205.6 mm), crop WUE (89.9 kg/ha cm) and nutrient (NPK) uptake.

Scheduling of irrigation at 4 cm evaporation from Can evaporimeter (D1) resulted in better growth parameters of the crop *viz.*, plant height, dry matter accumulation, LAI, SLA, CGR and RGR. On the other hand, irrigation at 6 cm evaporation from Can evaporimeter (D3) recorded better SLW. Irrigation at 4 cm evaporation from Can evaporimeter (D1) also recorded the highest yield attributing characters *viz.*, number of branches/plant, number of siliquae/plant and number of seeds/siliqua. The highest seed and stover yield was found under irrigation at 4 cm evaporation from Can evaporimeter (D1) [1173 kg/ha and 2152 kg/ha, respectively]. Similarly, irrigation at 4 cm evaporation from Can evaporimeter (D1) also recorded the highest oil yield (484.9 kg/ha), highest water use (216.3 mm), crop WUE (97.3 kg/ha cm) and nutrient (NPK) uptake. The highest field WUE (57.2 kg/ha cm) was recorded under irrigation scheduling at 5 cm evaporation from Can evaporimeter (D2).

Irrigation of 6 cm depth at 4 cm evaporation from Can evaporimeter (I3D1) recorded the highest dry matter accumulation, siliquae/plant, seed yield and stover yield. It was closely followed by 5 cm irrigation at 4 cm evaporation from Can evaporimeter (I2D1), 4 cm irrigation at 4 cm evaporation from Can evaporimeter (I1D1), 6 cm irrigation at 5 cm evaporation from Can evaporimeter (I3D2) and 5 cm irrigation at 5 cm evaporation from Can evaporimeter (I2D2). However, I1D1 required less irrigation than I2D1 and I3D1 and recorded higher crop WUE and field WUE. In terms of economics, the highest gross return ( 41510.00/ha), net return ( 14322.00) and benefit-cost ratio (1.53) were obtained by application of 6 cm irrigation at 4 cm evaporation from Can evaporimeter (I3D1) and closely followed by application of 5 cm irrigation at 4 cm evaporation from Can evaporimeter (I2D1) with gross return, net return and benefit – cost ratio of 41125.00/ha, 14237.00 /ha] and 1.52, respectively.

## Crop diversification in organic rice ecosystem

*Merajul Hussain*

A field experiment entitled “Crop diversification in organic rice ecosystem” was conducted at the organic block, Instructional-cum-Research farm of Assam Agricultural University, Jorhat during *kharif* and *rabi* seasons, 2019-20 to evaluate the effect of crop diversification in organic rice ecosystem. The experiment was laid out in a Randomized Block Design (RBD) with three replications. The main crop was scented rice (*kon joha*) with different diversified modules. The experiment consisted of eight different treatments *viz.*, sole rice (T1), rice + swamp taro intercropping (4:2) (T2), rice + buffalo spinach intercropping (4:2) (T3), T2 + pumpkin in bund (T4), T2 + marigold in bund (T5), T3 + pumpkin in bund (T6), T3 + marigold in bund (T7) and rice – lathyrus (relay) (T8). The soil of the experimental site was clay loam in texture with pH 5.28, organic carbon (0.82%), CEC {6.48 c mole (p+)/ Kg}, medium in available nitrogen (272.45 kg/ha), available P205 (28.11 kg/ha) and low in available K2O (132.38 kg/ha). The total rainfall received during the crop season was 2014.1 mm. The mean maximum and minimum temperature during the whole crop growing period ranged from 20.7 to 34.8 0C and 8.4 to 26.9 0C, respectively.

Most of the rice growth and yield attributes *viz.*, plant height, number of tillers/hill, number of effective tillers/hill, number of panicles/m<sup>2</sup>, weight of panicle, no. of filled grains/panicle, test weight, grain yield (18.46 q/ha) and straw yield (45.41 q/ha) were found to be highest in sole cropping of rice. However, the growth and yield attributes of component crops were not influenced significantly under different crop diversification modules. Accumulated GDD during each phenophases of rice was recorded and found that the *kon jon* variety require a total GDD of 2026 0C days.

Though crop diversification failed to exert much impact on growth and yield attributes of rice, it had positive influence on multiple cropping index, rice equivalent yield and diversity index which, ultimately resulted in increase in total system productivity. Quality of rice grain *i.e.* kernal length (6.77 mm), kernal breadth (2.32 mm), protein content (7.35%) and milling recovery (61.97%) were significantly improved under crop diversification and found best in rice + swamp taro intercropping + pumpkin in bund . It was *at par* with rice + swamp taro intercropping + marigold in bund. Soil bulk density, organic carbon, CEC and biological properties were significantly

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improved under crop diversification and recorded the best in rice + swamp taro intercropping + pumpkin in bund which was *at par* with rice + swamp taro intercropping + marigold in bund. A highest B:C ratio of 3.10 was recorded in rice + swamp taro intercropping + marigold in bund and was closely followed by rice + swamp taro intercropping + pumpkin in bund (2.94). The study revealed that crop diversification module, rice + swamp taro intercropping + marigold in bund was the best option in respect of profitability, rice equivalent yield, multiple cropping index, diversity index, quality of grain, physico-chemical and biological properties of soil.



## **Integrated nutrient management in summer maize (*Zea mays*)**

*Minakshi Bezboruah*

A field experiment entitled “Integrated nutrient management in summer maize (*Zea mays*)” was carried out at Instructional-cum- Research (ICR) Farm, Assam Agricultural University, Jorhat during the year 2019 to find out the effect of INM practice to the growth and yield of summer maize and to study the post-harvest nutrient status of soil as affected by different INM practices. The experiment was laid out in randomized block design with nine treatments and replicated thrice. The treatments consisted of both soil and foliar application of fertilizers viz., T1 [60-40-40 kg/ha NPK (RDF)], T2 [RDF + *Azospirillum* + PSB], T3 [RDF + *Azospirillum* + PSB + 2 sprays of vermiwash at 25 & 40 DAS], T4 [75% N of RDF + 25% of N replaced by vermicompost], T5 [75% N of RDF + 25% of N replaced by vermicompost + *Azospirillum* + PSB], T6 [75% N of RDF + 25% of N replaced by vermicompost + *Azospirillum* + PSB + 2 sprays of vermiwash at 25&40 DAS], T7 [50% N of RDF+ 50% of N replaced by vermicompost], T8 [50% N of + 50% of N replaced by vermicompost + *Azospirillum* + PSB], T9 [50% N of RDF + 50% of N replaced by vermicompost + *Azospirillum* + PSB + 2 sprays of vermiwash at 25&40 DAS]. The soil of the experimental site was sandy loam in texture, acidic in reaction, medium in organic carbon (0.72%), low in available N (156.19 kg/ha) and medium in available P<sub>2</sub>O<sub>5</sub> (23.78 kg/ha), and K<sub>2</sub>O (161.50 kg/ha). N was applied in two split doses one at knee high stage and second application was before tasseling. The maize seeds of the variety VMH-53 was sown on 15th of March (2019) and harvested by two picking on 10th June and 15th June. Experimental findings revealed that INM practices influenced both the growth and yield attributing characters. Application of RDF + *Azospirillum* + PSB + 2 sprays of vermiwash at 25 & 40 DAS (T3) recorded highest values for all the growth attributing parameters. Similarly, the yield attributing characters like weight of cob with and without husk, length of cob, number of rows per cob, grain per row, grain per cob, weight of grain per cob and nutrient (NPK) uptake was observed to be highest under RDF + *Azospirillum* + PSB + 2 sprays of vermiwash at 25 & 40 DAS (T3) which was *at par* with 75% N of RDF+ 25% of N replaced by vermicompost + *Azospirillum* +

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PSB + 2 sprays of vermiwash at 25&40 DAS. Likewise, the highest grain and stover yield being 43.04 q/ha and 89.66 q/ha respectively was produced from RDF + *Azospirillum* + PSB + 2 sprays of vermiwash at 25 & 40 DAS (T3) which was *at par* with the grain yield 41.81 q/ha and stover yield 87.42 q/ha obtained from 75% N of RDF+ 25% of N replaced by vermicompost + *Azospirillum* + PSB + 2 sprays of vermiwash at 25&40 DAS (T6). However, the protein content in maize and nutrient content in soil after harvest was found to be non-significant. In terms of economics, the highest gross return (₹ 96765), net return (₹ 77705) and the B:C ratio (4.08) was recorded from the treatment RDF + *Azospirillum* + PSB + 2 sprays of vermiwash at 25 & 40 DAS (T3) and which was nearly followed by the treatment 75% N of RDF + 25% of N replaced by vermicompost + *Azospirillum* + PSB + 2 sprays of vermiwash at 25 & 40 DAS (T6).

## **Intercropping of buckwheat and lathyrus in rice fallow under organic ecosystem**

*Nayan Jyoti Bordoloi*

An experiment entitled “Intercropping of buckwheat and lathyrus in rice fallow under organic ecosystem” was conducted at instructional-cum-research farm, Assam Agricultural University, Jorhat during the *rabi* season of 2017-18 with the objective to evaluate efficient proportion of intercrops under organic management system in rice fallow land and to monitor soil physico-chemical properties as influenced by different intercrops. The experiment was laid out in randomised block design with 3 replications. The experiment was consisted of nine different treatment combinations namely T1 [Sole buckwheat]; T2 [Sole lathyrus as grain ]; T3 [Sole lathyrus as fodder ];T4 [Buckwheat + Lathyrus as grain (1:1)]; T5 [Buckwheat + Lathyrus as fodder (1:1)]; T6 [Buckwheat + Lathyrus as grain (2:1)]; T7 [Buckwheat + Lathyrus as fodder (2:1)]; T8 [Buckwheat + Lathyrus as grain(2:2)] and T9 [Buckwheat + Lathyrus as fodder (2:2)]. The soil was sandy loam with high in organic C (0.77 %). The initial nutrient content of the soil were, N (296.56 kg/ha), P<sub>2</sub>O<sub>5</sub> (34.88 kg/ha) and K<sub>2</sub>O (148.32 kg/ha). The present investigation revealed that the yield of buckwheat, lathyrus grain and lathyrus fodder was highest in respective sole treatments and decreased with increasing share of intercrops [1,088.71kg/ha (for buckwheat)], 465.34kg/ha (for lathyrus grain), 6023.60 kg/ha (for lathyrus fodder)]. Among different intercropping systems highest buckwheat equivalent yield was obtained in buckwheat + lathyrus as grain at a ratio of 2:2. In terms of intercropping advantage measured by land equivalent ratio (LER), three intercropping *viz* T8 [Buckwheat + Lathyrus as grain(2:2)]; T9 [Buckwheat + Lathyrus as fodder (2:2)] and T5 [Buckwheat + Lathyrus as fodder (1:1)] showed superior performance over the sole croppings. However, intercropping of buckwheat + lathyrus as grain in 2:2 ratio recorded highest LER values over the other intercropping systems indicating intercrop advantage. Intercropping of buckwheat + lathyrus as grain at 2:2 row proportion proved to be the best since it recorded highest K value (3.32) indicating better complementary effect. Overall soil health as measured by soil available N, P and K content and organic carbon after harvest of test crops was not affected much due to sole and intercropping systems. Among different treatments, the highest cost of cultivation (₹ 25,100.00) was recorded in sole buckwheat. Among theintercroppings,

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the highest gross return (₹ 77,237.75.00), net return (₹ 55,024.75.00) and B:C (2.48) were obtained in buckwheat + lathyrus as (G) in 2:2. This study showed that among the sole cropping treatments, buckwheat was found to be the best crop under rice fallow land organic ecosystem. As a whole intercropping of buckwheat with lathyrus as grain in 2:2 ratio found to be the best in respect of buckwheat equivalent yield, biological efficiency and economic point of view. Since the findings are based on one year experimentation, further validation in farmers field will be helpful for generating best technology under fallow land organic ecosystem.

## **Nutrient and weed management in rainfed toria by organic methods**

*Prostuti Bora*

An experiment entitled “Nutrient and weed management in rainfed toria by organic methods” was conducted at Instructional-cum-Research Farm, Assam Agricultural University, Jorhat during the *rabi* season of 2019-2020 to study the effect of nutrient management (NM) and weed management (WM) by organic methods on growth and yield of toria. The experiment was laid out in randomized block design (factorial) with three replications. The treatments consisted of three nutrient management treatments *viz.*, control (N0), application of vermicompost 2.5 t/ha (N1) and application of vermicompost 5.0 t/ha (N2) and three weed management treatments *viz.*, control (W0), hand weeding at 30 DAS (W1) and dryland weeder operation at 30 DAS (W2). The soil of the experimental site was sandy loam in texture, acidic in reaction (pH: 5.1), medium in organic carbon (0.58%), available N (270.86 kg/ha), P<sub>2</sub>O<sub>5</sub> (21.87 kg/ha) and K<sub>2</sub>O (169.82 kg/ha). The weeds of the experimental fields were *Cynodon dactylon*, *Eleusine indica*, *Paspalum conjugatum*, *Panicum repens*, *Axonopus compressus* among grasses ; *Cyperus rotundus* the sedge and *Commelina benghalensis*, *Ageratum houstonianum*, *Mimosa pudica*, *Acmella euliginesa*, *Gynura bicolor*, *Oxalis corniculata*, *Alternanthera philoxeroides* and *Chenopodium album* among the broad leaved weeds. The density and dry weight of weeds in rainfed toria were found to be significantly lesser with application of 5.0 t/ha vermicompost compared with other treatments. As a result, the content and uptake of N, P and K by weeds were found to be significantly lesser with N2. The growth parameters like plant height, number of primary branches/plant, number of secondary branches/plant and yield attributing characters *viz.*, number of siliquae/plant, number of seeds/siliqua were found to be significantly improved in N2. The highest seed yield (929.26 kg/ha), stover yield (1997.95 kg/ha) was recorded with this treatment. The oil content, oil yield, N, P and K content and uptake also increased with N2.

In respect of weed management, dryland weeder operation at 30 DAS (W2) was found to significantly lower the density and dry weight. N, P and K content and uptake of weeds in rainfed toria. The growth and yield attributing characters of rainfed toria

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improved significantly with this treatment which recorded the highest seed (755.67 kg/ha) and stover (1750.18 kg/ha) yields. Oil content, oil yield, N, P and K content and uptake also increased with W2. NM interacted significantly with WM in respect of seed and stover yields of toria. The combination of N2W2 was found to be superior with 1038.28 kg/ha and 2217.17 kg/ha seed and stover yield.

The treatment combination N2W2 resulted in higher gross return (Rs. 67,082.69 /ha), net return (Rs. 43,379.69 /ha) and the benefit: cost ratio (1.83).

## **Studies on potato crop as affected by planting date and nutrient management**

*Rajibul Hoque Mullah*

A field experiment entitled —Studies on potato crop as affected by planting date and nutrient management was conducted during the *rabi* season of 2018-19 at the ICR farm of Assam Agricultural University, Jorhat, with a view to study the growth and productivity of potato crop as influenced by planting date and nutrient management. The experiment was laid out in a randomized block design (factorial) with three replications. The treatments consisted of four dates of planting *viz.*, November 15 (D1), November 25 (D2), December 5 (D3), December 15 (D4) and three nutrient management treatments *viz.*, recommended N-P<sub>2</sub>O<sub>5</sub>-K<sub>2</sub>O dose (120-100-100 kg/ha) [N1], 2/3rd of recommended N through chemical fertilizer + 1/3rd of recommended N through organic source (vermicompost) [N2], 3/4th of recommended N through chemical fertilizer + 1/4th of recommended N through organic source (vermicompost) [N3]. (Recommended P & K was applied through chemical fertilizer after adjusting with organic source). The soil of the experimental site was sandy loam in texture, acidic in reaction (pH: 5.1), medium in organic carbon (0.68%), available N (265.40 kg/ha), P<sub>2</sub>O<sub>5</sub> (25.37 kg/ha) and K<sub>2</sub>O (169.82 kg/ha).

The results revealed that the growth and yield attributing characters and N, P and K uptake by the potato crop were significantly higher with the planting on D1 (November 15) as compared to that in other dates of planting. Planting on D1 (November 15) produced the highest number of tubers per plant (10.34) which was significantly higher than that in D2 followed by D3 and D4. Tuber yield per plant was highest (196.17g) on D1 (November 15) as compared to that in other dates of planting. Planting on D1 (November 15) produced the highest tuber yield (182.67 q/ha) which was significantly higher than that in D2 followed by D3 and D4. The highest N, P and K uptake was found with the planting on D1 (November 15). Higher monetary return as well as B: C ratio was realized with the planting on D1 (November 15) as compared to that in other dates of planting.

The highest plant height, number of leaves/plant, leaf area index, dry matter accumulation were recorded with the nutrient management treatment N2 (2/3rd of

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recommended N through chemical fertilizer + 1/3rd of recommended N through vermicompost) as compared to that in other treatments. Nutrient management treatment N2 significantly increased the number of tubers per plant (9.22), tuber yield per plant (181.27 g) and total tuber yield (168.45 q/ha) as compared to that in other treatments. Nutrient management treatment N2 significantly increased the N, P and K content and uptake. Higher monetary return as well as higher B: C ratio was recorded with the treatment of N2 as compared to that in other treatments.



# **Response of rainfed late sown toria in rice fallows as influenced by application of sulphur and boron and sulphur**

*Rekhankona Pegu*

During the *rabi* seasons of 2018-19 and 2019-20, a field experiment entitled “Response of rainfed late-sown *toria* in rice fallows as influenced by application of sulphur and boron” was conducted at Instructional-cum-Research (ICR) Farm, Assam Agricultural University, Jorhat with a view to study the effect of sulphur and boron on growth, yield, quality of *toria* and the nutrient uptake by crop and its availability in soil. The *toria* crop variety used for investigation was Jeuti (JT-90-1). The experiment comprised of 5 levels of sulphur *viz.*, S0 : 0 kg S/ha, S1 : 10 kg S/ha, S2 : 20 kg S/ha, S3: 30 kg S/ha and S4 : 40 kg S/ha through gypsum and 3 levels of boron *viz.*, B0 : 0 kg B/ha, B1 : 1 kg B/ha and B2 : 2 kg B/ha through borax was laid out in a factorial randomized block design (RBD), with three replications. The soils of the experimental site was sandy loam in texture, acidic in reaction (pH 5.29 and 5.3), medium in organic carbon (0.53 and 0.52%), available N (313.6 and 325.55 kg/ha) and available K<sub>2</sub>O (136.55 and 138.39 kg/ha) and low in available P<sub>2</sub>O<sub>5</sub> (18.87 and 20.23 kg/ha), available S (15.59 and 19.15 kg/ha) and available B (0.215 and 0.243 mg/kg). Experimental findings revealed that levels of sulphur influenced growth parameters, yield attributing characters, seed and stover yields, oil content, oil yield, uptake of N, P, K, S and B by *toria* crop in both the years. Application of 30 kg S/ha (S3) gave significantly higher values in almost all the characters under study. The highest seed (979.97 kg/ha in 2018-19 and 928.33 kg/ha in 2019-20) and stover yields (2181.77 kg/ha in 2018-19 and 2052.89 kg/ha in 2019-20) were obtained by application of 30 kg S/ha (S3). As regard to oil content, oil yield, N, P, K, S and B content and uptake, the values were significantly higher with 30 kg S/ha. Available N, P, K, S and B content in soil after harvest of the crop were non-significant in both the years. The highest net return (₹ 36142.05 in 2018-19 and ₹ 32785.45 in 2019-20) and B-C ratio (2.31 in 2018-19 and 2.19 in 2019-20) were obtained when 30 kg S/ha was applied. Among the levels of boron, 2 kg B/ha (B2) proved superior in terms of growth parameters, yield attributing characters, seed and

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stover yield, oil content, oil yield, uptake of N, P, K, S and B by *toria* crop in both the years. Significantly higher seed (846.37kg/ha in 2018-19 and 807.15 kg/ha in 2019-20) and stover yields (1881.52 kg/ha in 2018-19 and 1812.47 kg/ha in 2019-20) were obtained in 2 kg B/ha (B2) which was statistically at par with 1 kg B/ha (B1) for seed (830.78 kg/ha in 2018-19 and 800.95 kg/ha in 2019-20) and for stover yields (1852.44 kg/ha in 2018-19 and 1798.67 kg/ha in 2019-20). In regards to oil content, oil yield, N, P, S and B content and uptake, the values were significantly higher with 2 kg boron/ha. No treatment differences were observed in respect of available N, P, K, S and B content in soil after harvest of the crop for two years of study. The highest net return (₹ 34444.70 in 2018-19 and ₹ 32505.75 in 2019-20) and B-C ratio (2.76 in 2018-19 and 2.66 in 2019-20) were obtained due to application of 1 kg B/ha. The highest interaction effect was recorded under combined application of 30 kg S and 2 kg B/ha treatment (S3B2) for both the years in respect of number of seeds per siliqua, seed yield (1035.77 kg/ha in 2018-19 and 986.36 kg/ha in 2019-20), stover yield (2276.02 kg/ha in 2018-19 and 2123.00 kg/ha in 2019-20), oil content (39.03% in 2018-19 and 38.36% in 2019-20), oil yield (404.11 kg/ha in 2018-19 and 367.45 kg/ha in 2019-20), uptake of N, P, S and B by seed, stover and total uptake by crop over rest of the treatment combinations. From the economic analysis, it has been found that the highest net returns (₹ 37469.05 in 2018-19 and ₹ 34257.40 in 2019-20) were recorded when 30 kg S/ha was applied in combination with 2 kg B/ha (S3B2).Whereas, the B-C ratio (2.30 in 2018-19 and 2.17 in 2019-20) were the highest in S3B1 (30 kg S and 1 kg B/ha).

## **Effect of irrigation schedule and sulphur fertilization on productivity of Indian mustard (*Brassica juncea* L.)**

*Shantanu Paul*

An experiment entitled „Effect of irrigation schedule and sulphur fertilization on productivity of Indian mustard (*Brassica juncea* L.)“ was carried out during rabi season of 2019-20, at the Instructional-cum-Research Farm of the Assam Agricultural University, Jorhat to find out the appropriate irrigation schedule and sulphur requirement of Indian mustard. The treatments comprised of six irrigation schedules viz., I0- Rainfed, I1- Irrigation at 25-30 DAS, I2-Irrigation at Flowering (F), I3 - Irrigation at 25-30 DAS + F, I4 - Irrigation at 25-30 DAS + Siliquae formation (SF) and I5- Irrigation at 25-30 DAS + F + SF and three levels of sulphur fertilization viz., S0 - No application (Control), S1 - 20kg ha<sup>-1</sup> and S2 - 40 kg ha<sup>-1</sup>. The experiment was laid out in a split-plot design with irrigation schedules in main plot and levels of sulphur in sub plots and each treatment was replicated thrice. The soils of the experimental site was sandy loam in texture, acidic in reaction (pH- 5.45), medium in organic carbon (0.59%), available N (282.24 kg ha<sup>-1</sup>), and available K<sub>2</sub>O (184.60 kg ha<sup>-1</sup>) and low in available P<sub>2</sub>O<sub>5</sub> (18.75 kg ha<sup>-1</sup>) and available S (15.2 kg ha<sup>-1</sup>). The mustard var. NRCHB- 101 was sown on 13.11.2019 and harvested on 22.02.2020. During the crop period, total rainfall received was 36.4 mm against the total evaporation of 123.7 mm, resulting in deficit of rainfall by 87.3mm. The results revealed that three irrigations at 25-30 DAS + F + SF (I5) and two irrigations either at 25-30 DAS + F (I3) or at 25-30 DAS + siliquae formation (I4) produced statistically at par values in plant height at harvest, dry matter production at 50 DAS, 75 DAS, crop growth rate during 25-50 DAS and 50-75 DAS and branches plant<sup>-1</sup> of Indian mustard over the treatments with one irrigation and rainfed. The yield attributes viz., number of siliquae plant<sup>-1</sup>, length of siliqua and number of seeds siliqua<sup>-1</sup> as well as seed, stover and oil yields with lower harvest index due to the said irrigation schedules were also at par and significantly higher over rest of the treatments. They produced significantly higher oil yields with higher oil content over other treatments. The irrigation schedule I5 resulted in higher evapo-transpiration and

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total water use followed by I3 and I4, but crop and field water use efficiencies were markedly lowest under three irrigations at 25-30 DAS + F + SF (I5). The per cent content of N, protein, P, K and S in both seed and stover (except K content in stover) due to I5, I3 and I4 were at par and significantly higher over other treatments. But, the uptake of N by seed and stover and the total uptake was significantly higher under I5 over I3 and I4, the latter two being at par but significantly higher over other irrigation regimes. While, the uptake of P, K and S by both seed and stover as well as their total uptake (except total P and K uptake) due to I5 and I3 were at par and significantly higher over other treatments. However, different irrigation schedules did not show any impact on weed density and dry matter and content and uptake of N, P, K and S by weeds. The soil organic carbon content and pH and N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O and S status of soil after the crop harvest were also remained unaffected by irrigation schedules. Economic analysis revealed that the cost of cultivation, gross and net return increased with increasing levels of irrigation and thus, the highest values were recorded under I5. But, the B/C ratios due to I5 followed by I3 and I4 were closure to each other and considerably higher over other treatments. The highest plant height at 60 DAS and at harvest, dry matter accumulation at 50 DAS, 75 DAS, crop growth rate during 25-50 DAS, 50-75 DAS and 75-harvest and number of ranches plant<sup>-1</sup> were recorded under 40 kg S ha<sup>-1</sup> which were at par with 20 kg S ha<sup>-1</sup> and significantly higher over control. Similar trend of results was also recorded on yield attributes viz., siliquae plant<sup>-1</sup>, length of siliqua and seeds siliqua<sup>-1</sup> as well as seed and stover yields, seed oil content and oil yield, in addition to content and uptake of nutrients N, P, K and S by seed and stover. The evapotranspiration and total water use though did not show much variations comparatively higher crop and field water use efficiencies were recorded with 40 kg S ha<sup>-1</sup> and 20 kg S ha<sup>-1</sup> over the control. However, different levels of S did not influence weed density, dry weight and content (except S content by weed at 60 DAS, which has no impact on its uptake) and uptake of nutrients N, P, K and S by weeds. The soil organic carbon, pH and N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O and S status of soil after the crop harvest were also not influenced by different levels of S application. Though, the cost of cultivation increased with increasing levels of S, the gross and net return also increased due to 40 kg S ha<sup>-1</sup> followed by 20 kg S ha<sup>-1</sup> with higher but closure B/C ratios.

## **Nutrient management in rapeseed through organic sources**

*Sonam Lhamu*

An experiment on “Nutrient management in rapeseed through organic sources” was carried out in the Instructional-cum-Research (ICR) Farm, Assam Agricultural University, Jorhat to study the effect of different organic sources of nutrients on growth and yield of rapeseed during the *rabi* season of 2018-19. The treatments consisted of eleven levels of organic sources of nutrients *viz.*, T1 – FYM @ 10 t/ha, T2 – Vermicompost @ 5 t/ha, T3 – Poultry Manure @ 5 t/ha, T4 – FYM @ 5 t/ha + vermicompost @ 2.5 t/ha, T5 – FYM @ 5 t/ha + poultry manure @ 2.5 t/ha, T6 – Vermicompost @ 2.5 t/ha + poultry manure @ 2.5 t/ha, T7 – FYM @ 5 t/ha + vermicompost @ 2.5 t/ha + mustard oil cake @ 1 t/ha, T8 – FYM @ 5 t/ha + poultry manure @ 2.5 t/ha + mustard oil cake @ 1 t/ha, T9 – Vermicompost @ 2.5 t/ha + poultry manure @ 2.5 t/ha + mustard oil cake @ 1 t/ha, T10 – FYM @ 5 t/ha + vermicompost @ 1.25 t/ha + poultry manure @ 1.25 t/ha + mustard oil cake @ 1 t/ha including one T0 – Control. The treatments were laid out in a randomized block design with three replications. The soil of the experimental site was sandy loam in texture, with bulk density 1.48 g/cm<sup>3</sup>, field capacity 24.45%, PWP 11.20%, water holding capacity 35.35%, organic carbon 0.53%, acidic in reaction (pH-5.1) and medium in available nitrogen (274.20 kg/ha), phosphorus (26.95 kg/ha) and potassium (192.00 kg/ha). A *toria* variety TS-67 was sown following all recommended practices of the crop.

Results revealed that the growth parameters *viz.*, plant height and dry weight of plants recorded at 30 DAS, 60 DAS and at harvest, plant population per unit area and number of primary, secondary as well as total branches per plant, the yield attributes *viz.*, number of siliquae/plant, seeds/silqua and seed and stover yield of rapeseed were significantly higher with the application of vermicompost 2.5 t/ha + poultry manure 2.5 t/ha + mustard oil cake 1 t/ha followed by FYM 5 t/ha + poultry manure 2.5 t/ha + mustard oil cake 1 t/ha over most of the other organic sources of nutrients and control. The increase in seed yield due to the said treatments were 330.7% and 307.2%, respectively over the control and on an average 45.5% and 37.5%, respectively over other organic sources of nutrients. The oil yield due to the said treatments was also

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significantly higher by 346.2% and 324.6%, respectively over the control. Significantly higher N, P and K contents and their uptake by both seed and stover of rapeseed under the said treatments were recorded over other organic sources of nutrients and the control.

Application of FYM, poultry manure and vermicompost either alone or in combination with mustard oil cake significantly reduced the weed population/m<sup>2</sup> over other organic sources of nutrients and the control but increased the N, P and K contents in weeds over the control. However, due to the lower dry weight of weeds, significantly lower uptake of such nutrients by weeds were recorded with the treatment FYM 5 t/ha + vermicompost 2.5 t/ha + mustard oil cake 1t/ha (T7) followed by vermicompost 2.5 t/ha + poultry manure 2.5 t/ha (T6) compared to other organic sources of nutrients and control.

Application of organic nutrient sources also considerably increased the soil moisture contents recorded from two different depths *viz.*, 0-20 cm and 20-40 cm of the profile at flowering and siliquae development stages over the control.

The highest cost of cultivation and gross return was recorded with the treatment vermicompost 2.5 t/ha + poultry manure 2.5 t/ha + mustard oil cake 1 t/ha (T9) followed by the treatment FYM 5 t/ha + poultry manure 2.5 t/ha + mustard oil cake 1 t/ha (T8). The highest B: C ratio (3.600) was recorded with the treatment FYM 10 t/ha (T1), but the highest additional net profit of Rs. 39180 was recorded under FYM 5 t/ha + poultry manure 2.5 t/ha (T5) over the control (T0).

## **Performance of direct seeded sali rice under two different crop establishment methods and weed management practices**

*Vigneshwaran M*

A field experiment entitled “Performance of direct seeded sali rice under two different crop establishment methods and weed management practices” was carried out at the Instructional-cum-Research (ICR) Farm, Assam Agricultural University, Jorhat during the sali season of 2018-19 with a view to study the growth and yield behaviour of direct seeded sali rice under two different crop establishment methods and to find out the appropriate weed management practices for direct seeded sali rice. The experiment was laid out in a factorial RBD with three replications. The treatments consisted of two methods of sowing i.e., dry seeding (M1) and wet seeding (M2) and seven different weed management practices viz., two hand weedings at 20 & 40 DAS (W1), pre-emergence herbicide application of pretilachlor @ 0.75 kg a.i./ha (W2), pre-emergence herbicide application of pretilachlor @ 0.75 kg a.i./ha + one hand weeding at 40 DAS (W3), pre-emergence herbicide application of pyrazosulfuron ethyl @ 20 g a.i./ha (W4), pre-emergence herbicide application of pyrazosulfuron ethyl @ 20 g a.i./ha + one hand weeding at 40 DAS (W5), weed free check (W6) and weedy check (W7). The experimental field was infested with different types of grasses viz., *Panicum repens*, *Leersia hexandra* and *Eragrostis unioloides*, sedges viz., *Cyperus rotundus* L., *Fimbristylis littoralis*, and broad leaved weeds viz., *Ageratum conyzoides*, *Alternanthera philoxeroides*, *Ludwigia decurrens* and *Acmella ciliata*. The method of sowing brought significant influences on weed density and weed dry weight in all the growth stages. The wet seeding proved statistically superior in regards to growth attributes i.e. number of tillers/m<sup>2</sup> and plant height at all growth stages compared to dry seeding. Similarly, wet seeding recorded significantly highest yield attributes i.e. number of panicles/m<sup>2</sup> (160.11), panicle length (26.32 cm), number of filled grains/panicle (118.83) of sali rice followed by dry seeding. The wet seeding also recorded significantly highest grain yield (31.27 q/ha) and straw yield (49.04 q/ha). Higher uptake of nitrogen, phosphorus and potassium in grain, straw and total uptake by sali rice and lower uptake by weeds were recorded in wet seeding. Among the different weed management practices, weed free

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plot recorded the lowest weed density and weed dry matter, highest weed control efficiency and highest weed control index at all growth stages as well as recorded the highest growth characters, yield attributes, grain yield and straw yield. Results indicated that apart from the weed free plot, pre-emergence herbicide application of pretilachlor @ 0.75 kg a.i./ha + one hand weeding at 40 DAS and pre-emergence herbicide application of pyrazosulfuron ethyl @ 20 g a.i./ha + one hand weeding at 40 DAS shown the lowest weed density, dry weight, highest WCI, highest WCE at 45, 60 DAS and at harvest stage as well as it recorded the highest yield attributes, grain yield and straw yield. At 30 and 60 DAS, lowest uptake of nutrients by weeds were recorded in weed free check followed by two hand weedings at 20 & 40 DAS. At harvest, lowest uptake by weeds were recorded in weed free check followed by pre-emergence herbicide application of pretilachlor @ 0.75 kg a.i./ha + one hand weeding at 40 DAS. Significantly higher uptake of nitrogen, phosphorus and potassium in grain, straw and total uptake by Sali rice was recorded in weed free check followed by pre-emergence herbicide application of pretilachlor @ 0.75 kg a.i./ha + one hand weeding at 40 DAS and pre-emergence herbicide application of pyrazosulfuron ethyl @ 20 g a.i./ha + one hand weeding at 40 DAS. The treatment combination of wet seeding (M2) combined with the weed free check recorded the highest grain yield (41.33 q/ha) and straw yield (59.33 q/ha) and it was statistically at par with the treatment combination of wet seeding along with preemergence herbicide application of pretilachlor @ 0.75 kg a.i./ha + one hand weeding at 40 DAS. An economic analysis showed that treatment combination of wet seeding combined with pre-emergence herbicide application of pretilachlor @ 0.75 kg a.i./ha + one hand weeding at 40 DAS (M2W3) recorded the highest net return (Rs. 63,089/ha) and benefit cost ratio (1.76).



## **Organic weed management in aromatic rice under two different systems of establishment**

*Yerradoddi Sindhu Sree*

A field experiment on organic weed management in aromatic rice under two different systems of establishment was carried out during sali season of 2019-2020 in organic block of Instructional-cum-Research farm of Assam Agricultural University, Jorhat to study the effects of different organic weed management practices on weed dynamics, growth and yield of aromatic rice (cv Kola Joha). The experiment was laid out in split-plot design with three replications. The treatment consisted of two systems of establishment viz., transplanting and direct seeded (wet seeding) method in the main plot and five organic weed management practices viz., weedy check, hand weeding at 20 and 40 DAT/DAS, weeding with rotary weeder at 20 and 40 DAT/DAS, weeding with cono weeder at 20 and 40 DAT/DAS and intercropping of dhaincha and incorporation at 40 DAT/DAS in the sub-plots. The soils of the experimental site was sandy loam in texture with pH 5.9, medium in organic carbon (0.58%), low in available N (242.5 kg ha<sup>-1</sup>), low in available P<sub>2</sub>O<sub>5</sub> (18.60 kg ha<sup>-1</sup>) and medium in available K<sub>2</sub>O (140.6 kg ha<sup>-1</sup>). Total rainfall received during the crop growth period was 1445.8 mm distributed in 63 rainy days. The experimental field was infested with different types of grasses viz., *Echinochloa crusgalli*, *Eragrostis japonica*, sedges viz., *Cyperus iria*, *Cyperus difformis* and broad leaved weeds viz., *Acmella paniculata*, *Hydrolea zeylanica*, *Ludwigia hyssopifolia*. The density and dry weight of weeds were found significantly lesser in transplanting method which resulted significantly lower N, P and K content and uptake by weeds as compared to direct seeded (wet seeding) rice. The growth parameters viz., plant height, number of leaves, plant dry matter per m<sup>2</sup> and yield attributing characters viz., number of tillers per m<sup>2</sup> (207), panicle length, panicle weight, number of filled grains per panicle, test weight as well as grain yield (18.17 q ha<sup>-1</sup>) and straw yield (30.12 q ha<sup>-1</sup>) were significantly higher under transplanting system as compared to direct seeded (wet seeding) rice. Different organic weed management practices significantly influenced the weed density and weed dry weight; N, P and K content and uptake by the weeds and rice crop as well as growth, yield attributes and yield of aromatic rice. Significantly lesser weed density, weed dry weight, N, P and K content and uptake by weeds were recorded with hand weeding at 20 and 40

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DAT/DAS. Nitrogen content in rice grain and straw was significantly highest with intercropping of dhaincha and incorporation at 40 DAT/DAS whereas P and K content; N, P and K uptake was found highest with hand weeding at 20 and 40 DAT/DAS. The significantly highest number of effective tillers per m<sup>2</sup> (231), grain yield (21.95 q ha<sup>-1</sup>) and straw yield (35.03 q ha<sup>-1</sup>) were recorded with hand weeding at 20 and 40 DAT/DAS. The interaction between organic weed management and systems of establishment was found significant in respect of weed density, dry matter, number of effective tillers per m<sup>2</sup>, nutrient content and uptake, grain yield and straw yield. The highest grain yield (27.53 q ha<sup>-1</sup>), straw yield (41.33 q ha<sup>-1</sup>) and net return (Rs.94,521.00 ha<sup>-1</sup>) was recorded with hand weeding at 20 and 40 DAT under transplanted method of establishment. However, due to comparatively lower cost of cultivation, the highest B: C (2.61) ratio was obtained with intercropping of dhaincha and incorporation at 40 DAT under transplanted method of establishment with a grain yield (22.4 q ha<sup>-1</sup>).

## **Effects of Manganese on some rice genotypes in acid soil of Assam**

*Aisina Yomso*

Rice (*Oryza sativa* L.) is the staple food for about 50% of the world's population and particularly more important in an agricultural country like India. The extent of acid soils in Northeastern hill (NEH) region is about 21 million ha (Mha) including Assam (4.7 Mha) where the concentration of Mn is 2-20 ppm. Manganese, being one of the micronutrients plays vital role in physiology and biochemistry of crop plants modulating growth and development depending upon its concentration in plants. So, a pot experiment was carried out (January 2019-June 2019) to study the effects of Mn (0, 10, 20, 30 ppm Mn in the form of MnSO<sub>4</sub>.H<sub>2</sub>O as foliar spray (misting) at vegetative stage i.e.70 days after sowing) on physio-biochemical parameters, and thereby to evaluate the Manganese use efficiency (MnUE) of ten rice genotypes (Kanaklata, Mulagabharu, Kapilee, Disang, Kolong, Joymoti, Jyoti Prasad, Luit, Lachit and Chilarai) cultivated in Assam. The relationships amongst the yield and yield attributing parameters of the rice genotypes under Mn treatments were also studied.

Results obtained during the investigation revealed the variations in responses of rice crop genotypes to doses of Mn in terms of physiological, biochemical and yield parameters of the crop. The lower dose of Mn (10ppm) as MnSO<sub>4</sub>.H<sub>2</sub>O increased significantly the SLW (4.72-11.12%), plant height (3.56-35.16%), shoot biomass (7.77-21.64%), tiller numbers (2.89-22.67%), total chlorophyll contents in leaf tissues (10.29-27.17%), NR activity (13.62-35.39%), carbohydrate contents (3.72-9.04%), cell membrane stability (29.70-37.06%), panicle length (16.29-37.46%), panicle weight (10.54-19.50%), panicle number per plant (4.54-13.63%), number of seeds per panicle (18.38-36.48%), test weight (7.21-29.15%), high density (HD) grains (5.59-30.45%), economic yield (14.40-28.03%), biological yield (32.58-47.70%), harvest index (3.2-7.90%), lower intercellular Mn (16.66–75.67%), lower exchangeable Mn (13.91-56.98%), and MnUE (0.021-0.160%) was increased upto 20ppm Mn as MnSO<sub>4</sub>.H<sub>2</sub>O. However, the highest dose of Mn (30ppm) as MnSO<sub>4</sub>.H<sub>2</sub>O affected adversely all the physiological attributes in the study. Among the ten genotypes, Kanaklata performed the best followed by Chilarai in the experiment. The physiological characteristics

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supporting the holistic performance of the variety Kanaklata are higher SLW (99.92 cm), Shoot biomass (29.03 g), tiller numbers (5.95 nos.), total chlorophyll (1.92 mg/gf.w.), carbohydrate content (9.05mg/gd.w.), higher cell membrane stability (29.804%), lower intercellular ions (17.85 ppm), lower exchangeable ions (13.91 ppm), 7 panicle weight (5.99 g), panicle number per plant (6.87 nos.), number of seeds per panicle (70.67 nos.), economic yield (13.85 g/plant), biological yield (46.09 g/plant) and harvest index (47.40%).

The correlation studies revealed that seed yield in Kanaklata was correlated positively with panicle length (0.999\*\*), panicle weight (1.000\*\*), panicle number per plant (0.990\*\*), seed per panicle (0.972\*), test weight (0.992\*\*), HD grains (0.966\*\*) and HI 0.981\*\*). In case of Manganese treatments, 10ppm Mn as MnSO<sub>4</sub>H<sub>2</sub>O was correlated positively with panicle weight (0.823\*\*), panicle number per plant (0.975\*\*), HD grains (0.704\*), HI (0.951\*\*) and MnUE (0.719\*). In case of 20ppm Mn as MnSO<sub>4</sub>H<sub>2</sub>O was correlated positively with panicle number per plant (0.959\*\*), HI (0.928\*\*), and MnUE (0.786\*\*). However for the treatment 30ppm Mn (as MnSO<sub>4</sub>H<sub>2</sub>O), economic yield was correlated positively with panicle number per plant (0.913\*\*), harvest index (0.902\*\*), and manganese use efficiency (0.866\*\*) only. It is concluded that yield and yield attributes including MnUE are influenced by Mn upto a certain limit (i.e.20ppm Mn) in rice crop. In the study, the rice genotype Kanaklata was found the best in terms of all physiological and biochemical attributes including MnUE, which was dose responsive to Mn misted on foliage at maximum tillering to heading stage (70 days after sowing).

# **Regulation of vase life and quality of gerbera (*Gerbera jamesonii*) by postharvest chemical application**

*Anirban Saikia*

Scientific approaches in the field of modern floriculture have been progressed commercially due to intense efforts made by various researchers. The increasing business potential of this field inspired many government and non-government organizations to review the prospects of Indian floriculture both in domestic and export market. Production and subsequent marketing of cut flowers are the most important aspects associated with this commercial approach. Gerbera (*Gerbera jamesonii*) is an important commercial cut flower grown throughout the world. Floral characteristics of this flower, such as colour, floral diameter, stem length, and vigour make it a very important commercially potential cut flower. However, very short vase life of gerbera is the major constraint and therefore the improvement of vase life is an urgent research need.

To address the problem, an investigation was carried out in the department of Crop Physiology, AAU, Jorhat-13 to evaluate the effects of different pulsing treatments and holding solutions on vase life of gerbera. In one experiment, after harvest gerbera was pulsed with different concentrations of salicylic acid (50,100,150 ppm), benzyl adenine (50,100,150 ppm) and nano-silver (5,10,15 ppm) for 1 hour. It was observed that moisture content, fresh and dry weights, amount of water uptake, transpirational water loss, scape bending, chlorophyll content, carbohydrate content and vase life were affected positively by the pulsing treatments. Among all the pulsing treatments, 10 ppm nano-silver was found to be the best in enhancing the vase life and quality of the cut flower. In another experiment, cut gerbera flowers were treated with different concentrations of salicylic acid (50, 100, 150 ppm), benzyl adenine (50, 100, 150 ppm) combined with 10 ppm nano-silver as holding solutions. Recorded data revealed that different physiological characters such as moisture content, fresh and dry weights, amount of water uptake, transpirational water loss, scape bending, chlorophyll content, carbohydrate content and vase life of the cut flower were altered positively by the

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holding solutions. Among the different treatments, salicylic acid 100 ppm+10 ppm NS+4% sucrose exhibited the longest vase life (13.30 days) of cut gerbera flower, which was found to be the best. Results of the two experiments confirmed that holding treatments had more positive effects compared to the pulsing agents with respect to quality and vase life.

## **Effect of jatropha leaf extract and seed oil on okra (*Abelmoschus esculentus* L.)**

*Jeffrey Malsawmzuala*

*Jatropha curcas* is a woody shrub that is projected to be one of the best sources for bio-diesel as it can be grown in diverse climatic conditions. However, it is also known to exhibit allelopathic and phytotoxic effects to nearby plants. The seed oil is known to be a potent source for biopesticide formulations due to its toxicity but its possible allelopathic effects on the recipient crop has not been properly explored. A series of experiments were conducted during July 2018 to October 2018 to test the possible allelopathic effects of jatropha leaf extract and seed oil on okra (*Abelmoschus esculentus* L.). In two separate experiments, aqueous extracts of jatropha leaf at 2.5%, 5.0%, 10.0% and 15.0% (W/V) concentrations and jatropha seed oil at 1.0%, 2.5%, 5.0%, 7.5% and 10.0% (V/V) concentrations were bio-assayed against germination and seedling growth of okra. In both the cases, germination percentage, germination index, root and shoot length, fresh and dry weights of root and shoot and vigour index were found to be significantly reduced by both the leaf extract and seed oil. Seed oil exhibited higher inhibitory effects than aqueous leaf extract. Two other separate pot culture experiments were conducted with both aqueous leaf extract and seed oil of jatropha at the same range of concentrations as employed in the above mentioned experiments to evaluate growth and yield of okra. In both the cases, significant reduction in plant height, leaf number, leaf area, root volume, dry weights of root and shoot, total leaf chlorophyll content, fresh and dry weights of pods were recorded. Different growth parameters of the crop were found to respond differentially to aqueous leaf extract and seed oil of jatropha. Higher reduction of pod fresh weight (yield) was recorded in aqueous leaf extract (25.37% inhibition over control) in comparison to seed oil (12.18% inhibition over control) at their highest applied concentrations. All inhibitory effects of both aqueous leaf extract and seed oil were found to be concentration dependent. In conclusion, seed oil was found to be more inhibitory in laboratory bioassay while final yield of okra was reduced more by the aqueous leaf extract of jatropha.

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## **Phenotyping of some cultivated and wild banana germplasm of NE India under rainfed and irrigated conditions of Assam**

*Nishita Pathak*

Banana (*Musa* spp.) is a tropical fruit crop which belongs to the family 'Musaceae'. Banana is a mesophytic plant and requires heavy feeding of nutrients and soil moisture for good growth and development. The major effect of moisture shortage in banana is that it reduces the photosynthetic capacity of the banana plants as the crop sensitivity is reflected by reduced greenness of foliage. Under Assam situation, highest moisture deficit occurs during November to January. A field experiment was conducted at the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during the year 2019-2020. Fifteen germplasm of banana viz., Athiya, Savari, Jahaji, Digjowa, Ludum, Assamese Malbhog, Naga Malbhog, GobinTulchi, Banria, Agnisagar, Balha Kual, Nagaland-1, Nagaland-2, Arunachal Pradesh-1 and Arunachal Pradesh-2 were taken to assess the extent of variation in phenotypic characters and contribution of phenotypic traits on yield performance under rainfed and irrigated conditions. Various parameters were recorded at 7th, 8th and 9th months after planting. Moisture stress progressively reduced the values of relative leaf water content, chlorophyll content (a, b, total), specific leaf weight leaf area, total leaf production, functional leaves, stomatal conductance, root biomass, pseudostem height, pseudostem girth, fruit length, fruit circumference, weight of 2nd hand, number of hands per bunch, number of fingers per hand, weight of finger, volume of finger, shelf life, duration of fruit filling, pulp-peel ratio, bunch weight and fruit yield while the contents of proline in leaf tissue and lipid peroxidation increased under moisture deficit. The individual germplasm under irrigated condition showed better results as compared to that of rainfed condition. In our study, under both rainfed and irrigated conditions the germplasm Jahaji (36.24 kg/ha; 38.47 kg/ha) was found to be highest yielder followed by Athiya (34.15 kg/ha; 35.66 kg/ha) and Digjowa (31.78 kg/ha; 33.21 kg/ha) whereas the germplasm Arunachal Pradesh-1 (24.99 kg/ha; 26.54 kg/ha) was found to be the lowest performer in this regard. As compared to irrigated condition, under rainfed

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condition the reduction in values of various parameters in the germplasm Jahaji (G3) which was found to be superior in our study were observed *viz.*, RLWC (6.48 per cent), Chlorophyll 'a' (3.92 per cent), Chlorophyll 'b' (7.64 per cent), total chlorophyll (11.68 per cent), total leaf production (8.08 per cent), functional leaves (17.04 per cent), leaf area (10.70 per cent), root biomass (2.28 per cent), fruit length (8.10 per cent), fruit circumference (16.73 per cent), weight of second hand (27.62 per cent), number of hands per bunch (14.63 per cent), number of fingers per hand (10.13 per cent), volume of finger (36.24 per cent), weight of finger (1.43 per cent) and fruit yield (5.80 per cent). In the case of the lowest producer i.e. lowest yielder Arunachal Pradesh-1 (G14), the corresponding reductions under rainfed condition were 7.49 per cent RLWC, 7.59 per cent Chlorophyll 'a', 15.65 per cent Chlorophyll 'b', 18.89 per cent total chlorophyll, 5.47 per cent total leaf production, 20.84 per cent functional leaves, 15.66 per cent leaf area, 9.26 per cent root biomass, 29.74 per cent fruit length, 15.34 per cent fruit circumference, 58.36 per cent weight of second hand, 28.57 per cent number of hands per bunch, 10.03 per cent number of fingers per hand, 41.54 per cent volume of finger, 2.95 per cent weight of finger and 5.84 per cent fruit yield. From the correlation study, it was found that the banana yield was positively and significantly correlated with the parameters *viz.*, number of fingers per hand ( $r = 0.9898$ ), weight of 2nd hand ( $r = 0.9847$ ), weight of finger ( $r = 0.9834$ ), total leaf production ( $r = 0.9780$ ), fruit length ( $r = 0.9774$ ) and leaf area ( $r = 0.9470$ ).

In our study, the germplasm Jahaji (G3) which was found to be superior from yield point of view both under rainfed and irrigated conditions also recorded higher values for these parameters *viz.*, RLWC, proline content, chlorophyll 'a', chlorophyll 'b', total leaf chlorophyll, total leaf production, number of functional leaves per plant, leaf area, root biomass, fruit length, fruit circumference, weight of second hand, number of hands per bunch, number of fingers per hand, volume of finger, weight of finger, bunch weight and fruit yield.

# **Physiological performance of lentil genotypes under late sown condition in rice fallow as influenced by rhizobacteria (*Pseudomonas fluorescens*)**

*Reshme Moirengjam*

A field experiment of lentil grown under moisture stress was carried out in *rabi* season of 2018-19 in Instructional Cum Research (ICR) farm premises and Department of Crop Physiology of Assam Agricultural University. The main objectives of the study were to evaluate the performance of the lentil genotypes under late sown (delayed by 20 days beyond recommended date of sowing) condition as compared to the timely (recommended date) sown condition and to assess the influence of applied Rhizobacterium, *Pseudomonas fluorescens* on the physiological performance of these genotypes under the two situations, timely sown and late sown condition. The eight lentil genotypes were KLS 218, HUL 57, PL 406, DPL 62, DPL 15, Borpeta local, IPL 316 and IPL 81 under timely sown and late sown condition. These eight genotypes were grown in field condition under recommended sowing date (timely sowing) on 15th November 2018 and late sowing on 5th December 2018 treated with liquid culture of rhizobacterium (*Pseudomonas fluorescens*) collected from Department of Plant Pathology, Jorhat that had a uniform population of  $2 \times 10^9$  CFU/ml which was initially inoculated as seed treatment (2% of *Pseudomonas fluorescens*) followed by foliar spray at 30 DAS (2% of *Pseudomonas fluorescens*) under both timely sowing and late sowing condition; along with vermicompost and inorganic fertilizers supplied as per recommended for lentil.

During the initial crop growth stages under recommended date of sowing the soil moisture content was quite optimum (20.90% in mid-October to mid-November) but it gradually declined (16.07% in December and 14.36% in January) due to lack of rainfall which reduced the values of the overall physiological, biochemical and yield attributing traits of late sown lentil when compared to timely sown condition with as well as without the application of *Pseudomonas*.

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Promotive effect of the treatment with rhizobacteria *Pseudomonas fluorescens* (seed inoculations as well as foliar spray) could be seen on the physiological performance of the lentil genotypes under both timely and late sown condition.

Plants under late sown condition showed reduction in the values of the parameters like plant height, above ground biomass, root biomass, whole plant biomass, root nodule count, total chlorophyll content, membrane stability index, *in-vivo* nitrate reductase activity, number of pods per plant, number of seeds per pod, test weight, seed yield, stover yield and harvest index whereas an increment in parameters like root volume, root surface area, lipid peroxidation, super oxide dismutase activity were observed. When the soil moisture content depleted during the late sown phase, plants responded with an increase in root growth parameters like root volume, root surface area for the purpose of efficient moisture extraction from deeper soil layers in order to supply water for maintenance of cellular functioning, cellular turgidity, structural stability and supply of various minerals and assimilates to all parts of the plant.

The genotypes DPL 62 and DPL 15 showed higher values in terms of plant characteristics like plant height, above ground biomass, whole plant biomass, root nodule count, root volume, root surface area, total chlorophyll content, membrane stability index, *in-vivo* nitrate reductase activity, SOD activity, pods per plant, test weight and low lipid peroxidation which contributed in producing high seed yield, stover yield and harvest index.

From the yield analysis, under timely sown condition genotype DPL 62 showed the highest seed yield of 9.92q/ha under no *Pseudomonas* and 10.94q/ha in *Pseudomonas* treated condition. In case of late sown situation the seed yield was found to be lesser but DPL 62 showed the highest yield of 9.59q/ha under no *Pseudomonas* and 10.55q/ha in *Pseudomonas* treated condition. Likewise for the parameter harvest index in timely sown condition DPL 62 showed the highest value of 34.49% under no *Pseudomonas* and 36.20% under *Pseudomonas* treatment. In case of late sown condition there was a decline in the harvest index but genotype DPL 62 showed the highest harvest index of 34.30% under no *Pseudomonas* and 35.99% under *Pseudomonas* treatment.

Other genotypes like KLS 218, DPL 15 and HUL 57 also responded well with a high yield upon application of rhizobacteria (*Pseudomonas fluorescens*) treatment.

A positive and significant correlation between above ground biomass and seed yield ( $r = 0.198$  for timely sown and  $r = 0.226$  for late sown); total chlorophyll content and seed yield ( $r = 0.869$  for timely sown and  $r = 0.890$  for late sown); pod number and seed yield ( $r = 0.612$  for timely sown and  $r = 0.646$  for late sown); test weight and seed yield ( $r = 0.556$  for timely sown and  $r = 0.500$  for late sown) were contributory factors of yield production in lentil. The results of the present study revealed that soil moisture deficit during early vegetative stage arising out of non-receipt of rainfall as well as delayed date of sowing were found to have detrimental effects on growth of plants at all stages that led to reduction in seed yield by adversely affecting the physiological performance and harvest index however the inoculation of rhizobacteria (*Pseudomonas fluorescens*)

as seed and foliar spray helped in mitigating the negative effects faced by plants in late sowing as compared to timely sowing. Late sowing had resulted in 5.2% and 2% reduction on an average in seed yield and harvest index respectively when compared to timely sowing. The genotype DPL 62 showed a reduction of 3% only in seed yield and 0.65% reduction in harvest index in late sowing as compared to timely sowing. Under timely sown condition the genotype DPL 62 showed the highest benefit cost ratio (2.14 under no *Pseudomonas* and 2.03 under *Pseudomonas* treatment) and the lowest benefit cost ratio was observed in the genotype Borpeta local (1.28 under no *Pseudomonas* and 1.17 under *Pseudomonas* treatment) and IPL 81 (1.17 under *Pseudomonas* treatment). Similarly, in case of late sown condition genotype DPL 62 showed the highest benefit cost ratio (2.04 under no *Pseudomonas* and 1.93 under *Pseudomonas* treatment) and the lowest was observed in Borpeta local (1.20 under no *Pseudomonas* and 0.99 under *Pseudomonas* treatment).

Among the eight genotypes studied, genotype DPL 62 could maintain its performance under depleted soil moisture in late sown condition followed by DPL 15 and KLS 218.

# **Impact of high temperature and carbon dioxide on plant growth and beneficial rhizospheric microbes of rice**

*Supriya Sarma Rajkhowa*

The rise of CO<sub>2</sub> (600  $\mu\text{mol mol}^{-1}$  CO<sub>2</sub> by the middle of 21st century) and temperature (1.8 and 4.0 °C by the end of the present century) will effectively influence the productivity of crop plants. In the present investigation, the responses of local genotypes of rice were studied in Carbon dioxide Temperature Gradient Tunnel (CTGT), to simulate elevated CO<sub>2</sub> concentration and temperature. Similarly, response of beneficial rhizospheric microbes to elevated CO<sub>2</sub> and temperature were also studied. Six genotypes of rice were studied *viz.*, Inlongkiri, Dehangi, Banglami, Sokinglong, Maibee and Bash under field condition and CTGTs. In CTGTs interactive treatments of CO<sub>2</sub> and temperature was induced at range of 390ppm+2°C (CTGT-I), 600 ppm+4°C (CTGT-II), 750ppm+6°C (CTGT-III) and in field condition as ambient. The results revealed that CTGT-II had a greater impact on various morpho-physiological parameters whereas CTGT-III showed a declining trend in maximum physiological and yield attributing characters indicating the deleterious effect of high temperature and CO<sub>2</sub>. In CTGT-II some soil parameters *viz.*, electrical conductivity, soil organic carbon and rhizospheric root carbon rate were recorded to increase while soil pH and microbial biomass nitrogen significantly decreased from ambient to CTGT-III. The microbial population rate increases with increased concentrations of CO<sub>2</sub> and temperature. For this study, experiment was conducted before treatments were induced i.e. initial and after the treatments were applied as final. The activity of the microbes raises in the final stage than the initial indicating the population growth of the microbes. Moreover, beneficial microbes *Trichoderma* spp. and *Pseudomonas fluorescens* also got increased with increasing CO<sub>2</sub> and temperature.

The genotypes Inlongkiri, Banglami and Dehangi showed higher values in terms of physiological characteristics like leaf area, leaf area index, leaf area duration, leaf weight ratio, relative leaf water content, plant height, photosynthetic rate, stomatal conductance, root biomass, root volume, tiller numbers, panicle numbers, panicle

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length, grains per panicle, grain weight which contributed in producing high grain yield. These genotypes also showed higher values in terms of soil chemical characters such as soil pH, electrical conductivity, organic carbon, rhizospheric root carbon, microbial biomass carbon and nitrogen.

A positive and significant correlation between grain yield and soil microbial biomass carbon was observed in Inglongkiri, Dehangi, Banglami and Bash but negative correlation was observed in Sokinglong and Maibee. The correlation coefficient was also analyzed between yield and soil microbial biomass nitrogen. It was observed that Soil microbial biomass nitrogen of selected rice genotypes with interactive effects were found to be positively related with the yield production in rice.

## **Study on growth and yield of green gram (*Vigna radiata* L. Wilczek) under high level of CO<sub>2</sub>**

*Tarique Aziz*

An experiment was carried out in the stress physiology laboratory, Department of Crop Physiology of Assam agricultural University under Open Top Chamber during the *rabi* season of 2019 with six genotypes of green gram *viz.* SML1827, SML832, SML1831, PM1533, Pusa M-19-31, Pant M-5. Three different levels of CO<sub>2</sub> concentration of 390ppm, 600ppm and 750ppm along with an ambient were maintained to assess the response of growth, physiological and yield parameters of green gram. The results obtained for this experiment showed that CO<sub>2</sub> has a greater effect on crop growth and development process. However some genotypes response differently at various level of CO<sub>2</sub>. Results indicated that the increase in CO<sub>2</sub> concentration up to 600ppm caused progressive increase in some growth parameters *viz.* leaf area, leaf area index, leaf area duration, plant height, number of branches per plant, length of pod, number of effective root nodules and total biomass of plant which ultimately linked with the increase of yield, however at 750 ppm opposite trend was recorded and most of these parameters were reduced. Similar trend was also found in case of physiological parameters like photosynthesis, internal CO<sub>2</sub> and stomatal conductance. But chlorophyll content, nitrate reductase activity and leaf nitrogen was significantly decrease due to higher level of CO<sub>2</sub> but reduction of these parameters were less in genotype Pant M-5 under 600 ppm of CO<sub>2</sub>. Highest reduction of these parameters were recorded in SML 1827 under 750 ppm of CO<sub>2</sub>. All yield and yield attributing character *viz.* number of pods per plant, number of seeds per pod, length of pod, seed yield per plant, thousand seed weight were significantly increased under elevated levels of CO<sub>2</sub> (600 ppm ). All these parameters were recorded higher in the genotype Pant M 5, followed by, Pusa M-19-31 under the treatment 600 ppm where lowest was recorded in SML 1827 in treatment 750 ppm CO<sub>2</sub>. Highest harvest index was recorded in Pant M-5 under 600 ppm CO<sub>2</sub> and the lowest was recorded in genotype PM 1533 under 750ppm. From the above study it can be concluded that, the genotype Pant M-5 and Pusa M-19-31 were found to be the high yielder whereas genotype SML 1827 showed lowest yield. These two responsive genotypes *viz.* (Pant M-5 and Pusa M-19-31 invariably maintained good

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plant biomass due to higher photosynthetic rate, nitrate reductase activity and chlorophyll stability index under high level of CO<sub>2</sub>. These two genotypes (Pant M-5 and Pusa M-19-31) were promising lines within the six genotypes under the varying level of CO<sub>2</sub>. These genotypes may be advocated for breeding and seed production programme in near future under changing climatic condition.



## **Studies on predator-prey and host-parasitoid relationship involving sucking pests and it's entomophages in mulberry ecosystem**

*Arindam Khanikar*

Studies on sucking pests and their natural enemies in mulberry crop were carried out during 2018-2020 at Assam Agricultural University, Jorhat. Four species of sucking pests viz., *Paracoccus marginatus*, *Maconellicoccus hirsutus*, *Pseudodendrothrips mori* and *Aleurodicus dispersus* were prevalent in the mulberry plantation. Among the four species of sucking pests the most abundant was *Paracoccus marginatus*. Three species of coccinellid predators viz., *Coccinella septempunctata*, *Coccinella transversalis* and *Micraspis discolor*, one species of lepidopteran predator viz., *Spalgis epius* were found associated with *Paracoccus marginatus*. Among these natural enemies *Spalgis epius* was relatively most abundant. The appearance and peak activity of the three coccinellids predators *Coccinella septempunctata*, *Coccinella transversalis*, *Micraspis discolor* and one lepidopteran predator *Spalgis epius* were synchronized with that of *Paracoccus marginatus*. The feeding potential of the first instar larvae of the two coccinellids predators *Coccinella transversalis* and *Coccinella septempunctata* were less voracious than the latter instars. The voracity increases in the succeeding instars. The first instar larvae of *Coccinella transversalis* consumed an average of 3.40 no of *Paracoccus marginatus* adult in 24 hours. An adult female of *Coccinella transversalis* consumed an average of 7.04 no of *Paracoccus marginatus* adult in 24 hours. Likewise the fourth instar larvae of *C. septempunctata* consumed an average of 5.10 no of prey in 24 hours. The first and fourth instar of *S.epius* larvae consumed an average of 3.74 and 6.00 no of adult stage of *Paracoccus marginatus* in 24 hours. Studies on functional response revealed the feeding potential of both the predators increase with the increased prey density and showed a positive density dependent pattern of prey consumption. The prey density showed significantly strong relationship with the feeding potential of I instar ( $r=0.98, 0.98$ ), II instar ( $r=0.98, .0.98$ ) III instar ( $r=0.99, 0.98$ ), IV instar ( $r= 0.99.0.99$ ), Adult female ( $r=0.99, 0.99$ ) and Adult male ( $r=0.99, 0.99$ ) of *C. transversalis* and *C. septempunctata* respectively. All the

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developmental stages of the *C. transversalis* and *C. septempunctata* exhibited Holling's Type III functional response which is characterised by the typical sigmoid response curve.

## **Efficacy of certain newer insecticides against major insect pests of okra, *Abelmoschus esculentus* (L.) Moench**

*Arpita Das*

Investigation on efficacy of certain newer insecticides against major insect pests of okra, *Abelmoschus esculentus* (L.) Moench was carried out in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during Kharif, 2019. The infestations of aphid was recorded in last week of June (26th SW) with a population of 1.98 aphids/leaf and it was continued to the last week of September (38th SW) with a population of 3.05/leaf and reached a peak population of 23.79/leaf in the fourth week of August (34th SW). The incidence of jassid was observed on young plants from last week of June (26th Standard week) with 2.33/leaf and attained a peak of 23.7/leaf during fourth week of August (34th Standard week). The incidence of whitefly was recorded for the first time as early as third week of June (25th SW) and the infestation of the insect attained a peak population of 10.89/leaf in third week of August (33rd SW). The population of shoot and fruit borer were first observed in fourth week of July (30th SW).

Correlation coefficient between different weather parameters and population of major insect pests revealed that, the minimum and maximum temperature showed positive correlation ( $r = 0.490$ ,  $r = 0.356$ ) whereas rainfall ( $r = 0.43$ ) and morning and evening relative humidity ( $r = -0.067$ ,  $r = -0.396$ ) showed negative impact with aphid population. Similarly, the minimum and maximum temperature showed positive correlation ( $r = 0.478$ ) ( $r = 0.353$ ) with leafhopper population but the rainfall was found negatively correlated and had a non-significant effect in case of leafhopper. The morning and evening relative humidity ( $r = -0.008$ ,  $r = -0.350$ ) showed negative correlation with leafhopper population. The minimum temperature showed positive but non-significant correlation ( $r = 0.389$ ) with whitefly whereas, rainfall had a negative ( $r = -0.282$ ) with non-significant correlation with the pest. The evening relative humidity ( $-0.389$ ) and rainfall ( $r = -0.198$ ) showed negative correlation and indicated a non-significant effect with shoot and fruit borer. The minimum temperature ( $r = 0.25$ ) and

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rainfall ( $r=-0.34$ ) was found to be non significant effect with coccinellids. All the treatments gave effective control of insect pests of okra and increased the crop yield compared to the untreated control.

As regards to the insecticides against sucking pests of okra, acetamiprid @ 15 g a.i/ha and thiamethoxam at 25 g a.i/ha was graded as the most effective treatments followed by lambda-cyhalothrin 5%EC @20 g a.i/ha. For effective management of sucking pests whereas profenofos 50% EC @ 600 g a.i/ha and emamectin benzoate @ 10 g a.i/ha proved to be effective against shoot and fruit borer of okra. The treatment acetamiprid gave the highest cost benefit ratio of 1:2.9 with a yield of 40.76 q/ha followed by 1:2.8 in thiamethoxam with maximum yield of 41.2 q/ha.

## **Bioassay of some plant extracts against banana leaf and fruit scarring beetle (*Nodostoma subcostatum* Jacoby, Coleoptera: Chrysomelidae)**

*Baishali Boruah*

Laboratory experiments were conducted in the Department of Entomology, Assam Agricultural University, Jorhat during 2018-20 to evaluate the efficacy of some aqueous and solvent plant extracts against banana leaf and fruit scarring beetle (*Nodostoma subcostatum*, Jacoby Coleoptera: Chrysomelidae) under laboratory condition. The results revealed that the chloroform plant extracts were found to be superior in terms of adult mortality of *N. subcostatum* as compared to aqueous plant extracts. The chloroform plant extract of *Polygonum hydropiper* L. was found having more insecticidal properties recording the highest of 90.00% mortality of adult *N. subcostatum* at 10.00% concentration at 72 hours after treatment (HAT). While, aqueous plant extract of *P. hydropiper* was found to be having insecticidal properties recording the highest of 83.33% of adult mortality of *N. subcostatum* at 10.00% concentration at 72 hours after treatment (HAT).

Among, all the aqueous plant extracts, *Polygonum hydropiper* L. was found to be most effective against *N. subcostatum* followed by *Terminalia chebula* Retz., *Melia azedarach* L. and *Carica papaya* L. and the lowest mortality was recorded in *Melastoma malabathricum* L. In case of chloroform plant extract, *P. hydropiper* was found to be most effective against *N. subcostatum* followed by *T. chebula*, *M. azedarach* and *C. papaya* and the lowest mortality was recorded in *M. malabathricum*. The order of toxicity with respect to LC50 value of aqueous plant extracts was *P. hydropiper* > *T. chebula* > *M. azedarach* > *C. papaya* > *M. malabathricum*. The order of toxicity with respect to chloroform extracts was *P. hydropiper* > *T. chebula* > *M. azedarach* > *C. papaya* > *M. malabathricum*.

Based on the data on screening of plant extracts for their efficacy against *N. subcostatum*, plant extract of *P. hydropiper* (chloroform) was found to be the most effective with the lowest LC50 value of 0.357% and *M. malabathricum* (aqueous) was found to be least effective with the highest LC50 value of 10.253%.

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Plant extracts can be used as an alternative to chemical pesticides. Thus, Present investigation exploring toxicity of five plant extracts paved a path in their possible incorporation and utilization in banana IPM programme.

## **Avifaunal diversity in Rice Agro ecosystem**

*Chiranjeeb Sonowal Borah*

The present study on avifaunal diversity of rice agro ecosystem was conducted in the Upper Brahmaputra Valley Zone (UBVZ) and North Bank Plain zone (NBPZ) of Assam in the year 2018-20. The various population indices like species richness, species diversity, species density, relative abundance and population density was calculated through line transect method in all the locations of the zone comprising all the crop stages. The average population of predatory and depredatory birds among all the six locations was found to be 72.8 % and 27.1 % respectively. Among all the six locations, the highest population was recorded from Baligaon, NBPZ with 1998 recorded individuals while the lowest population was recorded from ICR Farm AAU, UBVZ with 1210 individuals. In case of cropping stages, the highest population was recorded from harvesting stage while the lowest was recorded from sowing stage.

The species richness of 15 species was found to be highest in the harvesting stages and lowest of 8 species in the sowing stages among all the recorded locations. Similarly, the highest species diversity of 2.272 was recorded from harvesting stage in Batghoria while the lowest of 1.736 was recorded from ICR Farm in sowing stage. In case of similarity index, the panicle initiation stage at Batghoria showed lowest similarity of 0.171 while the sowing stage at Baligaon showed the highest similarity of 0.306.

The highest number of individual recorded species belonged to the Ardeidae family with 427 individuals which were mainly dominated by Cattle Egret, Little Egret and Pond Heron species with while the lowest individuals were recorded from Oriolidae family comprising the Black Hooded Oriole with 10 individuals. The average number of bird families recorded from each of the six locations was 18 families. The percentage of predatory birds was found to be highest in ICR Farm with 76% population under UBVZ and lowest in Baligaon under NBPZ with 69 % population. Similarly, the relative abundance of 10.06 was found to be highest in the sowing stages and lowest of 7.09 in the harvesting stages across all the locations.

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The estimation of damage caused by depredatory birds of rice was carried out in Boro and Sali rice at Upper Temera, UBVZ and Batghoria, NBPZ respectively. The damage estimation was carried out by following the quadrature method of damage estimation and it was found that the grain yield loss was higher in sali rice with 27.4 % loss as compared to Boro rice with 21.58 %.The major damage was caused by Baya Weaver and Munia in both the cropping seasons. The weight loss in both the seasons was also prominent and sali rice showed more weight loss as compared to the boro rice. More damage was recorded in the sali rice at grain filling stage as compared to the boro rice at harvesting stage.



## **Evaluation of Two Native Entomopathogenic Nematodes against Termite (*Odontotermes obesus*) and Cutworm (*Agrotis ipsilon*)**

*K. Sindhura Bhairavi*

Laboratory experiments were carried out in the Soil Arthropod Pests Laboratory, Department of Entomology, Assam Agricultural University (AAU), Jorhat during 2018-20 to evaluate the infectivity of two native Entomopathogenic Nematodes (EPNs), *Heterorhabditis bacteriophora* and *Steinernema aciari* against termite, *Odontotermes obesus* and potato cutworm, *Agrotis ipsilon*. Different concentrations of Infective Juveniles (IJs) of both the EPN species were tested along with untreated control. Both *O. obesus* workers and *A. ipsilon* larvae were found susceptible to the two native EPN species at different concentrations and time intervals.

Experimental results indicated that both *H. bacteriophora* and *S. aciari* were able to cause mortality at 24 hours in case of the workers of *O. obesus*. At 24 hours, *H. bacteriophora* induced 10, 30 and 40 per cent mortality at inoculation rates of 200, 250 and 300 IJs/termite respectively whereas *S. aciari* caused 10 and 30 per cent mortality at inoculation rates of 250 and 300 IJs/termite respectively. However, both the EPN species were able to register at least 50 per cent mortality at 48 hours at inoculation rates of 150 and 200 IJs/termite in case of *H. bacteriophora* whereas *S. aciari* exhibited 60 per cent mortality at 250 IJs/termite. Complete mortality of the workers was achieved by *H. bacteriophora* at an inoculation rate of 300 IJs/termite at 72 hours and by *S. aciari* at inoculation rates of 250 and 300 IJs/termite at 96 hours. The mortality of the workers seems to be increasing with an increase in concentration and time of exposure and the LD50 and LT50 values of both the EPN species showed variable differences. In case of *H. bacteriophora*, the highest and lowest LD50 values were 693.194 and 13.054 IJs/termite at 24 and 96 hours respectively. The highest LT50 value was 72.817 hours at 10 IJs/termite while the lowest value was 26.639 hours at 300 IJs/termite. With respect to *S. aciari*, the highest LD50 obtained was 2997.000 IJs/termite at 24 hours and the lowest value was 42.040 IJs/termite at 96 hours. The highest and lowest LT50 values for *S. aciari* were 99.616 and 31.761 hours at 10 and 300 IJs/termite respectively. Based on

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the mortality rates observed as well as considering the lower values of LD50 and LT50, *H. bacteriophora* was found to be more virulent against the workers of *O. obesus* than *S. aciari*.

While studying the infectivity of both the EPN species against *A. ipsilon*, it was recorded that none of them showed any mortality of larvae up to 48 hours and the 6

mortality was observed at 72 hours after exposure only. After 72 hours, *H. bacteriophora* recorded 10, 10, 20 and 30 per cent mortality at inoculation rates of 150, 200, 250 and 300 IJs/cutworm respectively. In case of *S. aciari*, mortality rates of 10, 20 and 20 per cent were observed at inoculation rates of 200, 250 and 300 IJs/cutworm respectively at 72 hours. However, after 96 hours, both the EPN species were able to surpass the 50 per cent mortality level. *H. bacteriophora* caused 60 per cent mortality at 250 IJs/cutworm whereas *S. aciari* showed 50 per cent mortality at inoculation rates of 250 and 300 IJs/cutworm. Complete mortality of the larvae was achieved by *H. bacteriophora* and *S. aciari* at an inoculation rate of 300 IJs/cutworm at 144 and 168 hours respectively. Comparatively lower LD50 values were registered in case of *H. bacteriophora* than *S. aciari*. The highest and lowest LD50 values of *H. bacteriophora* were 1314.790 and 35.711 IJs/cutworm at 72 and 168 hours respectively. As regards to *S. aciari*, the highest and lowest LD50 values were 2649.610 and 71.192 IJs/cutworm at 72 and 168 hours respectively. Similarly, the LT50 values of *S. aciari* were higher than *H. bacteriophora*. The highest LT50 value for *H. bacteriophora* was 156.655 hours at 10 IJs/cutworm while the lowest was 83.050 hours at 300 IJs/cutworm. The highest and lowest LT50 values of *S. aciari* were 173.144 and 97.921 hours at 10 and 300 IJs/cutworm respectively. Considering mortality rates as well LD50 and LT50 estimated, it can be inferred that *A. ipsilon* larvae were more vulnerable to *H. bacteriophora* than *S. aciari*.

## **Comparative biology of *Callosobruchus chinensis* (L.) under different colour cues**

*Komedy Chamua*

The high prevalence of storage pests is one of the principal causes of food insufficiency in India. For all those pests, food stores are excellent breeding grounds. Among the different storage pests, the genus *Callosobruchus* predominately infests the stored products. In recent years, the use of botanicals, biological control agents, irradiations and different physical control measures in storage are gaining importance over the chemical control because of their low residual toxicity, next to nil hazards to human health, bio-friendliness, less expensive nature and target specificity. Insects are extremely responsive to lights. Different aspects of light like photoperiod, frequency, wavelength, intensity etc. may have some influence on growth, metabolism, development and reproduction of the insect pests. Therefore, keeping above in view, the present investigation was carried out in the laboratory-II of AICRP on PHET under the Department of Agricultural Engineering, AAU, Jorhat-13, during the year 2018-2020 where efforts were made to find out the potency of physical means to study the biology of *C. chinensis* on different colour cues and thus examining the relative gradation of colour cues preference by *C. chinensis*.

During the investigation, it was observed that Green LED was found to be highly preferred for egg laying by pulse bruchid with the significantly highest numbers of eggs ( $93.60 \pm 0.83$  eggs/female and  $74.00 \pm 2.31$  eggs/female) and lowest on White ( $56.27 \pm 2.11$  eggs/female and  $36.00 \pm 1.16$  eggs/female) during both season I and season II respectively. Incubation period was maximum on UV ( $6.67 \pm 0.33$  days) and minimum on Green ( $4.30 \pm 0.12$  days) in season I while during season II, White ( $9.30 \pm 0.15$  days) recorded highest incubation period and lowest incubation days observed on Green ( $5.40 \pm 0.20$  days). In season I, the larval duration was prolonged on UV ( $21.47 \pm 0.30$  days) and hastened on Yellow ( $13.60 \pm 0.55$  days) and in season II, Blue ( $27.93 \pm 0.77$  days) recorded maximum larval duration and Green ( $20.53 \pm 0.42$  days) recorded minimum larval duration. The longer pupal period was recorded on Blue ( $8.57 \pm 0.26$  days and  $11.07 \pm 0.19$  days) and shorter pupal period was recorded on Yellow ( $5.00 \pm 0.15$  days and  $6.17 \pm 0.09$  days) in both season I and season II respectively. The

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adult emergence was maximum from Green ( $89.13 \pm 0.28\%$  and  $86.56 \pm 0.47\%$ ) and minimum from White ( $53.31 \pm 0.33\%$  and  $55.92 \pm 0.22\%$ ) in both season I and II respectively. The adults lived longer on Yellow (Male-  $11.87 \pm 0.62$  days, Female-  $12.53 \pm 0.62$  days) and shorter on White (Male-  $5.27 \pm 0.58$  days) and Blue 6 (Female-  $6.47 \pm 0.42$  days) during season I, while the longevity of adults during season II was longer on Yellow (Male-  $12.73 \pm 0.54$  days, Female-  $13.10 \pm 0.44$  days) and shorter on Blue (Male-  $6.13 \pm 0.03$  days, Female-  $6.70 \pm 0.25$  days). In both the seasons, females lived longer than the males. The average total life cycle in season I was maximum under UV ( $44.15 \pm 0.78$  days) and minimum under Green ( $33.76 \pm 0.70$  days) while during season II, it was maximum on White ( $53.73 \pm 0.25$  days) and minimum on Green ( $45.25 \pm 0.38$  days). It can be concluded from the present investigation that short wavelengths of lights like Blue, Ultraviolet and polychromatic light like White could be used for the management of *C. chinensis*. It was observed that exposure to short wavelengths of light significantly reduced fecundity, prolonged the duration of immature stages, decreased adult emergence and delayed the life span of both the sexes of *C. chinensis*. Based upon these findings, there is scope for formulating strategies for control/management measures of *C. chinensis*.

## **Application of Vastu Shastra for house design in Jorhat City**

*Khumukcham Jenita*

Vastu shastra is a traditional Hindu system of architecture which literally translates to "science of architecture." It is a science which deals with the management of cosmic energy in building and structures. The present study "Application of Vastu Shastra for house design in Jorhat City" was carried out with the objectives (1) To study the personal and demographic profile of the respondents, (2) To assess the knowledge level of respondents on Vastu Shastra for house design and (3) To study the application of principle of Vastu Shastra for house design. A multistage purposive cum random sampling method was adopted for the study. Out of 19 wards in Jorhat municipality area 5 wards were selected randomly and 120 numbers of household were selected by applying Probability Proportional to Size (PPS) method. People who constructed their own home were the respondents for the present research study. Both interview and observation methods were used to elicit the information. Questionnaire was used as a tool for collection of data. The study revealed that the respondents had knowledge score of 39.52 per cent was on kitchen which was followed by 31.25 per cent on dining room, 31.16 per cent on bedroom, 30.20 per cent on living room, 16.83 per cent on bathroom and 15.41 per cent for pooja ghar. Knowledge level of the respondents on Vastu shastra for house design was neither very good nor very poor. It was found that about 43.00 per cent of respondents had average knowledge whereas 37.00 per cent had poor knowledge and only 20.00 per cent respondents had good knowledge on orientation of rooms for house design. The findings of the study also revealed that application index i.e. 27.14 per cent was found on kitchen area which was followed by 19.50 per cent on bedroom, 13.54 per cent on dining room, 11.25 per cent on living room, 5.80 per cent on bathroom and 4.86 per cent on pooja ghar. It was also observed that almost 56.00 per cent respondents had poor application whereas 36.00 per cent had average application and only a very meagre per cent (8.00%) had good application of Vastu principles for their house design. Comparison of both knowledge and application index of the respondents in all areas of house that is pooja ghar, kitchen, bedroom, dining room, living room and bathroom knowledge index was higher than application index. Both knowledge index (39.52%) and application index (27.14%) of the respondents were maximum in kitchen area.

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## **Morphology of sensilla of lac insect, *Kerria chinensis* (Kerridae: Hemiptera)**

*Nang Himadri Chowsong*

The experiment on the study of sensilla present on different body parts of lac insect, *Kerria chinensis* (Hemiptera : Kerridae) along with their morphometric measurements was carried out at Department of Entomology, Assam Agricultural University, Jorhat during 2018-2020. The morphometric measurement of body parts along with the numbers and types of sensilla present on nymphs sampled at 15, 30, and 45 days after inoculation (DAI), along with male and female lac insect revealed a significant increase in size and numbers of sensilla over the time. The types and numbers of sensilla present on different body parts also found varied according to growth stages of lac insect. The antennae of nymphs were found to be 6 segmented, and measured to the highest of 291.76 $\mu$ m and 1.73 $\mu$ m in length and breadth, respectively at 45 DAI; as against 10 segmented antennae in male measuring 597.82 $\mu$ m in length and 2.13  $\mu$ m in breadth. The length and breadth of the five segmented legs of the nymph sampled at 45 DAI were found to be 382.58  $\mu$ m and 1.54 $\mu$ m in length and breadth, respectively, while it was recorded to be 697.52 $\mu$ m and 1.25  $\mu$ m in length and breadth, respectively in case of males. The body of the nymphs observed to be 12 segment (Length: 2409.57  $\mu$ m and breadth: 1485.21  $\mu$ m) at 45 DAI; while it was 10 segmented in male lac insect with a male copulatory appendage (2924.81  $\mu$ m in length and 1626.67 $\mu$ m in breadth). The female lac insect was found to be degenerated type with a bag-like body without a distinct head, thorax and abdomen and was measured to be 1,085.00  $\mu$ m in length and 859.93  $\mu$ m in breadth. Altogether, seven types of sensilla viz., sensilla trichodea 1 (ST1), sensillatrichodea 2 (ST2), sensilla trichodea 3 (ST3), sensilla basiconica (SB), sensilla flagellate (SF), sensilla chaetica (SCh), and sensilla coeloconica (SCo) were found present on antennae of nymphs of lac insect, but except sensilla flagellate (SF), other six types were found present on the antennal segment of the male insect. Moreover, six major types of sensilla viz., ST1, ST2, ST3, SB, SCh, and SCo were found on legs of nymphs and males of lac insect, but only four major types of sensilla viz., ST1, ST2, ST3, and SB were found on body segments of nymphs, male and female lac insect. On the nymphs of lac insect sampled at 45 DAI, the highest of

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2.40±0.25 Nos. of sensilla were present on the scape, as against 2.20±0.16 Nos. on the pedicel and 13.90±2.07 Nos. on the flagellum. The number of sensilla present on the male lac insect was found to be 2.60±0.23 Nos. on the scape, 5.50±0.51 Nos. on the pedicel and 66.62±3.96 Nos. on the flagellum. In the legs of the nymphs sampled at 45 DAI, as high as 2.98±0.20 Nos. of sensilla were found present on the coxa, while 1.90±0.13Nos. on the trochanter, 1.20±0.16 Nos. on the femur, 4.20±0.24Nos. on the tibia and 5.10±0.26 Nos. on the tarsus. The number of sensilla on the legs of male lac insect was found to be 9.00±0.83 Nos. on the coxa, 12.50±1.70 Nos. on the trochanter, 18.80±4.13 Nos. on the femur, 9.80±0.81 Nos. on the tibia and 7.30±0.27 Nos. on the tarsus. The nymphs sampled at 45 DAI were reported to bear the highest of 5.60±0.26 Nos. of sensilla on the 1st body segments, while 7.30±0.42 Nos. of sensilla was recorded on the 2nd body segment. But there were no any sensilla recorded to be present on the 3rd, 4th, and 5th body segment; while only 2.00±0.00 Nos. of sensilla were found present from 6th segment to 11th segment. Interestingly, a total of 2.50±0.26 Nos. of sensilla were found present on the 12th segment at 15 DAI, which was found absent on the nymphs observed at 30 and 45 DAI. In the case of male insect, 2.50±0.26 Nos. of sensilla were present only on the last body segment and 13.20±0.77 Nos. of sensilla were present on the penile style. While female insect found to bear 11.50±2.43 Nos. of sensilla only on the anal tubular opening only.

**Pests scenario of tea, *Camellia sinensis* (L.) O. Kuntze, and management of red spider mite, *Oligonychus coffeae* Nietner by newer acaricidal molecules**

*Parthiban. M*

The present investigation was carried out in the Experimental Tea Plantation, Department of Tea Husbandry and Technology, AAU, Jorhat as well as in the Acarology laboratory, Department of Entomology, AAU, Jorhat during March 2019 to February 2020 to record Pests scenario of tea and management of red spider mite *Oligonychus coffeae* Nietner by newer acaricidal molecules. Among the non- insect pest four mites species viz, red spider mite, scarlet mite, pink mite and yellow mite, occurrences were recorded in different periods of the year. The incidence of 33 insect species belonging to 7 orders and 27 families, were recorded Species abundance was observed as Lepidoptera (16 species) followed by Hemiptera (14 species), Orthoptera (2 species) and Diptera (1 species). Among the pest red spider mites, Tea mosquito bug, leafhopper complex and thrips were observed as important sucking pests, while leaf roller, tea tortrix and flush worm were observed as significant chewing pests. Among the leaf hoppers infestation two new rice leaf hopper species such as *Recilia dorsalis* (Zig Zag Leaf hoppers) and *Nephotettix virescens* (Green leafhopper blue biotype) and lepidopteran brush footed butterfly *Charaxes* spp. also newly recorded in Experimental tea plantation AAU. The incidence of maximum number of red spider mites was observed to be 54.78 per leaf during the 3rd week of Oct, the population trend continues up to December and reaches second maximum during 3rd week of December with 40.67 mites per leaf. No mites were recorded from the 2nd week of July to the first week of August, then the population trend started to build slowly from the 4th week of August. Correlation between weather parameters and incidence of red spider mite showed significantly positive correlation with morning relative humidity ( $r = 0.713$ ). Whereas the red spider mite population had a negative correlation with Maximum temperature ( $r = - 0.499$ ), Minimum temperature ( $r = -0.681$ ), Evening relative humidity ( $r = - 0.590$ ) and total rainfall ( $r = - 0.548$ ). The incidence of tea mosquito bug was maximum during

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**Major Adviser: Dr. Sahidur Rahman**



Nov – Dec with the highest population indices record of 70.00 infested shoots per bush, the second maximum population indices were recorded during the 4th week of Nov at the rate of 63.6 infested shoots per bush. Zero population indices were recorded during the 3rd week of July to 2nd week of August. The population indices in the rest of the months range from less than 10 infested shoots per bush. Correlation between weather parameters and population indices of tea mosquito bug showed population indices was significantly positive correlated with morning relative humidity ( $r = 0.531$ ). Whereas the tea mosquito bug population indices were negative correlation with Maximum temperature ( $r = -0.418$ ), Minimum temperature ( $r = -0.529$ ), Evening relative humidity ( $r = -0.318$ ) and total rainfall ( $-0.480$ ). Efficacy of newer acaricide against active stages of red spider mite during two rounds of spray showed the treatments T6 (Fenazaquin 20% EC 100 g *a.i.* ha<sup>-1</sup>), T7 (Rebufenpyrad 20% EC 200 g *a.i.* ha<sup>-1</sup>) recorded cent percent reduction in mite population and it was at par with T3 (Rebufenpyrad 20% EC 100 g *a.i.* ha<sup>-1</sup>), T5 (Fenpyroximate 5% EC @ 30 g *a.i.* ha<sup>-1</sup>) that recorded 0.04 and 0.77 mites per leaf respectively. Whereas T4 (Propargite 57% EC 612 150 g *a.i.* ha<sup>-1</sup>) recorded 3.23 mites per leaf. T1 (Rebufenpyrad 20% EC @ 50 g *a.i.* ha<sup>-1</sup>) recorded 8.70 mites per leaf, T2 (Rebufenpyrad 20% EC 75 g *a.i.* ha<sup>-1</sup>) recorded 2.59 mites per leaf indicting an increasing trend of mite population over the previous data counted. Efficacy newer acaricides against eggs of red spider mite during two rounds of spray showed the treatments T6, (Fenazaquin 20% EC @ 100 g *a.i.* ha<sup>-1</sup>) recorded 6.17 eggs per leaf and it was at par with T7, (Rebufenpyrad 20% EC @ 200 g *a.i.* ha<sup>-1</sup>), T5, (Fenpyroximate 5% EC @ 30 g *a.i.* ha<sup>-1</sup>) and T3, (Rebufenpyrad 20% EC @ 100 g *a.i.* ha<sup>-1</sup>) recorded 8.34, 9.00 and 15.83 eggs per leaf respectively. The least ovicidal activity was recorded in T1, (Rebufenpyrad 20% EC @ 50 g *a.i.* ha<sup>-1</sup>) and T4, (Propargite 57% EC @ 612 g *a.i.* ha<sup>-1</sup>) with 32.00 and 29.17 eggs per leaf. Effect of acaricides against the natural enemies of tea pests was recorded at different days after spray. Among the treatments T5 (Fenpyroximate 5% EC @ 30 g *a.i.* ha<sup>-1</sup>) and T6 (Fenazaquin 20% EC @ 100 g *a.i.* ha<sup>-1</sup>) recorded mortality against hymenopteran natural enemies. Whereas T4 (Propargite 57% EC @ 612 g *a.i.* ha<sup>-1</sup>) recorded mortality against grub of coccinellide beetle *Stethorus punctillum*. Effect of acaricides on predatory mites, *Amblyseius* sp evaluated under laboratory showed that among the treatments T5, (Fenpyroximate 5% EC @ 30 g *a.i.* ha<sup>-1</sup>), T6 (Fenazaquin 20% EC @ 100 g *a.i.* ha<sup>-1</sup>) and T7 (Rebufenpyrad 20% EC @ 200 g *a.i.* ha<sup>-1</sup>) recorded cent percent mortality. Whereas the least mortality was recorded in T1, (Rebufenpyrad 20% EC @ 50 g *a.i.* ha<sup>-1</sup>) with 6.67 predators per leaf.

## Botanicals for Tea Insect Pest Management

*Ritushree Mahanta*

The experiment on bioefficacy of *Annona squamosa* (L.) (Family: Annonaceae), *Adhatoda vasica* (L.) (Family: Acanthaceae), *Cascabela thevetia* (L.) Lippold (Family: Apocynaceae), *Datura stramonium* (L.) (Family: Solanaceae) and *Lawsonia inermis* (L.) (Family: Lythraceae) leaf extracts conducted at Department of Entomology, Assam Agricultural University, Jorhat during 2018-20 revealed a dose- and time-dependent mortality of red spider mite (RSM), *Oligonychus coffeae* Nietner (Tetranychidae: Acarina) and tea mosquito bug (TMB), *Helopeltis theivora* Waterhouse (Miridae: Hemiptera) attacking tea plantation. The leaves of the selected insecticidal plants were collected from the Jorhat district of Assam; which were later macerated and extracted with standard procedure in distilled water on weight/volume basis for preparation of desired concentrations through serial dilution method viz., 0.1%, 0.5%, 0.75%, 1.0%, 2.5%, 5.0%, 7.5%, 10.0%. Neem Seed Kernel Extract (NSKE) 0.15% EC 2.5 ml/litre of water as standard check along with a control (water) were also taken for toxicity comparison. The treatments were replicated thrice and the data on adult mortality were recorded at 6, 12, 24, 48 and 72 hours after treatment (HAT). Moreover, plant extracts at different concentrations were also tested for ovicidal activity against *O. coffeae*. Tea leaves were also tested for any change in biochemical properties of tea leaves after application of botanicals to control *H. theivora* and *O. coffeae* at Phytochemistry Laboratory, Department of Biochemistry & Agricultural Chemistry, AAU, Jorhat during 2018-20. Best three plant extracts showing lowest LC<sub>50</sub> values against the test insects were considered for biochemical investigation and data were recorded at 1, 3, 5 and 10 days after spraying (DAS) of botanicals with three replications.

The results on bioefficacy revealed the strong acaricidal properties of *D. stramonium* recording 90.00% mortality of *O. coffeae* adults, while *L. inermis* has been found to be having strong insecticidal properties against *H. theivora* adults recording 80.00% mortality at 72 hours after treatment (HAT). The water extract of *D. stramonium* had the highest ovicidal properties causing complete inhibition of hatching of *O. coffeae* eggs even upto 5.00% concentration as against 91.32% hatching in the control, which was followed by *A. vasica* recording 25.93% hatching at 5.00% concentration as compared to 93.03% hatching in the control.

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**Abstract of M.Sc. Thesis**

**Department : Entomology**

**Major Advisor : Dr. Surajit Kalita**

The order of toxicity of botanicals against *O. coffeae* in terms of LC<sub>50</sub> values was *D. stramonium* (0.270%)>*A. vasica* (1.979%) >*L. inermis* (2.085%) > *C. thevetia* (3.740%) > *A. squamosa* (3.942%); while the order of toxicity in case of *H. theivora* was found to be *L. inermis* (1.052%)>*D. stramonium* (2.228%) >*C. thevetia* (2.296%) >*A. vasica* (2.644%) >*A. squamosa* (4.534%).

The best three botanicals based on their LC<sub>50</sub> values viz., *Lawsonia inermis* (1.052%), *Datura stramonium* (2.228%) and *Cascabela thevetia* (2.296%) for *H. theivora* and for *O. coffeae* the botanicals viz., *Datura stramonium* (0.270%), *Adhatoda vasica* (1.979%) and *Lawsonia inermis* (2.085%) were tested for biochemical parameters including chlorophyll a & b, carotenoids, reducing sugar and polyphenols along with healthy leaf sample and found that the reducing sugar content in TMB and RSM infested tea leaves decreased upon application of *D. stramonium* leaf water extracts to 1.592 mg/100g and 3.477 mg/100g, respectively at 10 DAS as compared to control (6.566 mg/100g & 5.487 mg/100g respectively). Whereas, the polyphenol content in TMB and RSM infested tea leaves decreased upon application of treatment with *L. inermis* and *D. stramonium* leaf water extracts to 3.967 mg/100g and 3.247 mg/100g, respectively on 10 DAS as compared to the control (8.470 mg/100g & 6.773 mg/100g respectively). The chlorophyll a, chlorophyll b and carotenoids contents in both TMB and RSM infested tea leaves was found to have decreased upon application of *D. stramonium* leaf extracts.

## **Brood rearing and foraging activity of stingless bee (*Tetragonula iridipennis* Smith) in cucumber (*Cucumis sativus* Linnaeus) under protected condition**

*Sourav Sen*

Investigations on brood rearing and foraging activities of stingless bee (*Tetragonula iridipennis* Smith) in cucumber (*Cucumis sativus* Linnaeus) were carried out in the Department of Entomology and Horticulture Experimental Farm, Assam Agricultural University, Jorhat during 2019-2021. Three stingless bee colonies, maintained in wooden hives with specifications 15504 cc, 14364 cc and 6664 cc were selected to study the brood rearing activity in the apiary of the department. The brood, pollen and honey areas were measured by using a 5×5 cm sq. paper grid. The determination of foraging activities and effect of stingless bee pollination on cucumber was done by installing 15504 cc hive (approx. 700-1000 bees) at 25% flowering of the crop under protected condition during summer, 2020 and winter, 2020-2021. In 15504 cc hive, the highest brood (204.52±1.90 cm sq.), pollen (138.53±3.98 cm sq.) and honey (90.8±2.14 cm sq.) areas were observed during February, 2020 whereas the lowest brood (62.78±3.92 cm sq.), pollen (74.62±2.40 cm sq.) and honey (68.92±2.17 cm sq.) areas were observed during April, 2020, October, 2019 and July 2020. The maximum and minimum brood areas during February, 2020 and April, 2020 were also recorded in 14364 cc (163.15±1.10 and 46.95±3.07 cm sq.) and 6664 cc (137.99±1.45 and 48.10±3.46 cm sq.) hives. The highest pollen areas in 14364 cc (127.91±1.08 cm sq.) and 6664 cc (123.40±0.57 cm sq.) hives were observed during February and January, 2020 whereas the lowest pollen areas in 14364 cc (74.54±2.72 cm sq.) and 6664 cc (78.27±1.79 cm sq.) hives were observed during August 2020. The maximum and minimum honey area in 14364 cc (82.99±4.87 and 68.13±2.40 cm sq.) was observed during January 2020 and December, 2019. The highest and lowest honey area in 6664 cc (80.28±0.39 and 63.99±2.10 cm sq.) was recorded during June and July, 2020. A significant negative correlation was observed between brood, pollen and honey areas of 15504 cc hive and maximum temperature; brood, pollen and honey areas and minimum

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**Abstract of M.Sc. thesis**

**Department: Entomology**

**Major Adviser: Dr. Shimantini Borkataki**

temperature, brood, pollen and honey areas and evening relative humidity. Brood and pollen areas have also shown significant negative correlations with total rainfall and number of rainy days. Similar trend in the results of correlation studies was also observed in 14364 cc and 6664 cc hives at  $p < 0.05$ . A total of 35 plant species belonging to 23 families were recorded as foraging sources of *T. iridipennis* within the campus. The family Asteraceae (20%) was found to be the dominant one as most preferred foraging source followed by Solanaceae (11.43%) and Brassicaceae, Rosaceae and Caryophyllaceae with 5.71 per cent abundance. In the prepared floral cycle of *T. iridipennis*, the maximum foraging plants were available during December (16%), January (16%) followed by February (13%). Furthermore, a very few foraging plants were available during August (4%) and September (4%). In the second experiment, study on foraging behaviour have shown *Apis cerana indica* was the most predominant pollinator (29.87%) under open pollination followed by *A. dorsata* (21.07%), *Xylocopa* sp. (10.69%) and *T. iridipennis* (9.12%). The foraging behaviour of *T. iridipennis* in summer, 2020 and winter, 2020-2021 revealed that the maximum number of *T. iridipennis* per flower per minute ( $1.06 \pm 0.15$  and  $1.21 \pm 0.16$ ) was recorded in 0800-0900 hours and minimum number ( $0.51 \pm 0.11$  and  $0.49 \pm 0.08$ ) was found in 1600-1700 hours of the day during summer, 2020 and winter 2020-21 respectively. The maximum and minimum time spent per flower was  $11.57 \pm 0.37$  and  $12.07 \pm 0.99$  seconds during 0800-0900 hours during summer and winter, 2020-21 whereas the minimum was  $7.15 \pm 0.83$  seconds at 1600-1700 hours in summer, 2020 and  $8.32 \pm 0.71$  seconds at 1500-1600 hours during winter, 2020-21. The maximum pollen loads carried by 10 individuals was  $6.50 \pm 0.67$  mg and  $7.15 \pm 0.39$  mg at 0800-0900 hours and minimum was found to be  $2.93 \pm 0.56$  mg and  $2.98 \pm 0.45$  mg at 1600-1700 hours of the day during summer and winter, 2020-21 months respectively. During summer and winter, maximum fruit length ( $18.08 \pm 1.23$  and  $18.31 \pm 1.24$  cm), fruit girth ( $10.08 \pm 0.59$  and  $10.14 \pm 0.56$  cm), fruit weight ( $202.62 \pm 12.98$  and  $205.11 \pm 8.85$  g), fruit set ( $79.06 \pm 8.60$  and  $83.85 \pm 6.16\%$ ) and fruit yield/ha ( $13.15 \pm 6.68$  and  $14.65 \pm 2.31$  t) were recorded in stingless bee pollinated plot (SBP) whereas minimum ( $11.24 \pm 0.79$  and  $10.71 \pm 0.86$  cm,  $7.78 \pm 0.53$  cm and  $7.70 \pm 0.45$  cm,  $92.05 \pm 6.81$  and  $90.38 \pm 5.99$  g,  $34.14 \pm 9.40$  and  $35.80 \pm 8.04\%$  and  $2.13 \pm 0.68$  and  $2.39 \pm 0.67$  t) was observed in pollinator exclusion (PE). *T. iridipennis* pollinated cucumber plot produced 5 times more yield than pollinator exclusion plot. A significant positive correlation was observed between number of bees per flower per minute and average temperature and relative humidity during both the seasons whereas a positive significant correlation was found between pollen load per 10 bees per trip and average temperature during summer, 2020 only.

# **Haemocyte Morphology and Cellular Immune Response in Cabbage butterfly, *Pieris brassicae* (L.) against *Beauveria bassiana* (Bals.) Vuill.**

*Sravanthi Erla*

*Beauveria bassiana*, an entomopathogenic fungus is the alternative biocontrol agent exploited against the major economic crop pests. *Pieris brassicae* (L.) is an emerging pest of the Brassicaceae family. In the present study, fungal isolate of *B. bassiana* viz, BBJ-S-1 was evaluated to study the virulence against 5th instar larvae of *P. brassicae* (Lepidoptera: Pieridae). The work was carried out in the Insect Physiology laboratory, Department of Entomology, Assam Agricultural University, Jorhat-13 during 2018-2020. Study on biology of *P. brassicae* resulted out the various life stages viz., egg, 1st, 2nd, 3rd, 4th, 5th instar larvae and pupa with the average  $1.12 \pm 0.04$ ,  $4.25 \pm 0.95$ ,  $8.06 \pm 0.79$ ,  $15.10 \pm 0.88$ ,  $25.54 \pm 0.97$ ,  $36.50 \pm 0.98$  and  $0.54 \pm 0.06$ ,  $0.37 \pm 0.02$ ,  $1.65 \pm 0.19$ ,  $3.28 \pm 0.25$ ,  $4.18 \pm 0.36$ ,  $4.82 \pm 0.47$  mm in body length and width respectively. The average developmental period of larval instars and pupa were found to be 17.73 and 7.72 days respectively. The wing expanse of male butterfly was ranged between  $52.96 \pm 1.00$  mm and the female was  $62.92 \pm 1.01$  mm. The total developmental period from egg to adult was recorded  $39.13 \pm 2.29$  days. *B. bassiana* ( $1 \times 10^7$  conidia/ml) showed 84 per cent mortality rate of *P. brassicae*. Four types of haemocytes namely; prohaemocytes (PRs), plasmatocytes (PLs), granulocytes (GRs) and oenocytoids (OEs) were observed in the haemolymph of 5th instar larvae of *P. brassicae* (L.). PRs were smallest rounded with large nuclei, spindle or ovoid shaped PLs with round nuclei, rounded or ovoid GRs with round nuclei and largest rounded OEs with eccentric nuclei. The total haemocyte count (THC) ranged between 5145 to 5511 cells/mm<sup>3</sup> in control and 5545 to 3033 cells/mm<sup>3</sup> in treated insects. Differential haemocyte count (DHC) ranged as 5.01-5.71 (PRs), 34.16-36.65 (PLs), 54.32-54.98 (GRs), 4.92-5.14 per cent (OEs) in control whereas in case of treated 0.77-5.73 (PRs), 34.26-39.24 (PLs), 54.87-59.71 (GRs), 1.16-5.17 per cent (OEs). PRs were reduced drastically while PLs and GRs were increased significantly in response to *B. bassiana*. Granulocytes and plasmatocytes of *B. bassiana* infected larvae showed morphological changes whereas no change was observed in control. Granulocytes showed fine pseudo-pod like cytoplasmic extensions

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**Abstract of M.Sc. thesis**

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**Major Adviser: Dr. Mousumi Phukon**

and disintegration of the plasma membrane at 6 HAT accompanied by leakage of cell contents. In addition clumping of plasmatocytes and granulocytes, apposition of granulocytes, filopodial elongation, degranulation and vacuolation of GRs were observed. Cellular immune reactions *viz.*, phagocytosis, encapsulation and nodule formation were observed against *B.bassiana*. The plasmatocytes and granulocytes were the principal cell types, which responded mostly during the defence. The 5th instar larvae treated with *B. bassiana* although transformed into pupa but died after 2 days without transforming into adult whereas in control the larvae transformed into pupa and further to the adult stage was recorded. *B. bassiana* can be a promising biocontrol agent to manage the *P. brassicae* in near future.

## **Evaluation of release methods of Trichogrammatids (Hymenoptera: Trichogrammatidae) against lepidopteran pests of cabbage**

*Tanbir Hazarika*

A field experiment on release methods of Trichogrammatids (Hymenoptera : Trichogrammatidae) against lepidopteran pests of cabbage was carried out during *rabi* 2018-2019 at Experimental farm, Organic section, Department of Horticulture, Assam Agricultural University, Jorhat. The *Trichogramma pieridis* was released in the cabbage field using different methods for the effective biological suppression of the lepidopteran pests. The different treatments were trichocard stapled under the surface of leaves (T1), trichocard stapled under the surface of leaves + 20% honey solution (T2), trichocard covered with cup for protection from rain (T3), trichocard covered with cup for protection from rain +20% honey solution (T4), trichocard attached with stick at 50 cm distance (T5) and along with untreated control (T6). All the treatments brought about a significant reduction on the incidence of lepidopteran pests over untreated control. It was found that the plot treated with trichocard covered with cup for protection from rain + 20% honey solution (T4) registered the lowest population of pests. The second best treatment was found to be trichocard stapled under the surface of leaves + 20% honey solution (T2) followed by trichocard stapled under the surface of leaves (T1) trichocard covered with cup for protection from rain (T3) and trichocard attached with stick at 50 cm distance (T5) were found to be least effective in controlling the pests population. In the investigation a total of four lepidopteran pests belonging to three different families *ie* Plutellidae, Pieridae and Noctuidae have been found to attack the crop during different growth stages. Of lepidopteran insect pests diamondback moth, *Plutella xylostella* (L.), cabbage butterfly, *Pieris canidia* (L.) and cabbage looper, *Trichoplusia ni* (Huf) were considered as major pests of cabbage. Population of *Cotesia plutellae*, *Coccinella transversalis* and *Episyrrhus belteatus* were also recorded as natural enemies in cabbage ecosystem. The correlation study of different weather parameters indicated that both maximum and minimum temperature showed negative correlation with the population build up of *P. xylostella* ( $r=-0.31$ ,  $r= -0.74$ ), *P. canidia* ( $r=-0.83$ ,  $r=-0.64$ ), *T. ni* ( $r=-0.33$ ,  $r= -0.74$ ), *C. plutellae* ( $r= -0.60$ ,  $r= -0.59$ ), *E. belteatus* ( $r= -0.75$ ,  $r= -0.59$ ) and *C.*

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**Major Adviser: Dr. D.K. Saikia**



*transversalis* ( $r=-0.43$ ,  $r=-0.72$ ), respectively. As regards to yield, the highest yield was recorded in treatment T4 with 37.0 q/ha. The second best yield was found in treatment T2 with 33.0 q/ha followed by treatment T1 with 22.2 q/ha, treatment T3 with 20.7 q/ha and treatment T5 with 17.0 q/ha during 2018-19, respectively.

## **Effect of gamma irradiated rice seeds against certain insect pests of rice**

*Uddipana Shandilya*

An experiment entitled “Effect of gamma irradiated rice seeds against certain insect pests of rice” was carried out at the Instructional-cum-Research (ICR) Farm and insectary cum screening house, Assam Agricultural University, Jorhat during Sali 2018 (M2 generation) and Sali 2019 (M3 generation) respectively, to screen out the most effective doses of gamma irradiation showing tolerance against insect pests as well as to study the biochemical and morphological characteristics of the irradiated plants imparting tolerance against rice insect pests. Seeds of popular rice variety Ranjit Sub-1 were taken for irradiation at NRL laboratory, New Delhi. Five different gamma irradiated doses 100Gy, 150Gy, 200Gy, 250Gy and 300Gy along with an unirradiated control and a check variety (Jaya) was taken as treatments and each treatment was replicated four times. The field experiment was laid out in a randomized block design and the entire experiment was conducted organically. Three insect pests of rice i.e. *Diuraphis armigera* (Olivier), *Cnaphalocrocis medinalis* (Guenee), and *Leptocorisa oratorius* (Fabricius) were taken for screening. Experimental findings revealed that among the gamma irradiated doses, 200Gy showed minimum infestation as well as incidence of *Diuraphis armigera* (Olivier) and leaf folder, *Cnaphalocrocis medinalis* (Guenee) followed by 150Gy and 100Gy. Infestation by *D. armigera* was lowest at 200Gy (14.93±1.05%) and highest at 300Gy (25.81±1.18%). According to the Standard Evaluation System (SES), IRRI, the doses 100Gy, 150Gy and 200Gy were recorded as Moderately Resistant, 250Gy and 300Gy as Less Susceptible category against *D. armigera* infestation. Infestation by *C. medinalis* was lowest at 200Gy (14.84±0.98%) and highest at 300Gy (24.80±2.01%). The doses 100Gy, 150Gy and 200Gy were recorded as Moderately Resistant, 250Gy and 300Gy as Moderately Susceptible against *C. medinalis* infestation according to SES, IRRI. In case of grain infestation by *L. oratorius* none of the gamma irradiated doses were found to be tolerant. Biochemical characteristics of the rice plants like nitrogen, potassium, phenol and crude protein was found to have significant effect in imparting tolerance against rice insect pests. Nitrogen and crude protein was found to be positively correlated whereas potassium and phenol were negatively correlated with insect infestation. Morphological characters of rice plant

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**Department: Entomology**

**Major Adviser: Dr. Purnima Das**

like total leaves, total tillers and leaf width were found to have significant effect in insect infestation. Total leaves and total tillers were negatively correlated and leaf width was positively correlated with insect pest infestation. Highest yield among the gamma irradiated doses were found at 200Gy.

## **Resource Integration in *bari* system farming: A study in Jorhat district of Assam**

*Ashish Hazarika*

*Bari* system farming is the best way to integrate resources, which were present in every house of the small and marginal farmers such as: crops, fruits, live-stock etc. Considering the importance of the resource integration the present study was entitled ‘Resource integration in *bari* system farming: A study in Jorhat district of Assam’. The objectives that are taken for the study are:

- To assess the level of food availability and agricultural productivity from the *bari* system farming
- To study quality of resources in terms of soil, water and tree in *bari* system farming.
- To study social acceptability of *bari* system farming.

The study was carried out in Titabor sub-division of Jorhat district of Assam, from where 10 respondents were selected randomly from four villages. Data was collected from the randomly selected farmers. To study all these aspects of the *bari* system farming i.e., food availability, agriculture production and productivity, quality of resources, social acceptability of the components etc., an appropriate schedule was prepared and data was collected from all the selected respondents. For processing the data, statistical methods like frequency, mean, percentage, standard deviation, coefficient of variance, rank, regression analysis were used with the help of Microsoft excel and other concerned departments. The study revealed that majority of farmers were middle aged (35 to 50yrs.) and most of them are Schedule Tribe (Plain). Majority of farmers had land holding up to 1.76 ha. Majority of respondents had net annual income Rs.8199.52-Rs.26936.6. Average cultivable area of each family was 1.2 hectare of which only 0.4 hectare was for the horticultural area, 0.2 hectare for non-cultivable area. Area under the *bari* system farming, where of the majority had between 0.13 to 0.31hectare. Majority of the respondents with 67.5% were under the medium category level of resource integration. The integration between Vegetable and Livestock was found common with majority of the respondents.

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**Abstract of M.Sc. thesis**

**Department: Extension Education**

**Major Adviser: Dr. Sundar Barman**

# **An exploratory study on the utilization of Information and Communication Technologies (ICTs) by extension field functionaries and farmers for farm communication**

*Biplab Gogoi*

The present study entitled “An exploratory study on the utilization of information and communication technologies (ICTs) by extension field functionaries and farmers for farm communication” was carried out with the following objectives: 1. To study the extent of utilization of ICT tools by Extension field functionaries for dissemination of farm information 2. To study the extent of utilization of ICT tools by farmers for getting farm information 3. To identify the factors influencing extent of utilization of ICT tools by extension field functionaries and farmers 4. To identify the constraints as perceived by the extension field functionaries and farmers in utilization of ICT tools for farm communication The study was conducted in the state of Assam. The state consists of 33 districts, out of which 2 districts viz., Nagaon and Biswanath districts were selected randomly for the study. 2 sub-divisions, viz., Nagaon and Biswanath sub-division was selected randomly. From each of the selected sub-divisions, two ADO circles were selected randomly. Thus, Deodhar and Nonoi ADO circle from Nagaon sub-division and Biswanath and Kuwori ADO circle from Biswanath sub-division were selected randomly. From each of the selected ADO circles, one AEA eleka was selected randomly. Thus, from four ADO circles, four AEA elekas were selected randomly. From each selected AEA eleka, two villages were selected randomly thus making a total of 8 villages. The eight selected villages were- Namokuri, Deurigaon, Khatargaon, Mudoioni, Kubaigorha, Samorikhuwa, Japoubari and Kuwori. From each of the 8 selected villages, 10 farmers was selected randomly thus making a sample of 80 farmer respondents. From the two selected districts, a sample of 50 extension field functionaries was selected randomly. Thus, 80 farmer respondents and 50 extension field functionaries constituted the samples of the study. The data for the study were collected by the personal interview method with the help of a structured research schedule. Keeping in view the objectives of the study, a set of 7 independent

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**Abstract of M.Sc. thesis**

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variables for extension field functionaries and a set of 17 independent variables for farmer respondents were selected for the study. Two dependent variables were included in the study, which were extent of utilization of ICT tools by extension field functionaries for dissemination of farm information and extent of utilization of ICT tools by farmers for getting farm information. Data on extent of utilization of ICT tools were collected with the help of structured schedule. A simple index was developed in the present study to measure the respondent's extent of utilization of ICT tools. ii The independent variables for extension field functionaries were - Age, Education qualification, Service experience, ICT skills possessed, Job satisfaction, Level of aspiration and Availability of ICT tools. The independent variables for farmer respondents were - Age, Education, Size of operational land holding, Farming experience, Family type, Family size, Annual farm income, Mass media exposure, Extension contact, Extension participation, Innovativeness, Risk orientation, Economic motivation, Scientific orientation, Knowledge about ICT tools, Attitude of farmers towards ICT tools and Availability of ICT tools. The statistical techniques and tests used in the study for analysis and interpretation of the data were frequency, percentage, arithmetic mean, standard deviation, co-efficient of variation, multiple correlations, multiple regression and t-test. The findings of the study revealed that majority of the extension field functionaries (62.00%) belonged to middle aged group with 48.00 per cent graduates with B.A, B.Sc. or B.Sc. (Agri.) degrees. Majority of respondents (51.25%) had medium service experience. Majority of respondents (42.00%) possessed medium ICT skill. Majority of respondents (48.00%) had medium job satisfaction. Majority of respondents (48.00%) had medium level of aspiration and majority of respondents (36.00%) were found with high availability of ICT tools. The findings of the study revealed that majority of farmer respondents (51.25%) belonged to old aged group with 46.25 per cent belonged to HSLC category. Majority of the respondents (73.75%) were small farmers having land area from 1.1 to 2.0 ha. Majority of respondents (51.25%) were found to have short farming experience. Majority of respondents (81.25%) belonged to single family. Majority of respondents (78.75%) had small family (up to 5 members). Majority of the respondents (80.00%) had medium annual net farm income (Rs 22100 to Rs 136999). Majority of the respondents (63.75%) had medium mass media exposure. Majority of the respondents (57.50%) had medium level of extension contact. Majority of the respondents (36.25%) had low level of extension participation. Majority of the respondents (55.00%) had medium level of innovativeness. Majority of the respondents (42.5%) had medium level of risk orientation. Majority of the respondents (42.5%) had medium level of economic motivation. Majority of the respondents (45.00%) had medium level of scientific orientation. Majority of the respondents (47.75%) had medium level of knowledge about ICT tools. Majority of the respondents (56.25%) had medium favourable attitude towards ICT tools and majority of the respondents (51.25%) were found with medium availability of ICT tools. The findings of the study revealed that majority of the extension field functionaries (38.00%) had medium extent of utilization of ICT tools,

followed by 34.00 per cent of respondents had high extent of utilization of ICT tools and 28.00 per cent respondents had low extent of utilization of ICT tools. The findings of the study revealed that majority of the farmer respondents (63.75%) had medium extent of utilization of ICT tools, followed by 20.00 per cent of iii respondents had high extent of utilization of ICT tools and 16.25 per cent respondents had low extent of utilization of ICT tools. Findings of correlation analysis of extension field functionaries indicated that 6 independent variables were significantly correlated with the extent of utilization of ICT tools. The variables viz., Age, Educational qualification, Service experience, ICT skills possessed, Job satisfaction and Availability of ICT tools showed significant and positive relationship with the extent of utilization of ICT tools by extension field functionaries at 0.01 level of probability. Three variables viz., ICT skills possessed Job satisfaction and Availability of ICT tools showed significant contribution towards the variation in the extent of utilization of ICT tools at 0.05 level of probability and One variable i.e. Age showed significant contribution towards the extent of utilization of ICT tools at 0.01 level of probability. The 6 independent variables fitted in the linear regression analysis could predict 84.17 per cent of the variation in the extent of utilization of ICT tools by extension field functionaries. Findings of correlation analysis of farmer respondents indicated that 13 independent variables were significantly correlated with the extent of utilization of ICT tools by farmers for getting farm information. Among the 13 independent variables all 13 variables viz., Age, Education, Farming experience, Mass media exposure, Extension contact, Extension participation, Innovativeness, Risk orientation, Economic motivation, Scientific orientation, Knowledge about ICT tools, Attitude of farmers towards ICT tools and Availability of ICT tools showed significant and positive relationship with the extent of utilization of ICT tools by farmers at 0.01 level of probability. Six variables, viz., Education, Innovativeness, Scientific orientation, Knowledge about ICT tools, Attitude of farmers towards ICT tools and Availability of ICT tools were found to contribute significantly towards variation in the extent of utilization of ICT tools. Five variables viz., Education, Innovativeness, Scientific orientation, Knowledge about ICT tools, Attitude of farmers towards ICT tools showed significant contribution towards the variation in the extent of utilization of ICT tools at 0.05 level of probability. One variable i.e. Availability of ICT tools showed significant contribution towards the extent of utilization of ICT tools at 0.01 level of probability. The 13 independent variables fitted in the linear regression analysis could predict 88.90 per cent of the variation in the extent of utilization of ICT tools by farmer respondents. Majority of the extension field functionaries (76.00%) reported that non availability of ICT tools with farmers as the most important constraint (ranked first) faced by them in utilization of ICT tools for dissemination of farm information.. iv The other constraints faced by the extension field functionaries in utilization of ICT tools were non availability of ICT tools with farmers (68.00%), lack of awareness and knowledge among farmers regarding use of ICT tools (64.00%) and lack of proper training/skill on use of ICT tools (56.00%) which were ranked second, third and fourth respectively. Majority of the farmer respondents (90.00%) reported that

lack of proper training on ICT application, handling and use as the most important constraint (ranked first) faced by them in utilization of ICT tools for getting farm information. The other problems faced by the farmer respondents in utilization of ICT tools were lack of computer (87.50%), lack of smart phone (62.50%) and lack of internet connectivity/broad band internet (60.00%), lack of interest to know and explore ICT tools (55.00%) which were ranked second, third, fourth and fifth respectively.



# **A study on the effectiveness of Agricultural Technology Information Centre (ATIC), AAU, Jorhat**

*Chiranjeeta Dutta*

The present study entitled “A study on the effectiveness of Agricultural Technology Information Centre (ATIC), AAU, Jorhat” was undertaken with the following objectives:

1. To delineate the socioeconomic and personal profile of the visitors of ATIC.
2. To assess the effectiveness of ATIC of AAU, Jorhat.
3. To identify difficulties of the visitors if any, in availing ATIC services and their suggestive measures.

The study was conducted in Jorhat district of Assam to measure the effectiveness of ATIC located at Assam Agricultural University (AAU), Jorhat from the farmers’ point of view. Two villages from each direction (North, East, West and South) which are located within the radius of 50 km from ATIC were selected on random basis for the present study. Respondents from eight villages were selected purposively by using snowball sampling technique with the help of records available in ATIC register of AAU, Jorhat. Primary data was collected from 120 beneficiary farmers having regular and good contact with ATIC through personal interview technique. Effectiveness of ATIC was measured by the scores obtained from four different dimensions viz. attitude of the respondents, satisfaction level of respondents, respondent’s level of change/improvement in agriculture and allied practices, personal and economic empowerment of the respondents. The overall perceived effectiveness of ATIC was measured with the help of effectiveness index.

The study revealed that majority of the respondents belonged to the middle aged group (40.00%) of 36 to 55 years, from the OBC caste (56.67%), with educational qualification of High School passed (26.67%), were married (80.83%), belonged to joint family type (57.50%) having medium family size (55.00%) with 5 to 10 members. Majority of the respondents possessed marginal land holding (70.00%), had occupation of only farming with no subsidiary occupation (40.00%). Majority of the respondents

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had medium annual family income (73.33%) ranged between Rs. 53,764.36 to Rs. 1,56,893.98 with no membership in any organization (44.17%).

It was observed from the study that majority of the respondents had medium level of overall attitude (68.33%), medium overall satisfaction level (71.67%), medium level of overall change/improvement in agriculture and allied practices (60.00%), medium level of overall personal and economic empowerment (60.83%), medium level of overall perceived effectiveness of ATIC (65.83%).

The study indicated that age and annual family income of the respondents had significant relationship with attitude of the respondents. Annual family income of the respondents had significant relationship with satisfaction level of respondents. Age, operational land holding and annual family income of the respondents had significant relationship with respondent's level of change/improvement in agriculture and allied practices. Age, operational land holding and annual family income of the respondents had significant relationship with personal and economic empowerment of the respondents. Annual family income of the respondents had significant relationship with overall perceived effectiveness of ATIC whereas, the variables *viz.*, age, size of family and operational land holding had no significant relationship with overall perceived effectiveness of ATIC.

The findings of the study showed that education, occupation and social participation of the respondents had significant association with attitude of the respondents. Social participation of the respondents had significant association with satisfaction level of respondents. Education, marital status, occupation and social participation of the respondents had significant association with respondent's level of change/improvement in agriculture and allied practices. Caste, education, occupation and social participation of the respondents had significant association with personal and economic empowerment of the respondents. Social participation of the respondents had significant association with overall perceived effectiveness of ATIC whereas, the variables *viz.*, caste, education, marital status, type of family and occupation had no significant association with overall perceived effectiveness of ATIC.

The three severe difficulties faced by the respondents in availing ATIC services were "lack of awareness about the services and facilities available at ATIC" (72.50%), followed by "more distance between ATIC and host village" (70.83%) and "lack of proper transportation facilities to ATIC" (45.00%).

# **A Study on the Extent of Adoption of Recommended Muga (*Antheraea assamensis*) Rearing Practices in Lakhimpur District of Assam**

*Jagat Jyoti Baruah*

The present study was carried out in the Lakhimpur district of Assam with the objectives to study the extent of adoption of scientific Muga rearing practices along with the level of knowledge of Muga rearers on scientific Muga rearing practices and constraints faced by the Muga rearers. A total of 120 Muga rearers were selected as respondents by following simple random sampling technique. Appropriate statistical tools *viz.*, frequency, percentage, mean, standard deviation, weightage mean score, correlation and multiple regression analysis were employed to analyze the data. The findings revealed that most of the respondents were in the age group of 36-56 years with educational qualification as high school passed. Moreover, majority of the respondents were from ST caste, belonged to the joint family of medium sized family i.e., 4 to 8 members. Majority of the respondents had annual income from Muga between Rs. 67,000 to Rs 2,93,000. Majority of the respondents were marginal farmers having land holding up to 1 ha and an area of upto 5 bigha under Muga cultivation. Majority of the respondent family's primary occupation is Muga and allied agriculture having farming experience between 10-20 years and majority of the respondents used family members as help in Muga rearing. Fellow farmers/ Progressive farmers was ranked first in regard to extension contact by Muga rearers. Almost two third of the respondents had not attended any training on Muga rearing. Majority of the respondents were having medium level social orientation. Although information sources utilization were found as regular in majority respondents but had low information source relevancy to Muga. Majority of respondents have medium level of marketing orientation, risk bearing ability and decision making ability. With regard to knowledge level on adoption of recommended cultivation practice majority of the respondents had medium level. The majority of the Muga rearers exhibited a medium level of extent of adoption of recommended scientific practices of Muga. Correlation coefficient revealed a positive and significant relationship between the extent of adoption and variables namely age, total annual income, annual income from Muga, total landholding, area under Muga,

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farm experience, extension contact, risk bearing ability, and negative and significant relationship between the extent of adoption and variables namely education and decision making ability. Moreover, correlation coefficient revealed a positive and significant relationship between the knowledge on adoption and variables namely age, land holding under Muga, experience and extension contact. Whereas, for regression analysis the variables which were found to be significant relationship with dependent variable were considered. The multiple regression analysis with fifteen predictors produced  $R^2=0.714$ . Thus, this signifies that fifteen variables taken together could explain 71.4 per cent of the total variation in respondent's extent of adoption. The findings suggested that the government should take proper initiatives to help the rearers, machinery and other facilities should be provided by the extension agencies, institutions, etc. Periodically, training should be provided to the rearers based on their needs, timely meetings and contact should be there between the rearers and experts to get information and solutions. Proper financial, technical, and other support should be provided to the rearers, proper training, information, inputs about the diseases and pest management, and their measures should be given. The proper market channel, government center for collection, and appropriate rates for their products should be there. Moreover, extension contact need to be frequent to aware and inspire them to adopt recommended scientific practices of Muga cultivation and rearing.

## **Training need assessment of agricultural input dealers in Upper Brahmaputra Valley Zone (UBVZ) of Assam**

*Lisha Bordoloi*

Agricultural research and extension are two major factors of agricultural development. An efficient extension system is capable of timely dissemination of need based farm technology among farming communities which has great importance for achieving sustained growth in agriculture. The system of transfer of technology from research stations to the farming community has always played a crucial role in modernizing agriculture. Considering training as an important element for agricultural input dealers to increase their both theoretical as well as practical knowledge on agricultural technology the present study entitled 'Training need assessment of agricultural input dealers of Upper Brahmaputra Valley Zone (UBVZ) of Assam' was done. The study was conducted in Golaghat, Jorhat and Sivasagar districts of Assam under Upper Brahmaputra Valley Zone. A total of 121 agricultural input dealers as respondents (40% of total number of agricultural input dealers from each district) were selected by following the snowball sampling technique. Appropriate statistical tools like frequency, percentage, mean, standard deviation, coefficient of variance, t-test and chisquare analysis were used to analyze the data. The findings of the study with regard to the selected profile characteristics of the respondents indicated that 65.28 per cent of the input dealers were middle aged, 61.15per cent of the respondents had 'higher secondary level' of education, 61.16 per cent of the respondents had 'medium' experience in dealership, 52.89 per cent of the respondents sold one type of input, 61.98per cent of the agricultural input dealers had medium annual income, 60.33 per cent of the respondents had 'medium' level of extension contact, 75.21 per cent of the respondents had 'medium' information seeking behaviour, 78.51 per cent of the respondents had 'medium' level of cosmopolitaness, 67.78 per cent of the respondents had 'medium' level of risk orientation, 65.29 per cent of the respondents had 'medium' level of economic motivation and 57.02 per cent of the respondents had 'received' training. Most of the respondents (66.94%) had 'fair' level of advice provided to the

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farmers while dealing with agricultural inputs. Also, majority of the respondents (69.42%) had 'medium' level of training need.

# **A Study on the factors influencing entrepreneurial behaviour of the members of Farmer Producer Company with reference to commercial potato production**

*Manisha Barman*

The present study entitled “**A Study on the factors influencing Entrepreneurial Behaviour of the members of Farmer Producer Company with reference to commercial potato production**” was carried out with the following objectives: 1. Assess the personal, socio-economic, psychological and communication characteristics of the members of Farmer Producer Company, 2. Measure the Entrepreneurial Behaviour of the members of Farmer Producer Company with reference to Commercial Potato production, 3. Explore the relationship of Entrepreneurial behaviour of the members of Farmer Producer Company with their selected personal, socio-economic, psychological and communication characteristics, 4. Identify the constraints as perceived by the members of Farmer Producer Company in production and marketing of Potato The study was undertaken in Nagaon and Biswanath districts of Assam which were selected purposively, as two Farmer Producer Companies dealing with commercial potato production were operating in these two districts. Two FPCs namely, Satbhani Potato Producer Company of Biswanath district and Sankar Azan Agro Producer Company of Nagaon district were selected purposively for the study. A sample of 120 farmer members of two FPCs was selected from the six selected villages following a proportionate random sampling technique. The primary data for the study were collected by the personal interview method with the help of a structured research schedule. The primary data for the study were collected during the month of February 2020 and November 2020. Keeping in view the objectives of the study, 18 independent variables and 1 dependent variable were included in the study. The independent variable included in the study were age, education level, family size, family type, potato farming experience, occupational status, size of operational land holding, area under potato cultivation, annual net farm income, social participation, scientific orientation, leadership ability, decision making ability, risk orientation, achievement motivation,

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economic motivation, degree of information exposure and exposure to training. The dependent variable included in the study was the entrepreneurial behaviour of the members of Farmer Producer Company with reference to commercial potato production which was measured by using the scale developed by Rao (1985). The statistical techniques and tests used in the study for analysis and interpretation of the data were frequency, percentage, arithmetic mean, standard deviation, co-efficient of variation, multiple correlations, multiple regression and t-test for testing the significance of the coefficients for correlation and regression analysis. Findings revealed that majority of the respondents (50.00%) were in the middle aged group followed by 28.33 per cent of respondents in old aged group and 21.67 per cent of the respondents in young aged group. Most of the respondents (30.83%) had higher secondary/ PU level of education followed by 27.5 per cent respondents with high school level of education. Majority of the respondents (51.57%) had large family size and rest had small family size. Majority of the respondents (74.17%) belonged to the nuclear family and the rest 25.83 per cent belonged to the joint family. Majority of the respondents (53.33%) had medium term (10-20 years) experience of potato farming followed by 27.50 per cent respondents with long term experience (21 years and above). Majority of them (65.00%) had only cultivation as their occupation followed by 25.00 per cent of respondents had cultivation + business as occupation. Majority of the respondents (45.00%) belonged to the small farmer category followed by 26.67 per cent in semi-medium and 21.67 per cent of the respondents in marginal land holding category. Only 6.66 per cent of the respondents belonged to the medium land holding category. In case of area under potato cultivation, majority of the respondents (47.50%) were having a land area above 2 ha followed by 37.50 per cent respondents having land area from 0.3 to 2 ha. Majority of the respondents (61.67%) had medium annual net farm income ranging from Rs 41731.34 to Rs 109585.33 followed by 23.33 per cent respondents with low annual net farm income up to Rs 41731.33. In case of social participation, majority of the respondents (70.83%) were member of one organization, followed by 22.50 per cent respondents having membership with more than one organization/ institutions. Majority of the respondents (62.50%) had medium level of scientific orientation followed by 22.50 per cent respondents with low level of scientific orientation and 15.00 per cent respondents with high level of scientific orientation. Majority of the respondents (53.33%) had medium level of leadership ability followed by 24.17 percent respondents with low level of leadership ability and 22.50 per cent respondents with high level of leadership ability. Majority of the respondents (64.17%) had medium level of decision making ability followed by 23.33 percent respondents with low level of decision making ability and 12.50 per cent respondents with high level of decision making ability. Majority of the respondents (65.00%) had medium level of risk orientation followed by 20.83 per cent respondents with low level of risk orientation and 14.17 per cent respondents with high level of risk orientation. Majority of the respondents (58.34%) had medium level of achievement motivation followed by 20.83 per cent respondents with both low level and high level of achievement motivation. Majority of the respondents (66.67%) had



medium level of economic motivation followed by 18.33 per cent respondents with high level of economic motivation and 15.00 per cent respondents with low level of economic motivation. Among the personal cosmopolite sources of information, Input dealers were used in regular basis by majority (48.33%) of the respondents followed by NGO personnel (35.00%), Agril. Scientists/ KVK scientists (13.33%), ADO/Block Extension Personnel/SDAO/DAO (5.83%) and Agricultural Extension Assistant (4.17%) as their source of information. Among the personal localite sources of information, friends/ relatives/ neighbours or fellow farmers were used regularly by majority (22.50%) of the respondents followed by family members (20.00%) for getting information about the use of improved farming practices. Among the mass-media sources, farm publications were used regularly by majority (22.50%) of the respondents followed by mobile phones (20.83%), internet (17.50%), newspaper (15.00%), television (14.17%) and radio (11.67%) as their sources of information. Majority of the respondents (75.00%) had medium level of information exposure followed by 15.00 percent respondents with high level of information exposure and 10.00 percent respondents with low level of information exposure. Majority of the respondents (55.83%) had medium level of exposure to training followed by 23.34 percent respondents with high level of exposure to training and 20.83 percent respondents with low level of exposure to training. Findings revealed that majority (48.33%) of the respondents were prospective entrepreneurs, possessing a mix of both external and internal locus of control. While 31.67 per cent of the respondents highlighting more of internal locus of control belonged to the category of entrepreneurial internals, the remainder 20.00 per cent was entrepreneurial externals, showing more external locus of control. The mean value (2.27) indicated that on an average the sample tended to lean towards the prospective entrepreneur category, with the scores of individual respondents tending to cluster around the mean as depicted by the standard deviation value (0.83). Findings of correlation analysis indicated that out of the 18 selected independent variables, 12 independent variables were significantly correlated with the entrepreneurial behaviour of the members of FPC. Among the 12 independent variables, 10 variables *viz.*, education level (0.845), potato farming experience (0.351), scientific orientation (0.796), leadership ability (0.598), decision making ability (0.503), risk orientation (0.824), achievement motivation (0.833), economic motivation (0.677), degree of information exposure (0.763) and exposure to training (0.587) showed significant and positive relationship with the entrepreneurial behaviour of the members of FPC at 0.01 level of probability and 2 variables *viz.*, age (-0.566) and family size (-0.238) showed significant but negative relationship with the entrepreneurial behaviour of the members of FPC at 0.01 level of probability. The variables which were found to have significant correlation with entrepreneurial behaviour of the members of FPC were further selected for multiple regression analysis with a view to determining the relative influence of those independent variables in predicting the dependent variable (entrepreneurial behaviour). The predicting power of multiple regressions was estimated with the help of coefficient of multiple determinations (R<sup>2</sup>) and adjusted R<sup>2</sup>. Out of 12

independent variables, 7 variables, viz., education level (0.120), scientific orientation (0.032), leadership ability (0.113), risk orientation (0.260), economic motivation (0.378), degree of information exposure (0.354) and exposure to training (0.330) were found to contribute significantly towards variation in the entrepreneurial behaviour of the members of FPC. Two variables viz., education level and risk orientation showed significant contribution towards the entrepreneurial behaviour at 0.05 level of probability and five variables, viz., scientific orientation, leadership ability, economic motivation, degree of information exposure and exposure to training showed significant contribution towards entrepreneurial behaviour at 0.01 level of probability. The value of R<sup>2</sup> (0.837) indicated that 12 independent variables selected for the study were efficient in predicting the entrepreneurial behaviour of the members of FPC. The 12 independent variables fitted in the linear regression analysis could predict 83.70 per cent of the variation in the entrepreneurial behaviour of the members of FPC. Majority of the respondents (81.67%) perceived that 'Lack of credit facility' was the most important constraint (ranked first) faced by the members of FPC in production of potato. The other constraints faced by the members in order of importance were 'high cost of labour' (71.67%), 'non availability of good quality seeds' (68.33%), 'high cost of good quality inputs' (65.00%) and 'seeds and fertilizers are not provided in proper time'(62.50%) which were ranked 2nd, 3rd , 4th, and 5th , respectively. As regards marketing related problems, majority (76.67%) of the respondents perceived that 'problem of price variability' was the most important constraint faced by the members of FPC which was ranked first. The other constraints faced by the members in marketing of potato were 'lack of proper market place/ *mandis*' (72.50%), 'large number of middlemen in the marketing system'(68.33%), 'poor product handling and packaging'(48.33%), 'poor transportation and communication facility' (39.17%) and 'poor storage facility' (22.50%) which were assigned ranks from 2nd to 6th, respectively.

# **A Study on Technological Gap in Adoption of Recommended Practices of Khasi Mandarin (*Citrus reticulata*) Cultivation by the Growers in Tinsukia District of Assam**

*Pankaj Dahal*

The study entitled as “A study on technological gap in adoption of recommended practices of khasi mandarin (*Citrus reticulata*) cultivation by the growers in Tinsukia district of Assam” was conducted with the following objectives: 1. To study the socio-economic profile of khasi mandarin growers of Tinsukia district 2. To determine the extent of technological gap in adoption of recommended package of practices of khasi mandarin cultivation by the growers 3. To identify the factors influencing the extent of technological gap in adoption of recommended package of practices of khasi mandarin by the growers 4. To identify the problems in production and marketing of khasi mandarin as perceived by the growers The present study was conducted in Tinsukia district of Assam. The study intended to examine the extent of technological gap in adoption of recommended practices of khasi mandarin (*Citrusreticulata*). The factors influencing the technological gap were also examined in the study. Randomsampling design was followed for selection of sub-divisions, ADO circles, AEA Elekas and villages for the study. A multistage, purposive cum-random sampling technique was followed for selection of 120 respondents which constituted the sample for the study. Only those khasi mandarin growers who cultivate commercially were considered for inclusion in the sample of the study. The major tool used for collection of primary data in the study was a pretested schedule by personal interview method. All together 19 independent variables were selected, viz., age, education, family type, family size, occupational status, institutional linkage, experience as khasi mandarin grower, area under khasi mandarin, net annual income from khasi mandarin cultivation, exposure to training, availability of working capital, utilization of information source, farm mechanization, economic motivation, management orientation, risk bearing ability, scientific orientation, decision making ability and knowledge level on scientific practices of khasi mandarin cultivation respectively. Extent of technological

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gap in adoption of scientific practices of khasi mandarin cultivation was the dependent variable considered for the study. The statistical tools used for analysis and interpretation of data included frequency, percentage, mean, standard deviation and coefficient of variation. The findings revealed that majority of the respondents (45.00%) belonged to middle aged category with middle school level of education (24.17%). Majority of the respondents (65.84%) had large family size (above 5 members) with joint family (60.00%). Majority of the respondents (30.83%) had cultivation + business as occupation with medium term (5 to 10 years) experience as khasi mandarin grower (43.33%). Majority of them (37.50%) were found with membership of 1 organization. Majority of the respondents (60.83%) were medium growers having land area from 4.1-10 ha under khasi mandarin cultivation. Majority of them (63.33%) had medium net annual income from khasi mandarin cultivation. Majority of the respondents (37.50%) had exposure to 1 day training on scientific khasi mandarin cultivation. Majority of them (58.33%) had medium level of working capital availability. It was also found that majority of the respondents (65.83%) had medium information source utilization and medium level of farm mechanization (70.83%). Majority of them (71.67%) had medium level of economic motivation, medium level of management orientation (67.5%) and medium level of risk bearing ability (72.5%). Majority of the respondents had medium level of scientific orientation (78.33%), medium level of decision making ability (80.00%) and medium level of knowledge on scientific practices of khasi mandarin cultivation (72.5%). As regards the extent of technological gap majority of the respondents (45.83%) had medium overall extent of technological gap in adopting of scientific practices of khasi mandarin cultivation followed by (39.17%) with high overall extent of technological gap in adopting of scientific practices of khasi mandarin cultivation. A small percentage of them (15.00%) were found with low overall extent of technological gap in adopting of scientific practices of khasi mandarin cultivation. The overall mean technological gap score was 53.61 per cent indicating medium extent of overall technological gap in adoption of scientific practices of khasi mandarin cultivation in the sample of the study. As regards the technological gap for the selected 16 practices, findings revealed that maximum average technological gap was found in interval of irrigation (70.92%) followed by height of prune (69.7%), chemical pest control and mechanical weeding (61.71%). There was substantial extent of technological gap in adoption of scientific practices of khasi mandarin cultivation like length of pruning cycle (58.94), time period of fertilizer application (57.76%), pit size (57.61%), doses of applied fertilizers (55.34%), doses of applied manure (54.25%), chemical weeding (48.9%), time period of manure application (48.00%), dimensions of primary nursery bed (46.66%), spacing (46.15%), time of planting in the main field (42.62), time of prune (41.71%), dimensions of secondary nursery bed (33.9%). The findings of correlation analysis revealed that variables viz. area under khasi mandarin (2.965), management orientation (5.732), risk bearing ability (4.000), decision making ability (6.236), scientific orientation (5.351), exposure to training (4.243), knowledge level on scientific practices of khasi mandarin cultivation (4.438), family type (2.157),

economic motivation (2.263) and working capital availability for khasi mandarin cultivation (2.041) had negative and significant relationship with extent of technological gap. The result of regression analysis revealed that out of 10 independent variables, only 4 variables, viz. economic motivation, decision making ability, exposure to training and knowledge level were found to contribute significantly towards the variation in technological gap in adoption of scientific practices of khasi mandarin cultivation by the khasi mandarin growers. Among the computed PCI values for the production problems, “Problems of insects and diseases” has the highest value of 283 and has been ranked first as frequently faced problem as perceived by the growers. As regards the computed PCI values for the marketing problems, “Nonremunerative price for the produce” has the highest value of 280 and has been ranked first as frequently faced problem as perceived by the growers.

## **Preference of farm women towards sericulture as income generating activity- a study in Sivasagar district of Assam**

*Rekhamoni Gogoi*

The present study was carried out in Sivasagar district of Assam with the objectives to study profile characteristics of farm women and their level of participation in sericulture activities, assessing factors influencing in preferences for sericulture as income generating activity of farm women and to explore the problems faced by the women sericulture farmers. A total of 120 farm women were selected as respondents by following simple random sampling technique. Appropriate statistical tools *viz.* frequency, percentage, mean, standard deviation, co-efficient of variation, weightage mean score, correlation, chi-square test and multiple regression analysis were employed to analyse the data.

The findings revealed that majority of the respondents (51.67%) i.e. women silkworm rearer were belonged to middle age category i.e. 30-50 years, educated up to high school level (45.83%), having joint family (58.33%) and medium sized family with 5-7 family members (44.17%). Most of the women sericulture rearer were married (89.17%), in case of occupation sericulture + agriculture + wage earnings was the major source of income for majority of respondents(55.00%) and majority (55.83%) had annual family income up to Rs 70,000. In case of operational land holdings majority (84.16%) were under the category of marginal farmers with medium level of experience in sericulture (64.17) and majority of the respondents (63.33 %) had 15-30 numbers of host plants. Most of the respondents (56.67%) had medium level of social participation with medium level of relevancy (65.00%) to farm information sources and "neighbors" was ranked as the first in case of ranking of farm information sources based on relevancy mean score(3.75). Majority of the respondents had medium level of change agent contact (57.50%) with medium level of achievement motivation (73.33%) and majority of the respondents (95.83%) didn't not had any exposure to training programmes. In case of level of participation majority of the respondents (62.5%) had partial participation in the activities of sericulture.

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**Department: Extension Education**

**Major Adviser: Dr. Sundar Barman**

The study revealed that majority of the respondents i.e. 60.00% had medium preference towards sericulture as income generation activity. Low gestation high returns followed by high employment potential, high market demand, low investment high return, to conserve tradition, ideal for weaker section of the society, compatible for women etc were the cause for women to choose sericulture as income generating activity. Preference of farm women has strong, positive and significant relationship with age ( $r = 0.3872$ ), experience in sericulture ( $r = 0.4423$ ), total no of host plant ( $r = 0.3880$ ), change agent contact ( $r = 0.3851$ ), relevancy of information source ( $r = 0.4337$ ) and achievement motivation ( $r = 0.4807$ ). In case of total family size ( $r = 0.3172$ ), extent of social participation ( $r = 0.2911$ ), operational land holdings ( $r = 0.2023$ ) and income from sericulture ( $r = 0.2745$ ) were found significant and positive but weak relationship with the degree of preference. Again significant association was found in case of education and type of family with preference of farm women. Overall out of 12 variables 7 variables contributes 66.47% ( $R^2 = 0.6647$ ) to express the variation of preference of women towards sericulture as income generating activity. Women sericulture rearer faced many problems during silkworm rearing. 'No government facility' was ranked as 1st and 86.67% respondents termed it as most serious problem in the study area followed by lack of rearing equipment, no proper rearing house, shortage of leaf, financial problem etc ranked as 2nd, 3rd, 4th and 5th, respectively. Sericulture is an occupation which is mostly done by women, but still preference is medium towards it. So effort should be given to solve the problems related to sericulture. Sericulture has a vast scope for entrepreneurship development. So respondents should be trained properly to utilize sericulture venture as a major source of family income.

# **Information needs and information seeking behaviour of farmers in relation to organic vegetable production in two agro climatic zones of Assam**

*Sanjana Bora*

The study entitled 'A Study On The Extent Of Diversification And Level of Livelihood Security Of Farmers In The North Bank Plains Zone Of Assam' was conducted with the following objectives:

1. To find out the extent of diversification across different farm size groups
2. To find out the level of livelihood security of farmers across different farm size groups
3. To identify the factors influencing the extent of diversification and level of livelihood security across different farm size groups
4. To identify the constraints in diversification as perceived by the farmers across different farm size groups.

The present study was conducted in The North Bank Plains Zone Of Assam. The North Bank Plains Zone consists of 6 districts. Out of these 2 districts was selected randomly viz., Sonitpur and Lakhimpur. A random sampling was followed for the selection of sub-divisions, ADO circles, AEA blocks and villages. A sample of 160 farmers was selected from the 8 selected villages following a proportionate random sampling technique. The major tool used for collection of primary data in the study was a pretested schedule by personal interview method. The statistical tools used for analysis and interpretation of data included frequency, percentage, mean, standard deviation, coefficient of variation, t-test, multiple correlation coefficient and multiple regression analysis. The two dependent variables included in the study were extent of diversification and level of livelihood security. All together 15 independent variables were included in the study. Findings revealed that 23.12 per cent of the respondents were marginal farmers, 43.13 per cent small and 33.75 per cent medium farmers. Majority of the respondents were middle aged (50.62%) and literate (82.50%) with

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single type (71.87%) but large (51.25%) large size family and had medium (44.40%) credit seeking behaviour. Majority of the respondents (38.75%) had membership in one organization. Majority of the respondents had medium degree of information exposure (48.12%), medium farm mechanization (70/00%), medium scientific orientation (43.75%), medium risk orientation (54.37), medium economic motivation (56.87%), high innovativeness (37.50%) and medium management efficiency (60.63%). While, 54.05 per cent of the marginal farmers had less favourable attitude towards agricultural diversification, 68.12 per cent of small and 50.00 per cent of the medium farmers had moderately favourable attitude towards agricultural diversification. In this study, the extent of diversification was measured in terms of crop diversification and enterprise diversification across different farm size groups. As regards crop diversification, in case of marginal farmers, majority of the respondents (59.46%) had medium crop diversification followed by 27.03 per cent of them with low and 13.51 per cent of them with high crop diversification. In case of small farmers, majority of the respondents (75.37%) had medium crop diversification followed by 13.04 per cent of them with high and 11.59 per cent of them with low crop diversification. Whereas among the medium farmers, majority of the respondents (53.70%) had medium crop diversification category followed by 33.33 per cent of them with high and 12.97 per cent of them with low crop diversification. In the pooled sample of farmers, majority of the respondents (64.37%) had medium crop diversification followed by 20.00 per cent of them with high and 15.63 per cent with low crop diversification. As regards enterprise diversification, majority of the marginal farmers (64.86%) had medium enterprise diversification followed by 27.03 per cent with low and 8.11 per cent with high enterprise diversification. In case of small farmers, majority (66.67%) of the respondents had medium enterprise diversification followed by 17.39 per cent of them with low and 15.94 per cent with high enterprise diversification. Whereas among the medium farmers, majority (51.85%) of the respondents had medium enterprise diversification followed by 29.63 per cent with high and 18.52 per cent with low enterprise diversification. In the pooled sample of farmers, majority (61.25%) of the respondents had medium enterprise diversification followed by 20.00 per cent with low and 18.75 per cent with high enterprise diversification. As regards livelihood security, majority of the marginal farmers (57.76%) had medium level of livelihood security followed by 32.43 per cent with low and 10.81 per cent with high level of livelihood security. In case of small farmers, majority (63.77%) of the respondents had medium level of livelihood security followed by 18.84 per cent of them with low and 17.39 per cent with high level of livelihood security. In case of medium farmers, majority (51.85%) of the respondents had medium level of livelihood security followed by 33.33 per cent with high and 14.82 per cent with low level of livelihood security. In the pooled sample of farmers, majority (58.13%) of the respondents had medium level of livelihood security followed by 21.25 per cent with high and 20.62 per cent with low level of livelihood security. Findings of correlation analysis of crop diversification reveal that, in case of marginal farmers, 9 independent variables and in case of both small and medium farmers 7 independent

variables were significantly correlated with the extent of crop diversification. In the pooled sample of farmers, 10 independent variables were significantly correlated with the extent of crop diversification. The findings of regression analysis of crop diversification revealed that, in case of marginal farmers out of 9 independent variables, only 3 variables were found to contribute significantly towards the extent of crop diversification. The variables viz. size of operational land holding, scientific orientation and innovativeness had positive and significant contribution towards extent of crop diversification at 0.05 level. The value of  $R^2$  (0.674) indicated that 9 independent variables selected for regression could predict 67.40 per cent of the variation in extent of crop diversification. In regards small farmers, out of 7 independent variables, only 4 variables were found to contribute significantly towards the extent of crop diversification. The variables viz, innovativeness and management efficiency were had positive and significant contribution towards extent of crop diversification at 0.01 level, whereas the variable size of operational land holding and risk orientation had positive and significant contribution towards extent of crop diversification at 0.05 level. The value of  $R^2$  (0.787) indicated that 7 independent variables selected for regression could predict 78.70 per cent of the variation in extent of crop diversification. In case of medium farmers, out of 7 independent variables, only 4 variables were found to contribute significantly towards the extent of crop diversification. The variables viz. size of operational land holding, scientific orientation and economic motivation had positive and significant contribution towards extent of crop diversification at 0.01 level, whereas the variable farm mechanization was positively and significantly correlated with extent of crop diversification at 0.05 level. The value of  $R^2$  (0.787) indicated that that 7 independent variables selected for regression could predict 74.50 per cent of the variation in extent of crop diversification. In the pooled sample of farmers, out of 10 independent variables, 7 variables were found to contribute significantly towards the extent of crop diversification. The variables viz. size of operational land holding, scientific orientation, risk orientation, economic motivation, innovativeness and management efficiency had positive and significant contribution towards extent of crop diversification at 0.01 level, whereas the variable degree of information exposure had positive and significant contribution towards extent of crop diversification at 0.05 level. The value of  $R^2$  (0.813) indicated that 10 independent variables selected for regression could predict 81.30 per cent of the variation in extent of crop diversification. Findings of correlation analysis of enterprise diversification reveal that, in case of both marginal and medium farmers, 8 independent variables and in case of small farmers 12 independent variables were significantly correlated with the extent of enterprise diversification. In the pooled sample of farmers, 9 independent variables were significantly correlated with the extent of enterprise diversification. The findings of regression analysis of enterprise diversification revealed that, in case of marginal farmers out of 8 independent variables, only 3 variables were found to contribute significantly towards the extent of enterprise diversification. The variables viz. size of operational land holding, innovativeness and management efficiency had positive and significant contribution towards extent of

enterprise diversification at 0.05 level. The value of  $R^2$  (0.829) indicated that 8 independent variables selected for regression could predict 82.90 per cent of the variation in extent of enterprise diversification. In respect of small farmers, out of 12 independent variables, only 5 variables were found to contribute significantly towards the extent of enterprise diversification. The variables viz, education level and attitude towards agricultural diversification had positive and significant contribution towards extent of enterprise diversification at 0.01 level, whereas the variables size of operational land holding, social participation and innovativeness had positive and significant contribution towards extent of enterprise diversification at 0.05 level. The value of  $R^2$  (0.831) indicated that 12 independent variables selected for regression could predict 83.10 per cent of the variation in extent of enterprise diversification. In case medium farmers, out of 8 independent variables, only 4 variables were found to contribute significantly towards the extent of enterprise diversification. The variables viz. size of operational land holding, degree of information exposure and attitude towards agricultural diversification had positive and significant contribution towards extent of enterprise diversification at 0.01 level whereas the variable economic motivation had positive and significant contribution towards extent of enterprise diversification at 0.05 level. The value of  $R^2$  (0.745) indicated that 7 independent variables selected for regression could predict 74.50 per cent of the variation in extent of enterprise diversification. In the pooled sample of farmers, out of 9 independent variables, 6 variables were found to contribute significantly towards the extent of enterprise diversification. The variables viz., age, degree of information exposure, innovativeness, management efficiency and attitude towards agricultural diversification had positive and significant contribution towards extent of enterprise diversification at 0.01 level whereas, the variable operational land had positive and significant contribution towards extent of enterprise diversification at 0.05 level. The value of  $R^2$  (0.813) indicated that 9 independent variables selected for regression could predict 81.30 per cent of the variation in extent of enterprise diversification. Findings of correlation analysis of livelihood security revealed that in case of marginal farmers, 13 independent variables and in case of both small and medium farmers, 7 independent variables were significantly correlated with the level of livelihood security. In respect of pooled sample of farmers, 12 independent variables were significantly correlated with the level of livelihood security. The findings of regression analysis of livelihood security revealed that, in case of marginal farmers out of 13 independent variables, 5 variables were found to contribute significantly towards the level of livelihood security. The variables social participation and innovativeness had positive and significant contribution towards level of livelihood security at 0.01 level whereas, the variables size of operational land holding, risk orientation and management efficiency had positive and significant contribution towards level of livelihood security at 0.05 level. The value of  $R^2$  (0.929) indicated that 13 independent variables selected for regression could predict 92.90 per cent of the variation in level of livelihood security. As regards small farmers, the variables size of operational land holding, social participation, economic

motivation, innovativeness and management efficiency had positive and significant contribution towards level of livelihood security at 0.01 level. The value of  $R^2$  (0.849) indicated that 7 independent variables selected for regression could predict 84.90 per cent of the variation in level of livelihood security. In respect of medium farmers, out of 6 independent variables, 3 variables were found to contribute significantly towards the level of livelihood security. The variables social participation, economic motivation and innovativeness had positive and significant contribution towards level of livelihood security at 0.01 level. The value of  $R^2$  (0.776) indicated that 6 independent variables selected for regression could predict 77.60 per cent of the variation in level of livelihood security. In the pooled sample of farmers, out of 12 independent variables, only 5 variables were found to contribute significantly towards the level of livelihood security. The variables social participation, economic motivation, innovativeness and management efficiency had positive and significant contribution towards level of livelihood security at 0.01 level whereas, the variable size of operational land holding had positive and significant contribution towards extent of enterprise diversification at 0.05 level. The value of  $R^2$  (0.873) indicated that 12 independent variables selected for regression could predict 81.30 per cent of the variation in level of livelihood security. “Lack of finance to start a new enterprise”, “high cost of labour” and “Lack of information regarding scientific cultivation of crops” were perceived by the marginal farmers as the three most important constraints in diversification. “Lack of finance to start a new enterprise”, “High cost of labour” and “High cost of animal feed” were perceived by both small and medium farmers as the three most important constraints in diversification.

## **Perceived assessment of utilization pattern of remittance – A study on interstate migration from Assam to Kerala**

*Shinu Thomas*

The present study was carried out in Ernakulam district of Kerala with the objectives to study the profile characteristics of migrants from Assam and their perceived utilization pattern of remittance along with the perceived reason for out-migration and the relation between profile characteristics and perceived reason for migration. A total of 120 migrant respondents were selected by following the snowball sampling technique. Appropriate statistical tools viz. frequency, percentage, mean, standard deviation, mean score, and chi-square analysis were employed to analyze the data.

The findings revealed that 55 per cent of the respondents were having 25-30 years of age and majority of the respondents were male. 51.66 per cent of the respondents had high school level education and 38.33 per cent were from Nagaon district of Assam. Moreover, 59.16 per cent of the respondents were unmarried. 55.83 per cent of the respondents belonged to the nuclear family and 60.83 per cent were having a family size of 4 to 6 members. 78.33 per cent of the respondents had marginal land holdings up to 1 ha and 55.83 per cent of the respondents annual family income at source was between Rs.45000 to Rs.60000. 53.33 per cent of the respondents were having one migrant in their family. 94.16 per cent of the respondents migrated for doing unskilled jobs and 60 per cent of the respondents were working in the construction sector. 68.33 per cent of the respondents stayed in the destination for a range of 1 to 5 years. 43.33 per cent of the respondents' motivational source for out-migration was family members. 51.66 per cent of the respondents were having medium level of economic motivation. 71.66 per cent of the respondents were having a monthly income between Rs.14000 to Rs.18000 at the destination. 75.83 per cent of the respondents were sending an amount between Rs.11000 to Rs.15000 as remittance to their place of origin. 80 per cent of the respondents were using banks as the means for sending remittances and majority of the respondents were sending remittances monthly. 94.16 per cent of the respondent households were using the remittance for household consumption. The

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highest impact of the remittance was seen on the increased family income. 88.33 per cent of the respondents were having a high perception on pull factors of outmigration. 77.5 per cent of the respondents perceived decreased wage rates as the main push factor for out-migration. 92.5 per cent of the respondents perceived higher wages as the major pull factor for out-migration. Chi-square analysis revealed an association between push determinants of migration and profile characters like marital status, family size, landholding size, annual income, the purpose of migration, and remittance. And also chi-square analysis revealed an association between pull determinants and the number of migrants in the family, the purpose of migration, motivation for migration, and income at source.

## **An appraisal of Farmer Producer Organisation operating in Assam And Karnataka**

*Somesh Hiremath*

Farmer Producer Organisations are argued to be the institutions which can protect small farmers from exploitation of middlemen or make them participate successfully in modern competitive markets. Considering the importance of FPOs in farming community the present study entitled 'An appraisal of Farmers Producer Organization operating in Assam and Karnataka' was designed with following objectives-

1. To assess the business characteristics of Farmer Producer Organization.
2. To explore the activities performed by Farmer Producer Organization.
3. To study the performance level of Farmer Producer Organization.
4. To find out the problems faced by Farmer Producer Organization and its members in performing their roles.

The study was carried out in Nalbari and Dharwad district of Assam and Karnataka respectively where three FPOs from each district were selected randomly. Data was collected from randomly selected farmer members, office bearers and board of directors/FPO managers of the respective FPOs. To study all these aspects of the FPO i.e., business characteristics, activities performed and performance levels of the participating FPO, an appropriate schedule was prepared and data was collected from all the selected respondents. For processing the data, statistical methods like frequency, mean, percentage, standard deviation, coefficient of variance, rank, t-test, discriminate analysis were used with the help of Microsoft excel and Statistical Package for Social Sciences (SPSS) software.

The study revealed that majority of farmers were middle aged (35 to 55 yrs) and had completed high school education. Majority of farmers in Assam had land holding up to 1 ha and farmers in Karnataka had land holding between 2-4 ha with a cropping intensity between 95.4 to 137.47 %. Majority of respondents had a farming experience between 10-25 yrs. The mean credit availability of the farmers of Assam was Rs 37,701 and for the farmers of Karnataka it was Rs 1,68,409.1, the major source of credit was institutional banks for majority of farmers of both the states. Majority of respondents

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had a moderate level of economic orientation along with the moderate level of innovativeness. Majority of farmers of Assam had low mass media exposure while in Karnataka farmers had high mass media exposure. Majority of farmers had high level of 8 training exposure and majority of farmers of Assam were trained at KVK, Nalbari while in Karnataka majority farmers were trained at SAU. From the study it was observed that majority of office bearers were young aged (18-35 yrs) and majority office bearers had graduate level education level. Majority of office bearers had a low level of work experience (less than 10 yrs) and majority of office bearers had moderate level of achievement motivation.

The study also revealed majority of the FPOs had high level of profit motive, risk and uncertainty bearing ability, selling behaviour and capital utilization. Study also revealed that supply of inputs, extension services, procurement and packaging of the produce, insurance, value addition to the produce, formation of FIGs, and implementation of government sponsored schemes were some major activities of the FPOs. Study also revealed that out of six FPOs only two of them had a direct linkage with the processing units for the sale of the produce. It was observed that there was a difference in the performance levels between state of Assam and Karnataka in 13 out of 16 different dimensions of FPOs. The overall performance was better in case FPOs of Karnataka than Assam (Wilks  $\lambda$ -0.220 and X<sup>2</sup> value-186.261).

The findings from the study suggested that FPOs of Assam should give more emphasis in business orientation, input supply to farmer members, exploring marketing opportunities and mobilization of farmers for group activities. FPOs should establish better linkage with processing units/companies for assured market. Custom hiring centre should be established in each FPOs of Assam for speed up mechanization in agriculture.



## **Preparation and analysis of whey based fruit beverage**

*Ananya Borah*

Whey is the largest by-product of dairy industry with some proteins of nutritional and therapeutical benefits. These proteins are popularly known as whey proteins. Apart from its nutritional and therapeutical benefits, the utilization of whey has been done to produce different products like beverages in combination with fruit juice, soups, lactose derivatives, etc. In the present study, the compositional analysis of cow milk, buffalo milk and goat milk was done. The highest protein content was found in buffalo milk (3.6%), followed by goat milk (3.48%) and cow milk (3.34%). The highest carbohydrate content was observed in cow milk (4.84%), followed by buffalo milk (4.37%) and goat milk (3.98%). The goat milk showed highest ash content (0.8%), followed by buffalo milk (0.75%) and cow milk (0.7%). Fat content was recorded to be highest in buffalo milk (5.2%), followed by cow milk (3.6%) and goat milk (3.3%). Comparative analysis of whey protein was done in all the three milk sources. The highest whey protein was found in goat milk (0.50%), followed by buffalo milk (0.44%) and cow milk (0.39%). SDS-PAGE was run, where protein bands of ~35 kDa and ~14 kDa were observed in all the three milk sources of whey. Finally, the investigation was extended to the preparation of whey based fruit beverage with different concentrations of whey from cow milk, buffalo milk, and goat milk, and the fruit juices from pomegranate and orange. These beverages were analyzed for some important physiochemical parameters like TSS, pH, acidity, viscosity, microbial count and acceptability. The beverages were stored up to 21 days and analysis was carried out for all the above cited parameters at 7 days interval. The results thus obtained exhibited that on storage, TSS, acidity and viscosity for all the different kinds of beverages thus prepared increased significantly. However, the pH values were found to be decreased considerably over time during storage in all the cases. Again, in all the cases, microbial growth was observed from 7 days onwards. The comparative sensory evaluation was also carried out in both the whey based fruit beverages. Cow milk based pomegranate beverage (60:40 V/V) scored the highest point, 6.50 among all the different whey based pomegranate formulations. Again, the buffalo milk based orange beverage (60:40, V/V)

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**Major Adviser: Dr. Tankeswar Nath**

scored the highest point, 6.25 for overall acceptance among the different whey based orange beverage formulations. Comparing the two best formulations from whey based pomegranate and whey based orange beverages, it can conclude that the cow milk based pomegranate beverage (60:40 V/V) has the highest acceptability scoring the maximum point, 6.50 in the 9 point hedonic rating scale. The prepared whey based pomegranate and orange beverages can be utilize for further exploration.

## **Quality of elephant apple (*Dillenia indica* L.) powder as affected by drying methods**

*Aradhana Boruah*

Elephant apple (*Dillenia indica* L.) locally known as outenga in Assam is native to southeastern Asia. The fruits possess great medicinal properties and are rich in fiber,  $\beta$ -carotene, vitamins (B and C), carbohydrates and proteins. Higher moisture contents, seasonal availability and lack of proper processing techniques make it one of the most neglected wild fruits which have the potential to provide an income source if properly utilized. The present study was carried out to identify the suitable stage of fruit development and the drying method for maximum retention of quality of elephant apple fruit powder for getting its benefits during the off season. Different drying methods (oven drying at 50°C and 70°C, sun drying, solar drier drying and shade drying) were taken for the study. Flowers were tagged at first opening (days after flowering). Nutritional composition was investigated at 75, 100, 120 and 150 days after flowering under different drying methods. Significant differences in the nutritional parameters were observed in respect of growth stages of fruit and drying methods employed. Interaction between fruit development and drying methods was also found significant except for total carbohydrates. Solar drying was found better in maximum retention of crude fibre, total carbohydrate, ascorbic acid and anthocyanin. Whereas oven drying at 70°C was found better for moisture, ash & tannin and sun drying was found better for crude protein and total flavonoid. Fruit of 120 DAF was found nutritionally superior over other growth stages. Antioxidant activity of the elephant apple powder was found with fruit development drying methods employed and their interaction. Lowest activity was observed in 120 DAF dried under shade drying, whereas highest activity was found in 120 DAF dried under oven drying at 50°C, but 100 days old fruits showed better inhibition than the others.

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**Department: Food Science and Technology (Horticulture)**

**Major Adviser: Dr. Samindra Baishya**

## **Effect of seed priming and germination media on growth, flowering, and seed production of annual bedding dahlia (*Dahlia variabilis*)**

*Biprajit Datta Choudhury*

An experiment entitled “Effect of seed priming and germination media on growth, flowering, and seed production of annual bedding Dahlia (*Dahlia variabilis*)” was conducted for two years during Oct, 2018 - Apr, 2019 and 2019-20 in the Horticulture Experimental Farm, Assam Agricultural University, Jorhat with the objectives to assess the seed germination, seedling vigour, plant growth, flower and seed production of annual Dahlia as influenced by different seed priming treatments and germination media. A laboratory experiment was conducted by treating the seeds with five priming agents, viz. Hydropriming (P1), CaCl<sub>2</sub>@1% (P2), GA<sub>3</sub>@100ppm (P3), Salicylic acid@200ppm (P4), and Untreated Control (P5) and sown in Whatman Filter paper. Pooled data of two years revealed that GA<sub>3</sub>@100ppm (P3) treated seeds recorded significantly higher germination (87.78 %), seedling length (10.35 cm), and the highest seedling vigour index (909.14), followed by CaCl<sub>2</sub>@1%.

Three media compositions viz. M1 Cocopeat+Perlite+Vermiculite (2:1:1), M2 Cocopeat+Enriched Compost (1:1) and M3 Cocopeat+ Enriched Vermicompost (1:1) were filled up in plug trays of V-Type nursery and the seeds primed with five agents were sown for raising the seedlings. The seeds in P3M3 recorded the highest rate of germination and healthy seedling growth among all the treatments. The seedlings primed with GA<sub>3</sub>@100ppm (P3) exhibited better field performance after transplanting while those raised in M3 (1 Cocopeat+1 Enriched Vermicompost) media showed better results as compared to the other media compositions. Combined effect of P3M3 (GA<sub>3</sub>@100ppm and 1:1 Cocopeat+ Enriched Vermicompost) recorded significantly better vegetative growth in terms of plant height and spread (56.81 cm and 44.51 cm), leaf production (60.48 nos./plant), leaf length and breadth (6.11 cm and 4.29 cm), branch number and length (7.12 and 5.37 cm, respectively), followed by P1M3 (Hydropriming and Cocopeat+ Enriched Vermicompost). Increased flower production (26.00 nos. per plant), larger flower diameter (7.10 cm) and flower weight

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(4.30g), seed yield per plant (7.39g) and total seed yield (4.92 q/ha) was recorded with P3M3.

Analysis of the production economics indicated that for raising annual Dahlia seedlings, sowing GA3 primed seeds in (1:1) Cocopeat+Enriched Vermicompost (M3) media composition was most remunerative (1.17), followed by P4M3 and P3M2 (B: C ratio 1.16 and 1.15 respectively). However, in the main field P3M3 (GA3@100ppm and Cocopeat+Vermicompost((1:1)+Microbial Consortia) proved to be most effective treatment combination with reference to plant growth and flower production. The maximum seed production (4.92 q/ha) was also obtained with P3M3 resulting in the highest Benefit: Cost ratio (7.77), which was followed by P3M1(6.76). The lowest B: C ratio of 2.98 was recorded in P5M2 (1:1 Cocopeat+Enriched Compost without priming).

## **Nutrient management in Thailand ber (*Zizyphus mauritiana*)**

*Bipul Das*

An experiment was conducted to study the “Nutrient management in Thailand ber (*Zizyphus mauritiana*)” in the Experimental Farm and Laboratory, Department of Horticulture, Assam Agricultural University, Jorhat during 2018-2019. A total of 7 (seven) treatments including a control with three replications were laid out in a Randomized Block Design. The treatments comprising of T0: Control; T1: N:P:K @ 50:75:100g/Plant after pruning and 3 months after pruning (MAP); T2: N:P:K @ 50:75:100g/plant after pruning, 3 MAP and 6 MAP; T3: N:P:K @ 75:100:125g/plant after pruning and 3 MAP; T4: N:P:K@75:100:125g/plant after pruning, 3 MAP and 6 MAP; T5: N:P:K@100:125:150g/plant after pruning and 3 MAP; T6: N:P:K@100:125:150g/plant after pruning, 3 MAP and 6 MAP with the objective to develop the nutrient requirement of Thailand ber.

During the period of investigation, the treatments showed varied response to flowering, fruiting, yield attributing characters, yield and quality of fruits. The highest flowers per cluster (14.00), flowers per branch (322.00), fruits per branch (229.67), canopy volume (8.58m<sup>3</sup>), fruiting percentage (71.47%), fruit length (4.90cm), fruit girth (4.37cm), fruit volume (39cc), fruit weight (41.33g), pulp weight (36.00g) and peel weight (3.23g) were recorded in treatment T6 while the lowest values were recorded in T0 (Control). The minimum number of days taken for flowering (121.33) and flowering to harvesting interval (71.67) were recorded in treatment T6 while the maximum was recorded in T0 (Control). The yield was found to be the highest (9.45kg/branch) and (7.20ton/ha) in T6 treatment.

Among the quality parameters, the treatment T6 recorded the highest TSS (19.00%), ascorbic acid (69.45mg/100g), total sugar (14.46%), reducing sugar (7.69%), non-reducing sugar (6.77%).

After the application of the treatments, the highest leaf N, P, K contents were recorded in the treatment T6. Soil parameters studies revealed that, organic carbon, N, P and K were found to be the highest in T6.

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**Major Adviser: Dr. U. Kotoky**

Evaluation from the economics of cultivation showed that, the highest benefit-cost ratio of 3.77 was obtained in T6 followed by 3.74 in T5. The lowest B:C ratio (2.51) was recorded in T0 (Control). Thus, it can be suggested that, the treatment T6 is most profitable to improve flowering, fruiting, yield and quality of Thailand ber.

## **Studies on effect of different mulches on growth and yield of chilli (*Capsicum annum* L.)**

*Chayanika Das*

The present investigation entitled “Studies on effect of different mulches on growth and yield of chilli (*Capsicum annum* L.)” was carried out during 2018 to 2020. The field experiment was conducted in the ICR Farm, Department of Horticulture, B N College of Agriculture, AAU, Biswanath Chariali to evaluate (i) The performance of different mulching materials on growth and yield of chilli and (ii) To study the effect of different mulching materials on soil moisture content and soil temperature. The experiment was laid out in RBD design with four replications incorporating six treatments *viz.*, mulching with black polyethene (T1), mulching with white polyethene (T2), mulching with transparent polyethene (T3), mulching with dry banana leaves (T4), mulching with paddy straw (T5) and control, without mulching (T6).

The morpho-physiological, phenological and yield attributing parameters were significantly influenced by mulching treatments. Among the treatments, T1 produced significantly highest plant height (18.91 cm, 37.13 cm, 68.04 cm and 76.64 cm at 30, 60, 90 and 120 DAP respectively), total number of branches per plant (8.59, 17.92, 49.26 and 64.36 at 30, 60, 90 and 120 DAP respectively), primary branches per plant (8.08, 12.00, 15.73 and 19.53 at 30, 60, 90 and 120 DAP respectively) and plant spread of 67.91 cm at the time of first harvest. The same were lowest in T3. Moreover, T1 took shortest 44.32 days to first flower appearance, 118.17 days to first harvest and longest 182.06 days to last harvest. Highest RLWC (72.75%), chlorophyll content (1.61 mg g<sup>-1</sup> fw) and CSI (0.50) were recorded in T1. The same treatment also maintained the highest fruit yield (20.18 t/ha), number of fruits per plant (93.85), length of fruit (4.76 cm), fruit girth (2.75 cm), fruit fresh weight (1.30 g), fruit dry weight (0.50 g) and fruit volume (2.21 cc) which was followed by T2 and T4.

The highest soil moisture content at 0-15 cm and 15-30 cm depth, lowest weed population (317.25 No./plot, 404.25 No./plot and 517.75 No./plot at 30, 90 & 150 DAP respectively), weight of weed per plot were found in T1. during the crop growth period. Whereas, T3 recorded the highest soil temperature.

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However, the B:C ratio was highest in T4 (4.85) followed by T5 (4.20) and T1 (3.17). Therefore, organic mulching (T4 and T5 ) may be recommended to the chilli growers of Assam for maximizing profit with higher production rate.

## **Standardization of propagation of jackfruit (*Artocarpus heterophyllus* Lam.) by grafting**

*Debashree Baruah*

The present investigation entitled “Standardization of propagation of jackfruit (*Artocarpus heterophyllus* Lam.) by grafting” was carried out during 2018-2019 in the Instructional cum Research Farm of Biswanath College of Agriculture, AAU, Biswanath Chariali with two objectives viz. i) To determine the suitable time for propagation of jackfruit by grafting. ii) To assess the vegetative growth of grafts. The experiment was laid out in Completely randomized design (CRD) with three replications. The treatments were T1: March, T2: April, T3: May, T4: June, T5: July, T6: August, T7: September.

The growth parameters, phenological characters, physiological parameters were significantly influenced by time of grafting. The results of the investigation revealed that among the different treatments, T1 (March) showed better results in growth parameters like graft success rate (85.67%), graft survival rate (83.47%), longest scion growth (11.17 cm), longest leaf (12.67 cm), broadest leaf (7.25 cm), Bigger leaf (2.38 cm<sup>2</sup>), No. of leaves per graft (5.50). T1 also showed better results in physiological parameters like leaf area index (3.68), chlorophyll ‘a’ and chlorophyll ‘b’ was also highest (0.75 and 0.58 respectively). Phenological parameters like sprouting of buds after grafting was fastest (19.33 days) in grafts done in March (T1). The grafts produced in April (T2) recorded highest number of new shoots (1.91) per graft after 90 days of grafting. The percentage of survival of grafts gradually decreased from March to September under the study.

Days after grafting significantly influenced the percentage of success. Highest graft success was observed in 30 DAG (85.67%). Graft success declined steadily till 60 days after grafting and more reduction was observed at 90 days after grafting. Bud sprouting recorded at 3 different stages decreased gradually from month of March to September. In all the stages of observation, T7 (September) recorded the lowest bud sprouting. Grafting done in March required shortest period for bud sprouting and the period gradually longer till September (24.55 days).

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In the present study, graft success, survival percentage of grafts and growth of scions, leaf length and breadth after grafting were observed to be better in the grafts produced during March to June. Thus, it can be estimated that the time period from March to June will be the best time for the farmers of Assam (which is a sub-tropical region), to carry out the grafting method in jackfruit for propagation.

## **Response of chinese cabbage (*Brassica campestris* ssp. *Pekinensis*) to organic amendments**

*Dilsha Chandran*

An experiment entitled “Response of Chinese cabbage (*Brassica campestris* ssp. *Pekinensis*) to organic amendments” with the objective of “to assess the growth, yield and quality of chinese cabbage under the different organic amendment” was carried out with var. G-HA01 with eleven organic amendment laid in thrice replicated blocks of randomly allotted plots. The treatments were T1: Farmyard manure (FYM) 5 tonnes per ha, T2: Farmyard manure (FYM) 10 tonnes per ha, T3: Farmyard manure (FYM) 15 tonnes per ha, T4: Farmyard manure (FYM) 20 tonnes per ha, T5: FYM 5 tonnes + Azotobacter 0.16 tonnes per ha, T6: FYM 10 tonne per ha + Azotobacter 0.16 tonnes per ha, T7: FYM 15 tonnes + Azotobacter 0.16 tonnes per ha, T8: FYM 20 tonnes + Azotobacter 0.16 tonnes per ha, T9: Enriched compost 1.33 tonnes per ha, T10: Vermicompost 3 tonnes per ha, T11: Vermicompost 3 tonnes + Azotobacter 0.16 tonnes per ha. The observed parameters have revealed that for all of the field parameters the performance of Chinese cabbage treated with FYM 10 tonnes + Azotobacter 0.16 tonnes per ha were the best. Petiole length was least affected by different organic amendment. Enriched compost 1.33 tonnes per ha could not produce any remarkable impact on most of the observed parameters. The nitrogen content and crude protein content were maximum (3.24%, 20.24%) in FYM 20 tonnes + Azotobacter 0.16 tonnes per ha. The TSS content was maximum (6.41degree brix) in Vermicompost 3 tonnes + Azotobacter 0.16 tonnes per ha. The best shelf life was imparted by FYM 20 tonnes + Azotobacter 0.16 tonnes per ha (11.93days). The final soil NPK content and organic carbon content were the highest in crop treated with FYM 20 tonnes + Azotobacter 0.16 tonnes per ha (667.13,28.86,187.63 and 0.37). The final mcrobial biomass of soil was the highest (488.45%) in Vermicompost 3 tonnes + Azotobacter 0.16 tonnes per ha. FYM 10 tonnes per ha gave the highest benefit cost ratio (8.58).

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## **Integrated Nutrient Management in Lemon var. Assam lemon (*Citrus limon* L. Burm.)**

*Eleza Baro*

An experiment on “Integrated nutrient management in lemon var. Assam Lemon (*Citrus limon* L. Burm.)” was conducted during 2018-2020 at Instructional cum Research Farm, Department of Horticulture, B.N. College of Agriculture, AAU, Biswanath Chariali to study the effect of the integrated nutrient management (INM) on growth, yield and quality of Assam Lemon, to study the soil physical and chemical properties under INM and to standardize the suitable integrated nutrient management practices in Assam Lemon. Eight treatment combinations were laid out in Randomized Block Design with three replications in the field. The treatments were T1 (RDF *i.e.* Recommended dose of fertilizer), T2 (vermicompost @ 20 kg/plant), T3 (vermicompost @ 20 kg/plant + consortium @ 20 g/plant), T4 (enriched compost @ 20 kg/plant), T5 (75% RDF + enriched compost @ 20 kg/plant), T6 (75% RDF + vermicompost @ 20 kg/plant + consortium @ 20 g/plant), T7 (50% RDF + enriched compost @ 20 kg/plant) and T8 (50% RDF + vermicompost @ 20 kg/plant+ consortium @ 20 g/plant). The results revealed that treatments T6 (75% RDF + vermicompost @ 20 kg/plant + consortium @ 20 g/plant) showed maximum plant height (1.95 m), number of laterals per primary shoot (4.53), number of leaves (19.48) and total leaf area (522.64 cm<sup>2</sup>) with average number of hermaphrodite flower (62.49 per plant) during May 2019, fruit set (31.41% in April, 2019), total number of fruits (516.08 per plant) harvested during one year of study, fruit weight (153.92 g), fruit volume (168.43.38 cc) , pulp-peel ratio (3.27) with average fruit juice (27.59%), titratable acidity (5.01%), ascorbic acid content (39.82 mg/100ml) while longest fruit (12.50 cm) was recorded in the plants treated with T8 (50% RDF + vermicompost @ 20 kg/plant + consortium @ 20 g/plant) and maximum diameter (5.59 cm) of the fruit was recorded in T5 (75% RDF + enriched compost @ 20 kg/plant). Total chlorophyll content (1.25 mg/g of fresh weight), organic carbon content (1.34%), soil moisture content (23.32% at 0-20 cm depth and 21.45% at 20-40 cm depth) were highest in T6 (75% RDF + vermicompost @ 20 kg/plant + consortium @ 20 g/plant). Leaf nitrogen content (2.20%) was highest in T8, highest leaf

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phosphorus content (0.15%) in T3 and T8, the highest leaf potassium content (1.60%) was recorded in T6 and T5. Soil pH was highest in T3 and T8. In soil, the highest available N (291.16 kg/ha) was observed in plants treated with T1, while the highest phosphorus (27.81 kg/ha) was observed in T2 (vermicompost @ 20 kg/plant) and the highest potassium (173.06 kg/ha) was found in T8 (50% RDF + vermicompost @ 20 kg/plant + consortium @ 20 g/plant). The growth, yield and quality attributing characters of Assam lemon and improvement of soil parameters and benefit-cost ratio were higher in the plants treated with combination of 50 per cent inorganic and organic manures along with consortium. Though the highest benefit-cost ratio (5.48) was recorded in 100 per cent chemical fertilizers applied plants but considering the growth, yield and quality of Assam lemon fruits and improvement of soil parameters, the treatment T6 (75% RDF + vermicompost @ 20 kg/plant + consortium @ 20 g/plant), T7 (50% RDF + enriched compost @ 20 kg/plant) and T8 (50% RDF + vermicompost @ 20 kg/plant + consortium @ 20 g/plant) might be recommended for integrated nutrient management in Assam Lemon. Continuous application of chemical fertilizers would deteriorate soil parameters and the production of plants would gradually decrease. On the other hand, integrated nutrient management would gradually improve the soil condition and increase production in long run.

## **Ready-to-reconstitute soup mix from *Moringa* leaf and *Mentha* leaf powders**

*Jadhav Priyanka Yashwant*

An experiment was carried out in order to develop ready-to-reconstitute soup mix from *Moringa* leaf and *Mentha* leaf powders in the Food Science and Technology Laboratory of Department of Horticulture, AAU, Jorhat during 2018-2020. *Moringa* leaves and *Mentha* leaves are of one the old ingredients used in Indian cuisine owing to their nutritive value, flavor and medicinal properties. This study was aimed to develop a reduced bulk, nutrient dense health food i.e. Ready-to-reconstitute soup mix as a nutritional and functional product. The formulations F1, F2, F3, F4 and F5 were developed by varying the proportions of *Moringa* and *Mentha* leaf powders where the ratios of *Moringa* leaf powder to *Mentha* leaf powder were (50:5), (45:10), (40:15), (35:20), and (30:25) respectively. Corn flour was added as thickening agent along with spice mix and citric acid. *Moringa* and *Mentha* leaves were dehydrated in a cabinet drier at 50°C for 3 to 4 hours and 70 °C for 5 to 6 hours respectively using the established procedures. The preliminary trials were conducted using a 9-point Hedonic rating scale in order to optimize the proportion of ingredients in the soup mixes. The developed formulations were reconstituted with the hot water in ratio 1:15 which was found to be most preferable level for reconstitution of soup mix. The developed ready-to-reconstitute soup mixes were subjected to physicochemical and sensory analysis where the formulations were found rich in protein, ash content, carbohydrates and micronutrients like iron. Formulation F4 was selected for storage study for two months based on its good nutritive profile and highest scores in sensory attributes like appearance, colour, taste, flavor, texture, consistency, mouthfeel and overall acceptability. The physicochemical analysis at the end of storage period showed that formulation F4 contained 8.48% moisture content, 4.99% ash content, 16.89% crude protein content, 62.51% carbohydrate content, 6.3% crude fat content, 5.10% crude fibre content, 1651.81mg/100g Calcium and 4.83mg/100g iron. The rehydration ratio, water absorption capacity and bulk density of formulation F4 had values 3.15, 1.95g/ml and 0.77g/ml respectively. The developed soup mix was also found to be organoleptically

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acceptable at the end of two months without deterioration in quality. The formulations were found to be comparable with other commercial soup mixes in terms of cost of raw materials processing and packaging and high in terms of nutrition and suitable for consumption by all age groups.



## **Response of garden pea (*Pisum sativum* L.) to foliar application of zinc**

*Lupita Borah*

An experiment entitled “Response of garden pea (*Pisum sativum* L.) to foliar application of zinc” was conducted during the months of November-January 2018-19, at the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat with the objective to assess the growth, yield and quality of garden pea as influenced by foliar application of zinc. The experiment was laid out in a Randomized Block Design with five treatments which were replicated four times. The treatments were T1: Control, T2: 0.25% zinc, T3: 0.50% zinc, T4: 0.75% zinc and T5: 1.00% zinc. The application of 0.50% zinc in the form of zinc sulphate, applied through foliar application contributed significantly towards the yield and yield attributing characters like weight of the pod, number of seeds per pod, weight of seeds per pod and shelling percentage, which ultimately contributed towards highest pod yield per plant as well as per hectare. The results revealed that the fresh and dry weights of the plant as well as root weight per plant were also significantly higher in T3. Though, the number of pods per plant was found to be the highest in case of application of 0.25% zinc. Similarly, the highest plant height and number of branches were obtained in case of T4. Days to 50% flowering, days to harvest and shoot: root ratio were found to be non significant. The quality characters of the seeds showed significant variation among the treatments. T4 gave the highest nitrogen and hence crude protein content and also the starch content of seed, while the highest total sugar and TSS content was obtained in T5. The results revealed that, the highest available nitrogen, potassium and zinc content in soil was in T5. T3 and T5 showed the highest nitrogen and zinc content in leaves respectively, whereas T1 gave the highest leaf phosphorous content. The available phosphorous in soil and potassium content in leaves were found to be non significant. The economic analysis indicated that the foliar application of 0.50% zinc, that is T3 gave maximum benefit cost ratio of 2.72. However, T2 and T4 also showed good results with ratios of 2.48 and 1.99 respectively. In many instances the trend decreases after a particular point, due to negative effect of excess micronutrient application than the optimum amount needed, which affects the plant in various ways. In a broader view, it can be suggested

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from the present study that the one with 0.50% zinc application (T3) turns out to be the optimum treatment, beneficial towards improving the growth, yield and yield attributing characters along with maximum profit which is in compliance with the percentage of zinc foliar application as suggested by National Food Security Mission of India. Moreover, the application of 0.75% zinc is also notable regarding quality characters of the seeds.

## Standardization of growing media and assessment of plant species suitable for Vertical Gardening

*Madhushree Ghosh*

An experiment was carried out to standardize the growing media and assess plant species suitable for vertical gardening, constructed on the ground floor of the four-storey building of the Department of Horticulture of Assam Agricultural University, Jorhat during the year 2019-2020. The experiment was laid out in factorial completely randomized block design with three replications. Five ornamental plant species were selected for growing in the vertical garden which were subjected to five growing media. The five plant species selected were- S1 : Philodendron Ceylon (*Philodendron erubescens* ‘Gold’ K. Koch), S2: Spider Plant (*Chlorophytum comosum Variegatum* (Thunb.)), S3: Fern (*Nephrolepis exaltata* (L.) Schott), S4: Moses-in-the-cradle (*Rhoeo discolor* Sw. (syn. *Tradescantia spathacea*)) and S5: Baby Doll Cordyline (*Cordyline compacta Purple* (L.)). The media compositions were M1: soil + cocopeat + vermicompost + sand (3 : 0.25 : 1 : 1.5), M2: soil + cocopeat + vermicompost + sand (2.5 : 0.5 : 1.5 : 1.25), M3: soil + cocopeat + vermicompost + sand (2 : 0.75 : 2 : 1), M4: soil + cocopeat + vermicompost + sand (1.5 : 1 : 2.5 : 0.75) and M5: Soil.

The data analysis over the period of time revealed that growing medium M3 which was characterized by pH of 6.58, water holding capacity of 34.44% and total porosity of 47.42 % had a positive response on the growth and physiological characters of the plant species. The growth responses of the plant species grown in medium M2 followed those of the medium M3, while the least response was recorded in medium M5.

In Philodendron Ceylon (S1), the highest plant height (25.17 cm), canopy diameter (23.47 cm), number of leaves per plant (12.00), leaf length (14.24 cm), leaf breadth (4.83), leaf area (68.73 cm<sup>2</sup>), root number (11.73), longest root (16.63 cm) and root volume (12.22 cm<sup>3</sup>) was recorded in medium M3 followed by medium M2. This medium (M3) also recorded maximum net assimilation rate (0.076 mg/cm<sup>3</sup>), relative leaf water content (96.43%), total chlorophyll content (2.73 mg/g) and leaf area duration (75.33) in Philodendron. Out of the five species, Philodendron Ceylon recorded maximum mean root volume (11.78 cm<sup>3</sup>) and the highest mean physiological

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parameters- mean net assimilation rate (0.050 mg/cm<sup>3</sup>), relative leaf water content (95.86 %) and total chlorophyll content (2.10 mg/g). This species also recorded the highest ornamental value index (8.67). Moses-in-the-cradle (S4) performed best in medium M3 in terms of both growth and physiological parameters. It recorded highest plant height (31.33 cm), canopy diameter (24.70 cm), number of leaves (30.00), leaf area (83.52 cm<sup>2</sup>), root number (17.30), root volume (9.93 cm<sup>3</sup>) and root length (12.50 cm) in medium M3. Again it recorded the second highest net assimilation rate (0.038 mg/cm<sup>3</sup>), relative leaf water content (85.89 %) and leaf area duration (84.66) among all the species. It also achieved an ornamental value index of 8.14, which was the second of the five species.

Ferns (S3) grown in medium M3 recorded the highest plant height (21.86 cm), canopy diameter (21.60 cm), number of leaves per plant (22.67), leaf length (16.48 cm), leaf breadth (6.16 cm), leaf area (89.16 cm<sup>2</sup>), root number (32.83) and root length (19.40 cm). However, ferns had the lowest root volume (7.52 cm<sup>3</sup>) among all the species. It also recorded the lowest mean net assimilation rate of 0.015 mg/cm<sup>3</sup> and relative leaf water content of 65.52 % among the five species. The least ornamental value index (5.85) was also observed in fern.

Thus, it can be worked out from the present investigation that growing medium M3 comprising of soil + cocopeat + vermicompost + sand in the ratio of 2: 0.75: 2: 1 by volume, followed by growing medium M2 could be considered as ideal for vertical gardening under Assam condition. Also, on the basis of their performances, it can be inferred that Philodendron Ceylon (S1) followed by Moses-in-the-cradle (S4) performed best, whereas ferns (S3) performed the least satisfactory among the five species in the vertical garden system.

## **Studies on different exotic varieties of Lettuce (*Lactuca sativa*) in agro-climatic condition of North Bank Plain zone of Assam**

*Mrutyunjaya Behera*

The present investigation entitled “Studies on different exotic varieties of Lettuce (*Lactuca sativa*) in agro-climatic condition of North bank plain zone of Assam” was carried out during 2018-2020 at the Instructional cum Research Farm, Department of Horticulture, B.N. College of Agriculture, AAU, Biswanath Chariali with two objectives viz., i) To study the growth, yield, and quality of different exotic varieties of lettuce and ii) To catalogue the pest and diseases in the different varieties of lettuce. The experiment was laid out in RBD with three replications incorporating seven treatments viz., ., Till (T1), Red Salad Bowl (T2), Lollo Rossa (T3), Lollo Bionda (T4), Batavia Rossa (T5), Corcarda (T6), and Pasha (T7). The morpho-physiological, phenological, yield and quality parameters were significantly varied among the seven treatments. Among the treatments, T6 produced significantly highest plant height (23.44 cm and 34.64 cm at 30 DAT and at harvest respectively), highest canopy spread (24.14 cm and 41.82 cm at 30 DAT and at harvest respectively), maximum number of leaves (21.11 and 42.00 at 30 DAT and at harvest respectively), and maximum leaf length and breadth (32.73 cm and 19.27 cm respectively) during harvest. Significant variations in leaf characters viz., shape, shape of apex, incision of margin, number of divisions, intensity of green colour, and area covered by anthocyanin coloration were observed among the varieties. Moreover, T1 took shortest duration (60 days) to first harvest, maximum harvest duration (26 days) and longest duration (86 days) to last harvest. Leaf area per plant (458.32 cm<sup>2</sup> and 1376.73 cm<sup>2</sup> at 30 DAT and at harvest respectively) and leaf area index (4.23 and 4.33 at 30 DAT and at harvest respectively) were found significantly more in T6. The maximum dry weight (28.21g) was recorded in T2, while T5 maintained the maximum fresh weight (557.64g) and the highest yield

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(41.31 t/ha).T3 contained significantly more amount of moisture content (96.10%) and ascorbic acid (24.57 mg/100g), whereas T6 contained significantly more amount (4.25 mg/100g) of vitamin A. There was no incidence of diseases in the vegetative stage of the crop. However Insect pest like, cutworm (*Agrotis ipsilon*) were observed at the initial stage and were controlled by incorporating malathion 5% dust near the root zone.

## **Performance of radish (*Raphanus sativus* L) cv Japanese white as influenced by organic inputs and microbial consortium**

*Nandeesh J*

An experiment was carried out on radish (*Raphanus sativus* L.) in Experimental farm, Department of Horticulture, AAU, Jorhat during 2018-2019 and 2019-2020 with the objective to assess the "Performance of radish (*Raphanus sativus* L.) cv Japanese white as influenced by organic inputs and microbial- consortium". The experiment was laid out in RBD with three replications. There were altogether 8 treatments, T1:(Rock phosphate + Consortium) ,T2:T1 +Compost (2.5 t ha-1), T3 : T1 +Compost ( 5t ha-1), T4 :T1+Vermicompost (2.5 t ha-1), T5: T1+Vermicompost (5 t ha-1),T6 :T1 +Enriched compost (2.5t ha-1), T7 : T1+ Enriched compost (5t ha-1)and T8 : RDF (50:50:100kg NPK ha-1) + FYM @10t ha-1.

Pooled analysis over two years revealed that the growth and yield attributing characters were significantly influenced by application of different nutrient sources. The mean performance of growth characters revealed that the highest plant height (32.84 cm), maximum number of leaves (16.31), maximum leaf length (24.91 cm), maximum leaf width (7.6 cm) and maximum leaf area index (3.42) was exhibited by treatment T8(RDF 50:50:100kg NPK ha-1) + FYM @10t ha-1) followed by 29.25 cm, 16.0, 22.73 cm, 7.35 cm and 3.35 respectively in T7 : T1+ Enriched compost (5t ha-1).Pooled data over two years revealed that the maximum root length (25.45cm), maximum root diameter (2.715cm), maximum root weight with top (224.4g), maximum root weight without top (197.0g), highest total yield (8.44 kg/plot), maximum percentage of forked roots(2.25 %) and maximum physiological loss in weight(40.42%) was found in treatment T8[(RDF 50:50:100kg NPK ha-1) + FYM @10t ha-1]. Among organic treatments, Maximum root length (24.26 cm), highest root weight with top(190 g),highest total yield(25.41 t ha-1) were found highest in the treatment T7(T1+ Enriched compost (5t ha-1). All the growth and yield parameters were significantly poor in T1:(Rock phosphate + Consortium).

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Among the quality parameters, maximum total soluble solids (4.14) and highest ascorbic acid(15.34 mg/100g) was found in treatment T7[(T1+Enriched compost(5t ha-1)]and highest total ash content (5.28) was found under T5:[T1+Vermicompost (5 t ha-1)].

Soil physico-chemical and biological properties showed significant difference among the treatments. The T7[(T1+ Enriched compost (5t ha-1))] recorded for the best soil parameters viz., highest soil pH (5.54), highest organic carbon (0.86%), highest available K (137.24 kg ha-1 ) and highest available P(64.02 kg ha-1 ). In case of biological properties of soil, T7 was found to be statistically superior in respect of highest microbial biomass carbon (277.70), maximum dehydrogenase activity (215.40) and maximum phosphomonoestearse activity (377.10) was found in the treatment T7(T1+ Enriched compost (5t ha-1). Further, highest available nitrogen (271.66 kg ha-1) and highest B:C ratio was found in T8(RDF 50:50:100kg NPK ha-1) + FYM @10t ha-1).

The cost economics indicated superiority of T8(RDF 50:50:100kg NPK ha-1)+FYM @10t ha-1) with 2.58 benefit-cost ratio followed by 2.50 in T6 :[T1 +Enriched compost (2.5t ha-1)].

Hence, considering the positive effect on growth, yield, quality and soil health, T7 is considered the best organic treatment for adopting at a field level to reap good economic yield with better quality, shelf life, sustained soil health and high returns.



## **Studies on quality of dried Oyster mushroom (*Pleurotus ostreatus*) and Milky mushroom (*Calocybe indica*) as influenced by various pre-treatment and selected drying temperatures**

*Nastalina Borah*

The present investigation was aimed to evaluate the effect of pretreatment and drying temperatures on quality of oyster (*Pleurotus ostreatus*) and milky (*Calocybe indica*) mushroom. Three chemical pretreatments: NaCl, KMS and Citric acid; each of 0.1% concentration and two hot air oven drying temperatures (45°C and 60°C) were employed in the present research work. After drying, the mushroom samples were processed into powdered form. The proximate analyses of the samples were studied followed by sensory evaluation. Among all the pre-treatments, mushroom pre-treated with Sodium Chloride (T1), was found to have higher amount of protein and crude fiber, when dried at lower temperature (D1). The highest value for calcium content was observed in KMS pre-treated (T2) oyster as well as milky mushroom irrespective of drying temperature. The mushroom samples pre-treated with KMS (T2) dried at 45°C temperature (D1) retained maximum whiteness. Sensory evaluation for texture showed greater score in Sodium Chloride (T1) pre-treated mushroom samples (*Pleurotus ostreatus* and *Calocybe indica*) followed by KMS (T2) and citric acid (T3) dried at lower temperature (D1). Aroma was found to be the highest in dried mushroom pre-treated with Sodium Chloride (T1). The drying temperature 45°C (D1) was found better for colour, texture and aroma in oyster mushroom (*Pleurotus ostreatus*) pre-treated with sodium chloride (T1). In case of milky mushroom the highest overall acceptability was observed in KMS pre-treatment (T2) combined with 45°C drying temperature (D1).

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**Major Adviser: Dr. Pritom Kr. Borthakur**

## **Organic amendments on growth, yield and quality of strawberry (*Fragaria x ananassa* Duch.)**

*Pooja Rayanna Bastawadkar*

An investigation entitled “Organic amendments on growth, yield and quality of strawberry (*Fragaria x ananassa* Duch.)” was conducted in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during the period 2019-2020. The field experiment was laid out in Randomised Block Design (RBD) with eight treatments replicated thrice under 50% shade net condition with spacing of 50cm x 25cm. The treatments were RDF @ 100:120:80 kg/ha NPK + FYM @ 10 tonnes/ha (T1), rock phosphate + microbial consortium (T2), T2 + compost @ 2.5t/ha (T3), T2 + compost @ 5t/ha (T4), T2 + vermicompost @ 2.5t/ha (T5), T2 + vermicompost @ 5t/ha (T6), enriched compost @ 2.5t/ha + microbial consortium (T7) and enriched compost @ 5t/ha + microbial consortium (T8).

The results revealed that growth, yield and quality attributing characters were significantly influenced by different nutrient sources. T6 was found to be the best in respect to growth parameters viz. plant height, number of branches, plant spread and number of leaves measured at 30 days interval, leaf area as well as days taken to first flower. The yield attributes were the highest in T6 viz. flower number (28.40), fruit number (16.27), fruit weight (13.57g), length (4.76cm), breadth (2.95cm), fruit yield per plant (201.03g/pl) and yield per hectare (7.47t/ha). Among quality parameters, T6 recorded the maximum specific gravity of fruit (1.81), juice content (91.78%), pH (3.02), TSS (7.190B), TA (0.51%), vit C (53.95mg/100g), RS (4.01%), non-RS (3.27%) and TS (7.28%). However, T6 yielded dark red and dull fruits with minimum lightness (L\*) of 41, H0 value of 20.51 (more inclined towards red zone) and chroma (C\*) of 52.26.

The study on nutrient status of soil revealed that available N (292.49kg/ha), P (64.07kg/ha) and K (146.57kg/ha), pH (5.74), OC (0.88%), MBC (312.26 µg/g soil /24 hour) and activity of soil enzymes viz. Phosphomonoesterase (64.07 µg p-nitrophenol /g soil /hour) and Dehydrogenase (146.57 µg TPF /g soil /hour) were found to be the highest in treatment T6. The cost economics indicated superiority of T6 (Rock phosphate + microbial consortium + vermicompost @ 5t/ha) with BC ratio of 3.35

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followed by T5 (3.34). On the basis of results obtained in present investigation, T6 (Rock phosphate + consortium + vermicompost @ 5t/ha) is considered the best for adopting at field level to reap a good economic yield and better quality fruits with sustained soil health and high returns.

## **Development of Vinegar from Rice Varieties of Assam with Herbal Incorporation**

*Pratikshya Dutta*

An investigation was carried out during 2018-2020 to standardize the production process of vinegar from bora rice and black rice with the incorporation of locally available medicinal herbs and, to study the quality parameters of the developed products. *Acetobacter aceti* MTCC-3246 and 3347 were collected from Microbial Type Culture Collection & Gene Bank (MTCC), ICAR- Institute of Microbial Technology, Chandigarh. The study revealed that malted bora rice and black rice could be successfully fermented with the above-mentioned strains to develop herbal vinegar. The acetic acid content of the developed vinegars ranged from 3.89 to 4.82%, with the highest content present in vinegar C developed from bora rice using both the acetobacters strains. The lowest content was reported in the controls which were naturally fermented by wild bacteria. Alcohol residues were also observed in the vinegars (0.88-0.54% v/v). A fairly good amount of phenols was recorded in the range of 16.86-14.33 mg GAE ml<sup>-1</sup>, with the highest content in vinegar C and the lowest in the controls. The range of TSS in the vinegars was 2.20-0.97 °Bx. No contamination of *Lactobacilli* and *E. coli* was observed during 15 days of storage of the vinegars. The sensory evaluation revealed that all the rice vinegar samples were rated above 5 for overall acceptance with the highest overall acceptability recorded in the case of vinegar C followed by vinegar A, which was developed from bora rice using *A. aceti* MTCC3246; while the control samples, which were fermented naturally without incorporation of any herbs, got the lowest scores for overall acceptability. Product characterization of the vinegars revealed that the vinegars developed from bora rice scored significantly higher. The investigation establishes that both bora and black rice can be effectively used to develop vinegar with acceptable flavour and quality attributes.

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**Major Adviser: Dr. Ananta Saikia**

## **Formulation of ready-to-use curry powder for ethnic cuisines of North East India**

*Priyankhi Kalita*

The present investigation on —Formulation of ready-to-use curry powder mix for ethnic cuisines of North East India was carried out in Assam Agricultural University, Jorhat, Assam during the year 2018-2020. The experiment was laid out in a completely randomized design with nine treatments replicated three times. The bamboo shoot (BS), mustard green (MG) and spinach (SP) were processed into powdered form and blended in different ratios for developing nine types of ready-to-use curry powder mix. The mixes were named as MIX 1 (30 SP: 60 MG: 10 BS), MIX 2 (25 SP: 55 MG: 20 BS), MIX 3 (20 SP: 50 MG: 20 BS), MIX 4 (90 MG: 10 BS), MIX 5 (80 MG: 20 BS), MIX 6 (70 MG: 30 BS), MIX 7 (90 SP: 10 BS), MIX 8 (80 SP: 20 BS) and MIX 9 (70 SP: 30 BS), respectively.

Physico-chemical properties (total carbohydrate, crude protein, crude fat, crude fiber, ash and moisture) of the raw materials as well as nine curry-powder mixes were determined followed by food value determination of the nine mixes. Results obtained were statistically analysed based on ANOVA. Significant differences were observed in respect of different mixes. A curry recipe was standardized using the ready-to-use powders for sensory evaluation. The microbial safety of the best products was studied. It was observed that MIX 3 with ratio of SP: MG: BS=20: 50: 30 powder was found to be the most acceptable. This product recorded good sensory attributes concerning colour (7.5), flavour (7.9), taste (7.85), texture (7.35) and overall acceptability (7.89). The acceptability of MIX 3 was followed by MIX 4 (90 MG: 10 BS) and MIX 9 (70 SP: 10 BS). The food value of MIX 3 was found to be 37.97 cal/100g  $\pm$ 0.03 with total carbohydrate (4.576 g/100g  $\pm$  0.001), crude protein (3.376%  $\pm$  0.002), crude fat (0.319%  $\pm$  0.003), ash (2.14%  $\pm$  0.004) and crude fiber (2.234%  $\pm$  0.003) content, respectively. The moisture content of MIX 3 was recorded to be 7.587 % (w.b) indicating a good keeping quality and no microbial growth was observed in the products at 1, 3 and 6 months interval of storage time.

As no suitable mixes for the exotic non-vegetarian cuisines of North East are available in the market, the developed product can be expected to have a good market potential. Future works may be carried out by adding tastemakers like garlic powder, ginger powder, king chili powder etc. for wider acceptability.

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## **Response of Bitter Gourd (*Momordica charantia* L.) to organic amendments**

*Raktim Kiran Das*

An experiment entitled “Response of bitter gourd (*Momordica charantia* L.) to organic amendments” was carried out at the organic plot of the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat-13 during the spring-summer season of 2018-2019 with the objectives to study the impact of different organic amendments on the growth, yield and quality of bitter gourd. The experiment was laid out in Randomized Block Design with eleven treatments replicated three times and the variety selected was Bipasa F1. The treatments selected for the study were: T<sub>1</sub>: FYM @ 5t ha<sup>-1</sup>; T<sub>2</sub>: FYM @ 10t ha<sup>-1</sup>; T<sub>3</sub>: FYM @ 15t ha<sup>-1</sup>; T<sub>4</sub>: FYM @ 20t ha<sup>-1</sup>; T<sub>5</sub>: FYM @ 5t ha<sup>-1</sup> + AZB @ 3.6 kg/ha + PSB @ 3.6 kg/ha; T<sub>6</sub>: FYM @ 10t ha<sup>-1</sup> + AZB @ 3.6 kg/ha + PSB @ 3.6 kg/ha; T<sub>7</sub>: FYM @ 15t ha<sup>-1</sup> + AZB @ 3.6 kg/ha + PSB @ 3.6 kg/ha; T<sub>8</sub>: FYM @ 20t ha<sup>-1</sup> + AZB @ 3.6 kg/ha + PSB @ 3.6 kg/ha; T<sub>9</sub>: Vermicompost @ 3 t ha<sup>-1</sup>; T<sub>10</sub>: Vermicompost @ 3t ha<sup>-1</sup> + AZB @ 3.6 kg/ha + PSB @ 3.6 kg/ha; T<sub>11</sub>: Enriched compost @ 2t ha<sup>-1</sup>.

The parameters to be studied were: growth parameters *viz.*, vine length, number of leaves/ plant, crop duration; flowering parameters *viz.*, days to appearance of first male and female flower, node position of first male and female flower, total male and female flowers, male: female flower ratio; fruit parameters *viz.*, fruit length, fruit diameter, fruit weight, fruit flesh thickness, no. of seeds/fruit, 100 seed weight; yield parameters *viz.*, total number of marketable fruits/plant, net income and B: C ratio; quality parameters *viz.*, TSS content, ascorbic acid content and carbohydrate content; soil parameters *viz.*, pH (initial), texture (initial), initial and final NPK content, initial and final organic matter content and initial and final microbial biomass carbon content.

The results revealed that all the parameters varied significantly with respect to the treatments applied, except male: female flower ratio of bitter gourd. T<sub>10</sub> (Vermicompost @ 3 t ha<sup>-1</sup> + AZB @ 3.6 kg/ha + PSB @ 3.6 kg/ha) recorded maximum for all the growth, flowering, fruiting, quality and yield parameters *viz.*, highest vine length (5.54 m), highest number of leaves plant<sup>-1</sup> (310.00 nos.), longest crop duration (120 days), lowest days to appearance of first male (43.33 days) and female (47.33 days)

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flower, lowest node position/ number of first male (7.33) and female (21.00) flower, highest number of male (241.33 nos.) and female (15.33 nos.) flowers, highest fruit length (26.96 cm), highest fruit diameter (4.98 cm), maximum flesh thickness of fruit (1.16 cm), highest fruit weight (205 gram), highest number of seeds fruit<sup>-1</sup> (27.66 nos.), highest 100 seed weight (24.54 g), highest number of marketable fruits plant<sup>-1</sup> (13.33 nos.), highest TSS content (5.13°Brix), highest ascorbic acid content (42.33 mg/100g FW), highest carbohydrate content (4.53 g). T<sub>11</sub> was at par with T<sub>10</sub> in terms of fruit diameter, number of seeds/ fruit and ascorbic acid content. On the other hand, T<sub>1</sub> (FYM @ 5t ha<sup>-1</sup>) proved to be the most inferior treatment for most of the parameters.

The soil physico-chemical and biological parameters also showed best results with application of T<sub>10</sub> viz., highest organic matter content (1.23%), highest N (296.55 kg ha<sup>-1</sup>), highest P (29.29 kg ha<sup>-1</sup>), highest K (172.32 kg ha<sup>-1</sup>) content and highest microbial biomass carbon content (494.25 µg g<sup>-1</sup> 24 hr<sup>-1</sup>). The most inferior treatment for all the soil parameters was found to be T<sub>1</sub>.

T<sub>10</sub> provided the highest net income of Rs. 6,43,036.40 and highest B: C ratio of 3.03 followed by T<sub>8</sub> providing net income of Rs. 5,67,986.40 and B: C ratio of 2.96. Whereas, T<sub>1</sub> provided the lowest net income and B: C ratio of Rs. 1,91,265.20 and 1.07 respectively.

Thus, it could be suggested that vermicompost @ 3t ha<sup>-1</sup> in combination with biofertilizers such as AZB and PSB @ 3.6 kg ha<sup>-1</sup> each would be a good organic practice to derive more yield and profit from bitter gourd cultivation. However as an alternative, combined application of FYM @ 20 t ha<sup>-1</sup> and biofertilizers or sole application of enriched compost @ 2t ha<sup>-1</sup> can be taken into consideration.

## **Growth performance of some gladiolus cultivars in paired row system**

*Rocktim Baruah*

A field experiment entitled “**Growth performance of some gladiolus cultivars in paired row system**” was undertaken with the objectives to study the performance of gladiolus cultivars in paired row system, to find out the suitable cultivars of gladiolus for cut flower production, to study the multiplication behavior of the cultivars under study and to evaluate the economics of cultivation. To achieve these objectives, seven treatments or cultivars (Friendship, Candyman, White Prosperity, Novalux, Priscilla, Summer Sunshine and Dull Queen) were considered and the trial was carried out at the Experimental Farm, Department of Horticulture, Assam Agricultural University during 2019-2020.

Different characters relating to vegetative growth, flower and corm and cormel were assessed to identify suitable cultivars under paired row system. The cultivars White Prosperity, Novalux and Candyman were better performers during the vegetative phase where White Prosperity was superior in early shoot emergence (5.566 days) and plant height (160.620 cm), Novalux was superior in shoots per corm (1.867) and Candyman in terms of number of leaves (8.33). In respect to flower characters, variety Priscilla performed better in terms of early spiking (65.33 days) and first floret opening (78.55 days), spikes per corm (1.733), self life (15.267 days) and vase life (10.733 days). While White Prosperity was superior in certain critical flower characters like florets per spike(16.400) and florets open at once(6.733), rachis(81.827 cm) and spike length(103.587 cm) and size of florets(10.673 cm). The multiplication of corms (2.400) and cormels (47.267) was highest in Dull Queen while size of corm (9.060 cm) and weight of corm (212.133 g) and cormels (20.091 g) was highest in Novalux variety. In the economic aspect, Priscilla cultivar showed good remunerative quality with highest BC ratio (1:2.4). Hence cultivars White Prosperity, Priscilla and Novalux can be concluded as suitable varieties for cultivation under paired row system.

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## **Effect of dehydration methods on quality parameters of drumstick (*Moringa oleifera* Lam.) leaves**

*Sahinur Ahmed*

The present investigation entitled “Effect of dehydration methods on quality parameters of drumstick (*Moringa oleifera* Lam.) leaves” was carried out during 2018-2020 in the laboratory, Department of Horticulture, B.N. College of Agriculture, AAU, Biswanath Chariali with two objectives viz. i) Effect of dehydration on nutritive values of drumstick leaves and ii) Storage stability of dehydrated drumstick leaves. The experiment was laid out in factorial CRD with three replications. The treatments were: Three methods of drying (T1: Sun drying, T2: Shade drying and T3: Cabinet tray dryer) with three pre-treatments (B1: Unblanched, B2: Blanched with hot water and B3: Blanched followed by KMS dip). All the pre-treatments had significant effect on physiochemical characteristics of drumstick leaves. Among the pre-treatments, unblanched leaves (B1) retained higher nutrient contents over other two pre-treatments. The results of the investigation revealed that among the three different drying methods, shade dried sample was found to retain better nutritional properties. Significantly maximum values for moisture (11.18 %), ascorbic acid (156.27 mg/100g), vitamin-A (22.71 mg/100g), iron (16.54 mg/100g), oxalate (378.66 mg/100g), chlorophyll (5.33 mg/g) and antioxidant activity (77.11 %) was recorded in shade dried (T2) sample. The interaction effect between pretreatment and drying methods showed variation in results. However, the treatment combination T1B1 (Unblanched sun dried) was found to retained more protein (26.43 g/100g), magnesium (318.70 mg/100g) and potassium (1378.79 mg/100g) whereas T2B1 (unblanched shade dried) showed higher ascorbic acid (179.47 mg/100g), saponin (3.66 %), oxalate (541.47 mg/100g), chlorophyll (6.80 mg/100g) and antioxidant (80.33 %) than rest of the treatment combinations. During storage period, protein, ascorbic acid, vitamin-A, minerals, antioxidant and antinutritional content of drumstick leaves showed a decreasing trend. However, retention of protein (22.88 g/100g), calcium (2006.20 mg/100g), magnesium (274.85 mg/100g) and potassium (1190.16 mg/100g) were more in sun dried sample, while

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shade dried sample retained more ascorbic acid (130.57 mg/100g), vitamin-A (13.60 mg/100g), iron (11.48 mg/100g), saponin (1.70 %), oxalate (346.17 mg/100g), chlorophyll (3.91 mg/g) and antioxidant activity (68.59 %) at the end of storage period (90 days). A gradual decrease in nutritional content of leaves was observed throughout the storage period but the level of retention of protein, vitamin-A, minerals and antioxidant was much higher than the fresh leaves.

## **Impact of seed priming and priming durations on early season okra [*Abelmoschus esculentus* (L.) Moench]**

*Sarath Krishna R*

The present investigation entitled “Impact of seed priming and priming durations on early season okra [*Abelmoschus esculentus* (L.) Moench]” was undertaken to assess the impact of different priming agents and priming durations on germination and seedling growth of okra seeds in the laboratory and growth, yield parameters were studied in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat. Seed priming of okra seeds was done by soaking the seeds in distilled water, KCl, PEG 6000 and GA3. Germination test was carried out in the laboratory of the Department of Horticulture, Assam Agricultural University, Jorhat during 2019. The field experiment was laid out in Randomized Block Design and replicated thrice. There were nine treatments consisting of T0 (untreated dry seeds), T1 (hydropriming with distilled water for 12 hours), T2 (hydropriming with distilled water for 24 hours), T3 (halopriming with 1% KCl for 12 hours), T4 (halopriming with 1% KCl for 24 hours), T5 (osmopriming with 5% PEG 6000 for 12 hours), T6 (osmopriming with 5% PEG 6000 for 24 hours), T7 (hormonal priming with 50 ppm GA3 for 12 hours) and T8 (hormonal priming with 50 ppm GA3 for 24 hours). In germination test, T1 (hydropriming with distilled water for 12 hrs) recorded the highest root length, whereas T3 (halopriming with 1% KCl for 12 hrs) obtained the highest shoot length, seedling length and seed vigour index. The maximum shoot length, seedling fresh weight, seedling dry weight and germination index was exhibited by T6 (osmopriming with 5% PEG-6000 for 24 hours). In the field regarding germination parameters, T6 (osmopriming with 5% PEG-6000 for 24 hours) requires minimum days for appearance of first emergence and 50% emergence of seedlings in each plot respectively. However, highest plant stand per plot was observed in T3 (halopriming with 1% KCl for 24 hours). In case of flowering parameters, T6 (osmopriming with 5% PEG-6000 for 24 hours) has recorded the minimum days for appearance of first flower and 50% flowering in each plot respectively. The present investigation revealed that the

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maximum plant height at 30 days after planting (DAP), 60 DAP, 90 DAP, 120 DAP and last harvest were observed in T6. Minimum days to first fruiting, minimum days to 50% fruiting, minimum days to first picking, the maximum days to first picking and maximum harvesting latitude were recorded in T6 (osmopriming with 5% PEG-6000 for 24 hours). T6 (osmopriming with 5% PEG-6000 for 24 hours) exhibits highest number of branches per plant, maximum root biomass and root volume among all treatments. Regarding yield parameters, T6 (osmopriming with 5% PEG-6000 for 24 hours) exhibited the highest value regarding number of fruits per plant, fruit yield per plant, yield per plot and yield per hectare among all the treatments. The highest yield of 189.51 q/ha was recorded in the treatment T6 (5% PEG-6000 for 24 hrs), followed by T3 (1% KCl for 12 hrs) of yield 183.02 q/ha. In case of quality parameters such as crude protein and the total ash content, T6 (osmopriming with 5% PEG for 24 h) recorded superior results among all the treatments. Economics of production showed that the highest benefit:cost ratio of 4.25 was obtained from treatment T6 (5% PEG-6000 for 24 hrs), followed by T3 (1% KCl for 12 hrs) with B:C ratio of 4.07. The results suggest that all the priming treatments shows significantly improved germination, growth and yield than those of non-primed okra seeds. Hence, the seed priming methods can be used to improve field emergence and marketable pod yield in okra sown in early season. Seed priming improved yield was attributed principally to better stand establishment. This study showed that seed priming resulted in uniform germination, better crop establishment, higher growth and yield attributing parameters in early season okra. It can be said that these priming methods are cost effective, economic, non-toxic and eco-friendly.

## **Development of a beverage powder using Elephant apple (*Dillenia indica*) and whey**

*Udangshree Borah*

*Dillenia indica* has recently gained a lot of spotlight because of its multifarious medicinal properties; however, processed products from the same are scanty. In the present study, *Dillenia indica* juice (2% total solids) was blended with concentrated whey (30% total solids) in different proportions (v/v) (T1 (100% *Dillenia indica* juice), T2 (9:1), T3 (4:1), T4 (7:3), T5 (3:2), T6 (1:1), T7 (2:3), T8 (3:7), T9 (1:4), T10 (1:9) and T11 (100% whey)) for assessing their organoleptic acceptability. Principal Component Analysis of the sensory scores indicated good preference for four blends, namely, T6, T7, T8 and T9 over the others. Subsequent analysis of their antioxidant activity revealed the superiority of T6 amongst the four counterparts. The study was further extended to develop a ready-to-reconstitute beverage powder using T6 as the base, wherein suitable proportions of maltodextrin (MD) was added and spray dried at different inlet temperatures as per as the Rotatable Central Composite Design of Response Surface Methodology. The dependent variables selected for optimizing the process condition were yield, dispersibility, antioxidant activity and organoleptic acceptability of the beverage powder. All the powders recuperated at different experimental conditions were organoleptically favourable (scores above the limit of acceptance) with good yield (63.33-88.33%), dispersibility (33.40-56.57%), and moderate antioxidant potential (37.45-54.57%). The quadratic polynomial models for the responses were found to be significant ( $p < 0.05$ ) and adequate for prediction, which was validated by conducting confirmatory trials at the predicted optimum condition (160°C of inlet temperature and 19.727% MD). Additional quality attributes of the beverage powders developed at different processing conditions were also evaluated; the powder developed at 120°C inlet temperature and 5% MD retained the maximum polyphenols (2.06 mg GAE/g), flavonoids (0.55 mg QE/g) and exhibited high antioxidant activity (54.57%); while that obtained at 120°C inlet temperature and 25% MD had the highest amount of sugars (293.97 mg/g) and the one obtained at 140°C inlet temperature with 29% MD concentration showed the highest soluble protein content (105.58mg/g) and crude protein (66.50%). The effectiveness of the said optimization

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approach was further validated by analysing the physicochemical properties of the powder derived at the predicted optimized condition, which exhibited good solubility ( $89.02 \pm 0.41\%$ ), dispersibility ( $49.73 \pm 0.33$ ), intermediate hygroscopicity ( $23.00 \pm 0.61$ ), and fair flowability (Carr Index= $24.80 \pm 3.0$ ). With respect to the feed (T6) used for spray drying, a reduction of 49.08%, 38.41% and 54.5% were observed in the total sugar, crude protein and soluble protein of the optimized powder, respectively. Nonetheless the decrease in its antioxidant activity was only 17.42%, which was ascribed to the protective effect of high amount of MD on bioactives and formation of Maillard reaction products at high processing temperature. Organoleptic acceptability score and WI of the reconstituted optimized beverage powder were better than that of the pristine *D. indica* juice, and this improvement was credited to the masking of undesirable brown pigments of the fruit juice by amalgamation of MD and whey. Scanning electron microscope showed particles ranging from 2-30  $\mu\text{m}$  in diameter. Surface morphology of the powder obtained at high inlet temperatures, revealed shrunk and wrinkled particles; while those dried at low temperatures and higher amount of MD showed fused or clumped entities. Thus, *Dillenia indica* and whey based ready-to-reconstitute beverage powder, with acceptable sensory and quality attributes, could be developed using a spray dryer under statistically optimized process condition.

## **Effect of growth regulators on Assam Lemon (*Citrus limon* L)**

***Wahedullah Bakhtari***

An experiment was conducted on Assam Lemon (*Citrus limon* L.) at the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during 2018-2019 to study the “Effect of growth regulators on Assam Lemon (*Citrus limon* L)”. Six treatments with four replications were laid out in a Randomized Block Design. The treatments comprised of GA3 (60, 80 and 100ppm) and NAA (30, 40 and 50ppm). The growth regulators were applied as foliar spray at three growth stages: (1) at pre flowering stage in the month of November, 2018, (2) at flowering stage and (3) one month after fruit set. The plant growth regulators showed significant response on flowering. The minimum number of days (52.67days) was recorded in T2 (GA3 80ppm) from the date of plant growth regulators application and the highest number of days were required in case of T6 treatment (NAA 50ppm). The highest number of flowers per plant (476.74), highest fruit set (81.32%) and the lowest fruit drop (18.50%) was recorded from T2 (GA3 80ppm) during the experiment. Number of fruits per plant was recorded highest in GA2 80ppm (371.33) and the lowest in T6 (NAA 50ppm). The highest fruit weight (136.53g), fruit length (10.00cm), fruit girth (15.93 cm), fruit volume (162.89cc) and yield (52.72 t/ha) were recorded in T2 (GA3 80ppm) while the lowest values were recorded in T6 (NAA 50ppm). The results revealed that, pulp weight and pulp-peel ratio were significantly influenced by growth regulator applications. The highest pulp weight (108.32g) and the highest pulp-peel ratio (4.83) were recorded in T2 (GA3 80ppm). Peel thickness was lowest (0.48cm) in T2 (GA3 80ppm) and the highest of 0.73cm was recorded in T6 (NAA 50ppm). The results revealed that, T2 (GA3 80ppm) took the lowest number of days required for flowering to harvesting (102.47 days) and the highest (133.77 days) in T6 (NAA 50ppm). Regarding the total leaf chlorophyll content, the highest was recorded (1.29mg/g of fresh weight) in T2 (GA3 80ppm). However, there were no significant differences in leaf nitrogen and leaf phosphorous among the treatments. Highest leaf potassium (1.69%) was recorded in T1 (GA3 60ppm). The highest juice content (37.29cc) was recorded in T2 (GA3 80ppm). The highest TSS (5.18°Brix), titrable acidity (3.50%) and TSS-Acidity ratio (1.48) was

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recorded in T1 (GA3 60ppm), whereas, the lowest values were recorded in T6 (NAA 50ppm). From the results of the ascorbic acid content (32.15mg/100ml) the highest was recorded in T2 (GA3 80ppm). Regarding evaluation of the economics of cultivation, it can be concluded that, the highest benefit-cost ratio of 3.52 was obtained from T2 (GA3 80ppm) followed by 3.44 from T1 (GA3 60ppm). The lowest B:C ratio (2.41) was recorded in T6 (NAA 50ppm). Thus, it can be suggested that, GA3 at 80ppm is the most economical plant growth regulator to improve flowering, yield and quality of Assam Lemon.



# **Survey and management of root-knot nematode, *Meloidogyne incognita* on tuberose, *Polianthes tuberosa***

*Abhijit Chetia*

In the present investigation on survey and identification of plant parasitic nematodes associated with tuberose, total seven genera of plant parasitic nematodes viz., *Meloidogyne*, *Helicotylenchus*, *Hoplolaimus*, *Tylenchorhynchus*, *Pratylenchus*, *Rotylenchulus reniformis* and criconematids were encountered from various tuberose growing localities of Kamrup, Jorhat and Morigaon districts. The study of perineal pattern confirmed the species of root-knot nematode as *Meloidogyne incognita*. *Meloidogyne* spp. and *Helicotylenchus* spp. population were found to be dominant in most of the surveyed localities. Studies on the pathogenicity of *M. incognita* on tuberose showed that there was a progressive decrease in the growth of tuberose plants as the inoculum level of *M. incognita* increased. An initial inoculum level of 100 J2 per kg of soil caused significant reduction in plant height, shoot and root weight and proved to be pathogenic to the tuberose plants. The reproductive rate of nematode was maximum at the initial inoculum level of 10 J2 per kg of soil and minimum at the highest inoculum level of 10,000 J2 per kg of soil. In all the five varieties of tuberose showed varied degrees of susceptibility to *M. incognita*. Out of five varieties, three varieties viz., „Prajwal“, „Phule Rajani“ and „Arka Nirantara“ were found to be susceptible and rest two varieties viz., „Local Single“ and „Shringar“ were found to be moderately resistant and resistant to *M. incognita*. Studies on efficacy of Org-Trichojal and Org-Pochojal for the management of *M. incognita* on tuberose showed that the treatment where bulb treated with Org-Pochojal @ 5 ml/lit water + soil treated with Org-Pochojal @ 40 ml/kg enriched compost was found to be most effective in increasing plant height, root length, fresh and dry weight of shoot and root of tuberose plants as well as reducing galls, eggmasses and final nematode population in soil. Maximum spike production was recorded in the treatment where bulb treated with Org-Trichojal @ 5 m.

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**Abstract of M.Sc. thesis**

**Department: Nematology**

**Major Adviser: Dr. A. Borah**

# **Bio-management of rice root knot nematode, *Meloidogyne graminicola* through native fungal bioagent**

*Indumoni Phukan*

An *in-vitro* experiment was conducted to study the efficacy culture filtrates of native fungal bioagents viz., *Trichoderma viride*, *T. harzianum*, *Pochonia chlamydosporia* and *Purpureocillium lilacinum* on juvenile (J2) mortality of rice root knot nematode, *Meloidogyne graminicola*. The culture filtrates of these fungal bioagents were found to be effective in causing mortality of second stage juveniles at various concentrations and time of exposures. Among them *T. viride* was found to be most effective against *M. graminicola* in respect of larval mortality. There was an increase in larval mortality with increase in concentrations and time interval. Hence *T. viride* was selected for studying its efficacy against *M. graminicola* under pot conditions. For this, *T. viride* was applied as seed treatment, soil application and both. Carbofuran was applied as chemical check. The results showed that *T. viride* when applied together as seed treatment and soil application, significantly improved plant growth parameters of rice and reduced nematode multiplication as compared to when they were applied either as seed treatment or soil application. Further, the defense related enzymatic activities were worked out and it showed increase in the activities of PO, PPO, PAL and total phenol content in roots of rice. The maximum enzymatic activities like PO, PPO, PAL and total phenol content was recorded in the rice roots treated with *T. viride* when applied together as seed treatment and soil application. The results of the present investigation revealing some of the mechanisms of fungal bioagents against rice root knot nematode might be of great help in formulating rice root knot nematode management programme.

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**Abstract of M.Sc. thesis**

**Department: Nematology**

**Major Adviser: Dr. Bhabesh Bhagawati**

## **Mechanism of *Lantana camara* leaf extracts in the management of *Meloidogyne incognita* on tomato**

*Kankana Bordoloi*

An experiment was carried out on the mechanism of *Lantana camara* leaf extract in the management of *Meloidogyne incognita* on tomato. For this, leaf extract of *L. camara* (25gm/75ml w/v) were evaluated at 25, 50, 75 and 100 percent concentration through egg hatch inhibition and larval mortality test. The result of the *in-vitro* efficacy test showed that maximum egg hatch inhibition of *M. incognita* was recorded in the 100 percent concentration of *L. camara* leaf extract where as minimum was recorded in the 25 percent concentration after 7 days of exposure time. The maximum mortality of *M. incognita* J<sub>2</sub> was recorded in the 100 per cent concentration of *L. camara* leaf extract where as minimum was recorded in the 25 per cent concentration after 24, 48, 72 and 96 hours of exposure time. No mortality was recorded in the control treatment *i.e.* sterile distilled water. It was observed that there was an increasing trend in the mortality of J<sub>2</sub> with increase in the concentration and time of exposure. Similarly, egg hatch inhibition was also found to be more with increase in the concentration. A pot experiment was conducted to explore the biochemical mechanism of leaf extracts of *L. camara* in the management of *M. incognita* on tomato. For this the activity of defence related enzymes *viz.*, peroxidase (PO), polyphenoloxidase (PPO) and total phenol content were observed at 25,50,75 and 100 percent concentration of *L. camara* leaf extract after 35 and 45 DAI of *M. incognita* in tomato. Among the different concentrations, highest activity of peroxidase (PO), polyphenoloxidase (PPO) and total phenol content was observed at 100 percent concentration while the minimum activity was recorded in the 25 percent concentration both after 35 and 45 DAI. However, maximum activity of the biochemical compounds was recorded at 35 DAI while the same declined at 45 DAI. The lower concentration of *L. camara* leaf extract *viz.*, 25 and 50 percent showed stimulatory effect on plant growth parameter whereas higher concentrations *viz.*, 75 and 100 percent concentration of *L. camara* leaf extract showed inhibitory effect on plant growth. The maximum plant growth parameter like shoot height, shoot weight (fresh) and root length and root weight (fresh), dry shoot weight were recorded in the 50 percent concentration

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of *L. camara* leaf extract where as the minimum was recorded in the nematode alone treatment. The minimum nematode multiplication like number of galls, number of eggmasses and final nematode population in soil were recorded in the 100 percent concentration of *L. camara* leaf extract followed by 75, 50 and 25 percent concentration.

## **Management of root knot nematode (*Meloidogyne incognita*) in Tomato by Bacterial Bioagent**

*Karter Nyodu*

Investigations were carried out to evaluate the efficacy of bacterial bioagents viz., *Bacillus subtilis*, *Bacillus megaterium*, *Bacillus pumilus* and *Pseudomonas fluorescens* as seed as well as soil treatment against root knot nematode, *Meloidogyne incognita* on tomato (var. Pusa Ruby).

Seed treatment experiment was conducted with thirteen treatments viz., T<sub>1</sub>: *B. subtilis* (1×10<sup>9</sup>cfu/gm of talc formulation) @ 10gm/kg of seed, T<sub>2</sub>: *B. subtilis* (1×10<sup>9</sup>cfu/gm of talc formulation) @ 20gm/kg of seed; T<sub>3</sub>: *B. subtilis* (1×10<sup>9</sup> cfu/gm of vermi formulation) @ 10 gm/kg of seed; T<sub>4</sub>: *B. subtilis* (1×10<sup>9</sup> cfu/gm of vermi formulation @ 20 gm/kg of seed; T<sub>5</sub>: *B. pumilus* (1×10<sup>9</sup>cfu/gm of talc formulation) @ 10gm/kg of seed; T<sub>6</sub>: *B. pumilus* (1×10<sup>9</sup>cfu/gm of talc formulation) @ 20gm/kg of seed; T<sub>7</sub>: *B. megaterium* (1×10<sup>9</sup>cfu/gm of talc formulation) @ 10gm/kg of seed; T<sub>8</sub>: *B. megaterium* (1×10<sup>9</sup>cfu/gm of talc formulation) @ 20gm/kg of seed; T<sub>9</sub>: *B. megaterium* (1×10<sup>9</sup> cfu/gm of vermi formulation) @10gm/kg of seed; T<sub>10</sub>: *B. megaterium* (1×10<sup>9</sup> cfu/gm of vermi formulation) @ 20gm/kg of seed; T<sub>11</sub>: *Pseudomonas fluorescens* (1×10<sup>9</sup>cfu/gm of talc formulation) @ 10gm/kg of seed; T<sub>12</sub>: *P. fluorescense* (1×10<sup>9</sup>cfu/gm of talc formulation) @20/kg of seed and T<sub>13</sub>: untreated control. Results revealed that there were a significant increase in plant growth parameters and significant decrease in galls, eggmass and soil nematode population in all treatments over untreated control. However, seed treated with *Pseudomonas fluorescens* @ 20g/kg seed recorded the best result in increasing the plant growth parameters of tomato and reducing the root knot nematode multiplication followed by *Bacillus subtilis* (vermi formulation) @ 20g/kg seed.

Pot experiment was conducted to evaluate the efficacy of bacterial bioagents as soil application with thirteen treatments viz., T<sub>1</sub>: *Bacillus subtilis* (1×10<sup>9</sup>cfu/gm of talc formulation) @ 2%(w/w); T<sub>2</sub>: *B. subtilis* (1×10<sup>9</sup>cfu/gm of talc formulation) @ 3%(w/w); T<sub>3</sub>: *B. subtilis* (1×10<sup>9</sup> cfu/gm of vermi formulation) @ 2%(w/w); T<sub>4</sub>: *B. subtilis* (1×10<sup>9</sup> cfu/gm of vermi formulation @ 3% (w/w); T<sub>5</sub>: *B. pumilus* (1×10<sup>9</sup>cfu/gm of talc formulation) @ 2% (w/w); T<sub>6</sub>: *B. pumilus* (1×10<sup>9</sup>cfu/gm of talc formulation) @ 2%

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**Major Adviser: Dr. Debanand Das**

(w/w); T<sub>7</sub>: *B. megaterium* (1×10<sup>9</sup>cfu/gm of talc formulation) @ 3% (w/w); T<sub>8</sub>: *B. megaterium* (1×10<sup>9</sup>cfu/gm of talc formulation) @ 2% (w/w); T<sub>9</sub>: *B. megaterium* (1×10<sup>9</sup> cfu/gm of vermi formulation) @ 3% (w/w); T<sub>10</sub>: *B. megaterium* (1×10<sup>9</sup> cfu/gm of vermin formulation) @ 3% (w/w); T<sub>11</sub>: *Pseudomonas fluorescens* (1×10<sup>9</sup>cfu/gm of talc formulation) @ 2% (w/w); T<sub>12</sub>: *Pseudomonas fluorescens* (1×10<sup>9</sup>cfu/gm of talc formulation) @3% (w/w) and T<sub>13</sub>: Untreated control; The result revealed that all the treatments significantly increased plant growth parameters and significantly decreased gall per root system, eggmass per root system and final root knot nematode population in soil over untreated control. However, maximum plant growth parameters and reduction in root knot nematode multiplication were recorded in soil treated with *Pseudomonas fluorescens* @ 3% (w/w) followed by *Bacillus subtilis* (vermi formulation) @ 3% (w/w) whereas minimum was recorded in untreated control.

## **Characterization and evaluation of *Heterorhabditis bacteriophora***

*Madhumita Goswami*

Morphological and morphometric characters of infective juveniles of entomopathogenic nematode under investigation showed close similarity with the original description of *Heterorhabditis bacteriophora* (Poinar, 1976) with respect to head shape, body length, ES, EP, NR, tail length, MBW, ratio a, ratio b, ratio c. Whereas D% was slightly variable from original description. The first generation male have higher body length than second generation. In first generation male, length of gubernaculum and tail were observed as stable characters whereas ES, NR, MBW, spicule length and testis reflexion showed slight variation. The observation of morphometric characters of second generation male revealed body length, tail length, ABW and GS% were similar with original measurement whereas ES, EP, NR, MBW, spicule length and testis reflexion were different. The amphimictic female and hermaphroditic female resembles to original description except for their body length which obtained within a range of 1,038.80-1423.58  $\mu\text{m}$  and 1,881.50-2,522.80  $\mu\text{m}$ , respectively.

The pathogenicity test of native *H. bacteriophora* was carried out against major pest of banana viz., banana leaf and fruit scarring beetle (*Nodostoma subcostatum*) in laboratory condition. The infective juveniles of *H. bacteriophora* were inoculated at a rate of 50,100,150 and 200 IJs/ml and mortality of the insect recorded at 24h, 48h and 72h of interval. The hundred percent mortality of banana leaf and fruit scarring beetle were observed after 72h of exposure in treatment T4 which was followed by treatment T3 and T2. While evaluating the LD50 values for *H. bacteriophora* against banana leaf and fruit scarring beetle it was found as follow 296.7 IJs/ml, 126.5 IJs/ml (95% FL 94.8-168.9) and 55.6 IJs/ml (95% FL 36.0-86.0) at 24, 48 and 72 h of exposure, respectively.

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**Abstract of M.Sc. thesis**

**Department: Nematology**

**Major Adviser: Dr. Nibedita Borgohain**

## **Antagonistic crop biomass as a tool for improving carrot yield in root knot nematode (*Meloidogyne incognita*) infested field**

*Mirlona Rongpipi*

Carrot (*Daucus carota*) is a common root vegetable grown throughout the world. A number of pests like insects, fungi, bacteria and nematodes hampers carrot production in a huge way. One of the most common nematode which causes considerable damage to the carrot plant is root-knot nematode (*Meloidogyne* spp.). The present study on effectiveness of haritaki (*Terminalia chebula*) and french marigold (*Tagetes patula*) biomass in the management of *Meloidogyne incognita* in carrot, under pot condition showed that all the treatments were effective in reducing number of galls and egg masses per root system and final nematode population in soil. The treatment with french marigold @ 3% w/w was found to be the most effective. Studies on economic feasibility of carrot cultivation by using haritaki and french marigold biomass in nematode infested field showed that haritaki and french marigold were effective in all the three concentrations, in increasing carrot yield and reducing the final nematode population in soil. Among all the biomass treatments, french marigold @ 3t/ha was found to be the most effective. While determining the benefit: cost ratio in all the treatments, benefit: cost ratio was found to be more than 1. The treatment with french marigold @ 3t/ha resulted in highest gross return (Rs. 3,10,000.00/ha), net return (Rs. 2,00,952.80/ha) and benefit: cost ratio (2.84).

Keywords: Carrot; *Meloidogyne incognita*; Haritaki; French marigold; Management

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**Abstract of M.Sc. thesis**

**Department: Nematology**

**Major Adviser: Dr. Bina B. Gogoi**



# **Histopathological and biochemical changes in traditional rice cultivars due to rice root-knot nematode *Meloidogyne graminicola***

*Priyanka Gogoi*

An investigation was carried out to observe the histopathological and biochemical changes in traditional rice cultivars of Assam. A total of 35 rice cultivars were screened against rice root-knot nematode *Meloidogyne graminicola*. Out of these, eight cultivars viz., Bongal ahu, Malbhog ahu, Naga ahu, Bahadur sub-1, Shraboni, Disang, Kolong and Jaymati were found to be resistant whereas five cultivars viz., Ahu joha, Bhogali bora, Aghoni bora, Ranjit sub-1 and Kanaklata found to be moderately resistant. The two traditional cultivars viz., Sambha mashuri and Kanaklata were found to be susceptible and the remaining 20 cultivars were found to be highly susceptible.

Histopathological studies of resistant cultivars revealed that there is no establishment of feeding cells with hypersensitive like reaction in pericycle areas, whereas in susceptible cultivars multinucleate giant cells with dense cytoplasm and large number of vacuole were observed. The hypertrophied and hyperplasia cell were observed surrounding the body of the nematodes and the giant cells were observed at little distance to the nematode head.

While evaluating the chlorophyll content, the highest chlorophyll was found in the cultivar Naga ahu i.e 0.040 µg/ml and lowest in Dhanshree. Similarly lowest phenolic content (0.0004 mg/ml) was recorded in the cultivar Sambha mashuri and the highest in Disang and Jaymati (0.00041 mg/ml). The enzymatic activity of PPO was maximum (0.294 mg/min) in cultivar Jaymati and minimum (0.140 mg/min) in Sambha mashuri at 3min time interval. The activity of PAL was highest in the Malbhog ahu (1.57 m<sup>-1</sup> mg<sup>-1</sup> protein) followed by Bahadur sub-1 (1.51 m<sup>-1</sup> mg<sup>-1</sup> protein) and minimum in Sambha mashuri (0.16 m<sup>-1</sup> mg<sup>-1</sup> protein).

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**Abstract of M.Sc. thesis**

**Department: Nematology**

**Major Adviser: Dr. N. Borgohain**

## **Effect of Silver Nanoparticles on the development of root knot nematode (*Meloidogyne incognita*) in Green gram**

*Rishikesh Phukan*

An investigation was carried out to study the effects of silver nanoparticles (AgNPs) on plant growth parameters and multiplication rate of *Meloidogyne incognita* in green gram using two different concentrations of AgNPs viz., 0.03 ppm and 0.15 ppm. Both the concentrations of AgNPs improved plant growth parameters in green gram and reduced galls, egg masses and final nematode population in soil. Among all the treatments, the treatment with 0.15 ppm AgNPs was found to be the best treatment in increasing plant growth parameters and reducing galls, egg masses and final nematode population in soil. Study on the effect of silver nanoparticles on genomic DNA of *Meloidogyne incognita* juveniles (J2) using two different concentrations of AgNPs viz., 0.03 ppm and 0.15 ppm along with a control (distilled water) showed that gel documentation of the PCR products of the three treatments with two universal primers (ITS-1 & ITS-4) revealed a common DNA size of 620 bp for the amplified ITS region. No difference was observed in DNA sizes among the control and treated *M. incognita* juveniles.

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**Abstract of M.Sc. thesis**

**Department: Nematology**

**Major Adviser: Dr. Bornali Mahanta**

## **Characterization of rice (*Oryza sativa* L.) cultivars for traits associated with adaptation under moisture stress**

*Abu Saleh Nizamuddin Ahmed*

The cultivated rice, *Oryza sativa* L. is a member of the Poaceae family. It is the premier staple food widely consumed by over 50% of the world human population, of which 90% are in Asian countries. Rice crop faces a multitude of abiotic as well as biotic stresses of which drought is the major abiotic constraint. The present study was undertaken to evaluate 54 rice genotypes in PVC pipes for assessing genetic variability, correlation, path coefficients and genetic divergence under low-moisture stress condition. Analysis of variance revealed a highly significant difference for all the characters under study. High range of variation, PCV, GCV and high heritability coupled with high GAM was observed for root volume, days to 50 *per cent* flowering, root dry weight, shoot dry weight, root length density, plant height, days to maturity, filled grains per panicle and grain yield per plant. Yield component characters such as shoot dry weight, filled grains per panicle, total chlorophyll, plant height and chlorophyll stability index exhibited a highly significant association with grain yield. The phenotypic path-coefficient analysis revealed that filled grains per panicle, days to maturity, root dry weight, plant height and effective tillers per plant had the highest positive direct effect on grain yield. Using Mahalanobis' D2 statistics, genotypes were grouped into five (5) clusters in PVC pipes under low-moisture stress condition. The intra and inter-cluster distances indicated wide genetic variability. Based on cluster means, cluster V and I ranked first and fifth respectively. Among all the characters, root volume (12.83%) had the highest contribution towards genetic diversity. Highest genetic distance was observed between cluster III & V followed by cluster IV & V. Based on the mean performance of the genotypes, Haccha (cluster V) was identified for early maturity and highest root-shoot ratio. Similarly, genotypes from cluster IV viz., Saru Jahinga (effective tillers, root dry weight and root length density), Vasudev and Jaibangla (root length and root volume), Bhogali (filled grains per panicle) were found promising. For grain yield, Ronga Joha (cluster II) was found to yield highest among all

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**Abstract of M.Sc. thesis**

**Department: Plant Breeding and Genetics, BNCA**

**Major Adviser: Dr. M. K. Sarma**

the genotypes across all the clusters. Based on the *per se* performance of the identified genotypes and their *inter se* genetic distance an efficient hybridization programme would be possible to undertake in order to obtain desirable segregants for their further utilization in breeding varieties under moisture stress environment.

## **Morphometric Characterization of Selected Mutants of Mungbean (*Vigna radiata* L. Wilczek)**

*Deepshikha Saikia*

Mungbean (*Vigna radiata* L. Wilczek) is one of the significant *kharif* and summer pulses of India. The present investigation was conducted to evaluate genetic variation and morphometric characteristics of selected mutants at Assam Agricultural University during *kharif* season of 2018 and summer of 2019. A randomized block design of 3 replication was used. Significant differences were observed for most of the characters except for days to pod initiation and pod length in M4 generation and days to pod initiation and plant height in M5 generation. High phenotypic and genotypic coefficient of variation was observed for seed yield per plant and number of branches per plant in M4 generation. In case of M5 generation, none of the traits showed high phenotypic and genotypic coefficient of variation but number of clusters per plant, pods per cluster, seeds per cluster, seeds per pod, percentage of disease infection, 100 seed weight and seed yield showed moderate phenotypic and genotypic coefficient of variation. High heritability estimate coupled with high genetic advance as per cent of mean was observed for number of branches per plant, pods per plant, percentage of disease incidence, 100 seed weight and seed yield per plant in M4 and for number of clusters per plant, pods per cluster, seeds per pod, percentage of disease incidence and 100 seed weight in M5 generation indicate the preponderance of additive gene action. In the present study, seed yield per plant was found to be significantly and positively correlated with number of pods per cluster, seeds per pod, pod length and 100 seed weight at genotypic and phenotypic level in M4 generation and with number of clusters per pod, pod length and 100 seed weight in M5 generation. The genotypic path coefficient analysis revealed that the highest direct and positive effect on seed yield was exhibited by 100 seed weight in M4 generation and by number of pods per cluster in M5 generation. Hence, these characters could be the major components of seed yield. Both the generation showed distinct type of clustering. For M4 generation, three clusters were observed and four clusters were observed for M5 generation. The genotypes SM-1, SM-3, BARC-III and BARC-IV were observed to be consistent in both the generation.

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**Abstract of M.Sc. thesis**

**Department: Plant Breeding and Genetics**

**Major Adviser: Dr. Akashi Sarma**

# **Assessment of genetic variability for glucosinolate in a set of Indian mustard [*Brassica juncea* (L.) Czern. & Coss.] genotypes and their relationship with economically important agronomic traits**

*Devidutta Lenka*

*Brassica juncea* (L.) Czern & Coss. known as Indian mustard is one of the most important oilseed crops of the country occupying considerably larger acreage among the Brassica crops. The mustard plants are much taller than that of toria (*Brassica rapa*). It has a solid stems unlike toria and has a much higher biological yield than toria. However despite these characteristics, mustard is not a favoured crop in Assam because it takes much longer duration to mature and farmers prefer oilseed varieties which are medium to short height and duration. The present study was conducted to study the genetic variability and character interrelationship of 17 quantitative characters along with 2 biochemical parameters between 18 Indian mustard genotypes. The validation of molecular marker linked to glucosinolate QTLs for marker-assisted selection was also carried out.

The pooled analysis of variance revealed significant variation among all the genotypes along with 12 characters showed significant genotype x environment interaction. Foot length, seed yield per plant and glucosinolate content exhibited high GCV, PCV, heritability and genetic advance as % mean.

From both the years, it was observed that the character seed yield per plant showed significant positive correlation with maximum root length, biological yield per plant and harvest index. Glucosinolate content showed significant and positive correlation with days to 50% flowering, days to maturity and oil content. Days to 50% flowering was highly correlated with the trait oil content.

From the path analysis result it was observed that the overall direct effect of characters harvest index and biological yield per plant are significantly higher than positive and negative indirect effect of the other character, thereby exhibiting a high significant correlation of harvest index & biological yield per plant with yield.

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**Abstract of M.Sc. thesis**

**Department: Plant Breeding and Genetics**

**Major Adviser: Dr. Rumjhum Phukan**

The banding patterns of 50 SSR markers were studied, out of which 21 primers showed polymorphism. The PIC value ranged from 0.019 to 0.383 with an average of 0.171. Multiple-regression analysis of 17 characters including glucosinolate content was carried out with 18 genotypes. From this analysis, 9 primer pair showed association with 11 characters. Out of these 9 primers which showed association, 6 primers were found to be associated with more than one character. The trait glucosinolate content exhibited association with 3 marker i.e. NI03-H07a, sR7178 and OL10-A03a.

## **Evaluation of inbred progenies of maize (*Zea mays* L.) for yield and important morphometric traits**

*Dikshita Gogoi*

The present investigation was conducted with evaluation of twenty-two genotypes in RBD during *rabi*, 2019-20 at the ICR farm, AAU, Jorhat with an objective to estimate genetic variability, genetic association and path coefficients among the inbred progenies for the traits. Observations were recorded for nine qualitative characters and seventeen quantitative characters. Significant to highly significant genotype mean squares were observed for the traits. The best performing S1 lines based on grain yield per plant and other important morphometric traits were IMPCH 35, IMPCH 70 and IMPCH 110. Estimates of phenotypic coefficient of variation were high for ear height and chlorophyll content and estimate of genotypic coefficient of variation was high for ear height. High heritability coupled with high genetic advance as per cent of mean was observed for the traits *viz.*, ear height, chlorophyll content at reproductive stage, 100 kernel weight, tassel length, kernels per row, ear length, kernel rows per ear and plant height indicating the preponderance of additive gene action for these traits. Association studies revealed significant and positive association of grain yield per plant with shelling percentage at both phenotypic and genotypic levels and with ear diameter, kernel rows per ear and kernels per row at genotypic level only. Negative and significant association of grain yield per plant was observed for days to 50% pollen shed and days to 50% silk at genotypic level. Genotypic path analysis revealed that days to 50% pollen-shed had the highest positive direct effect and days to 50% silk had the highest negative direct effect on grain yield per plant. The residual from path analysis was found to be 43.25% which suggested that characters taken in the path analysis contributed 56.75% of the total variability in the grain yield.

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**Abstract of M.Sc. thesis**

**Department: Plant Breeding and Genetics**

**Major Adviser: Dr. N. Sarma Barua**



## **Interspecific hybridization in the genus *Capsicum* and Molecular characterization of F1 hybrids**

*Gayatree Hazarika*

Interspecific hybridization allows transfer of genes governing desirable traits between different species, such as those involved in disease resistance, allowing breeders to develop genetically superior genotypes. However, introgression of the desirable traits from wild-related species into cultivated species is limited by crossability barriers. Moreover, it is imperative to know about the direction of the cross, since, in some species, the interspecific cross is possible in one direction only.

The present investigation was carried out using three different species of chilli—two genotypes of *C. annuum*, five genotypes of *C. chinense* and one genotype of *C. frutescens* which exhibited significant diversity for all the traits under study. Most of the characters were found to have high heritability coupled with high genetic advance. Significant positive correlation was observed for days to first flowering, length and girth of fresh fruit, fresh and dry fruit weight, seeds per fruit, thousand seed weight and dry fruit yield per plant with fresh fruit yield per plant; while it showed negative correlation with number of primary branches per plant and number of fruits per plant.

The crosses involving *C. chinense* and *C. frutescens* were found to be compatible; whereas crosses involving *C. annuum* and *C. chinense* were found to be partially incompatible. Both the *C. annuum* (Krishna, Capsicum) species were found to be cross compatible with King chilli accession A18; while the species *C. frutescens* (Mem) was cross compatible with only accession A5 indicating genotype specificity in success of interspecific cross. Presence of pre-fertilization barriers such as drying of pollinated fruits while still on the mother plant, unilateral incompatibility and post-fertilization barriers with the formation of abnormal/empty seeds, lack of vigor and hybrid sterility etc. were observed.

The pollen viability of the parents ranged from 72.64 per cent(%) to 94.92 per cent(%) whereas pollen viability of the hybrids ranged from 23.55 to 81.02 per cent(%). Thus, hybrids exhibited lower pollen viability compared to the parents.

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**Abstract of M.Sc. thesis**

**Department: Plant Breeding and Genetics**

**Major Adviser: Dr. Rumjhum Phukan**

Significant difference was observed in between parents and their hybrids for the traits under present study except for the traits- number of secondary branches, number of nodes per plant and length, breadth of leaf. On comparison of morphological characters between parents and F1 progeny it was observed that some of the characters were similar to the male or female parent and other characters were either intermediate or novel.

Estimation of Usual Euclidean distance among parents and their F1 plants revealed that Capsicum (*C. annuum* L.) had the maximum dissimilarity with rest of the genotypes including parents and their F1s.

A total of thirty SSR primers were screened for detection of parental polymorphism and then the polymorphic markers obtained were used for the confirmation of hybridity of F1s.

## **Effect of different storage structures on the seed quality of green gram (*Vigna radiata*)**

*Madhurima Bezboruah*

Green gram (*Vigna radiata*) is the fourth important pulse crop in India. India is the largest producer of green gram and contributes 10 to 12% national share among the total Indian pulse production (Basu, 2011). Storage is an essential part of its seed industry. The humid climatic condition of the North Eastern region, including Assam is identified for its poor storability. Lack of scientific storage facility, inappropriate storage medium makes it difficult for its storage up to the next season Green gram seeds were usually attacked in stores by different insect pests and micro-organisms. In the present investigation, the effect of different storage structures on the seed quality of green gram (*Vigna radiata*) was studied.

The seeds were stored in four different packaging materials *viz.*, Gunny bags, Polylined gunny bags, HDPE bags and Cloth bags with and without treatments. Different seed quality parameters like moisture content, germination percentage, seedling vigour index, field emergence, biochemical parameters (alpha amylase and lipid peroxidation activities), seed health parameters like mycoflora association and insect infestation were observed at the time of storing (0 day) and at an interval of two months up to nine months (270 days) of storage.

At the end of nine months of storage, lowest moisture content was observed in seeds stored in HDPE bags+ seed treatment with fungicide (9.81 per cent), followed by polylined gunny bags + seed treatment with black pepper powder @3g/kg of seeds (9.85 per cent) and the maximum was in case of cloth bags (11.26 per cent). Germination above IMSCS level (83.67 per cent and 75.67 per cent respectively) and seed vigour index (1416.07 and 1101.47 per cent respectively) were maintained only by two treatments *i.e.*, HDPE bags+ seed treatment with fungicide and polylined gunny bags + seed treatment with black pepper powder @3g/kg of seeds. The physiological parameters *viz.*, speed of germination, mean daily germination, peak value and germination value were found to be reduce with increase in the storage duration. Speed of germination was significantly highest in HDPE bags+ seed treatment with fungicide (27.66) till 270 DAT. Similar trend was also followed for mean daily germination, peak

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value and germination value. Mean germination time was significantly maximum in the seeds stored in cloth bags (4.94).

Among the biochemical parameters, lipid peroxidation activity was recorded to be minimum in seeds stored in HDPE bags + seed treatment with fungicide (0.38  $\mu\text{g/g}$ ) while the maximum was observed in seeds stored in cloth bags (0.67  $\mu\text{g/g}$ ) after 270 days of storage. The seeds stored in HDPE bags+ seed treatment with fungicide (0.42 mg maltose released/min) exhibited highest alpha amylase activity and the lowest was observed in cloth bags (0.10 mg maltose released/min) till 270 DAT. Six microorganisms viz., *Aspergillus flavus*, *A. niger*, *Rhizopus* spp., *Fusarium* spp., *Penicillium* spp. and *Alternaria* spp. were found to be associated with the green gram seeds under storage. The percentage of insect infestation was maximum in cloth bags (58.33 per cent) and the lowest insect infestation was maintained by HDPE bags + seed treatment with fungicide (23 per cent) upto 270 days of storage.

## **Varietal characteristics and divergence of rice varieties for genetic identity**

*Mannem Niveditha*

The identification and characterization of crop varieties has always been the basic and pre-requisite step in maintenance breeding, pre-breeding programs. With the growing population, decreasing cultivable land, narrowing genetic diversity of the crop species, changing climatic conditions and increasing demand, it has now become essential to maintain and conserve the traditional and local crop cultivars to protect the naturally existing crop diversity among the specific crop species. In order to maintain, protect and conserve the traditional cultivars systematic identification and documentation are crucial for each crop variety, which will also be a source of information for breeding programmees. The North-eastern India, has a rich source of genetic diversity for rice crop, being one of the primary centers of origin for rice crop. The present study is a step towards characterizing few traditional rice cultivars of Assam. 20 rice genotypes collected from various regional research stations of Assam, were studied for different morphological traits supported by statistical analysis. Total of 18 quantitative and 10 qualitative traits were studied and for distinguishing the 20 rice genotypes more precisely analysis of variance, divergence analysis using D2 statistics and principal component analysis were performed. All the traits under the study showed significant differences among the 20 rice genotypes. All the genotypes under the study were identified with some unique morphological traits, supported with the divergence analysis and principal component analysis. The genotypes based on the D2 statistic of mahalanobis distance were grouped into 2 different clusters and also based on PCA the genotypes were grouped into 6 different clusters. In both the clusters the genotype Betguti was out layered as a separate cluster from all the other 19 genotypes. The genotypes Betguti, Kanaklatha, Bor Malbhog, Kekua Bao, Jul Bao, Negheri Bao, Maguri, Solpuna, Rongabordhan, Rongdoi, Basudev and Rongadhan were able to be uniquely distinguished based on yield and grain related traits in the study.

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## **Influence of seed priming on aged seeds**

*Pratha Pratim Bora*

Seed is the basic and most important input for sustainable agriculture which contain all the required genetic materials that can effectively influence yield potential. One of the major problems in agriculture is the loss of seed viability and vigour particularly in tropical regions with high humidity during seed storage due to seed ageing. Seed ageing is a major and inevitable problem for both cereal and pulses. During the ageing process, seeds lose their vigour and ability to germinate. The slow or poor germination problem of aged seeds can be ameliorated through seed priming. For the present investigation, seeds of rice varieties Kon Joha and Keteki Joha and, French bean variety Arun were naturally aged for a period of 9 months to evaluate the effect of seed ageing on physiological and biochemical parameters; and then hydro-primed, osmo-primed with 5% and 10% PEG, halo primed with 1% and 2% KCl and hormonal primed with 5 ppm and 10 ppm GA3 for 12 and 24 hours, to evaluate the effect of priming treatments on seed ageing. The experiment was conducted in the department of Plant Breeding and Genetics, Assam Agricultural University, Jorhat during 2018-20. Physiological parameters like moisture percentage, germination percentage and index, mean germination time, seedling length and dry weight, seed vigour index, field emergence, seed reserve utilization rate, seed reserve use efficiency, seed reserve depletion percentage, and, biochemical parameters like electrical conductivity, lipid peroxidation and alpha amylase were observed during the study. Results revealed gradual deterioration of seed quality due to ageing during storage. Rate of deterioration was faster in seedling vigour traits than germination parameters. Also, the rate of deterioration was slower at the beginning of the storage period but faster at later period especially after 6 months. There was varietal difference in the rate of deterioration. The rate of deterioration was slower in Kon Joha, an indigenous variety which showed dormancy. The priming treatments were able to ameliorate the effect of seed ageing on seed germination, seedling growth and biochemical parameters in Kon Joha. The seed germination, seedling growth and biochemical parameters showed variation in their performance with respect to different priming agent, concentration and duration. KCl priming was found to be the best priming agent, 24 hours of priming for all agents were

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found better than 12 hours. 1% KCl, 10 ppm GA3 and 5% PEG were proved better concentrations than 2%, 5 ppm and 10% concentrations respectively in enhancing almost all the germination parameters and vigour indicators. The treatments could enhance the vigour but once the seeds were dead, treatments cannot ameliorate the effect of deterioration. Since GP is positively correlated with SRUR, SRDP and alpha amylase activity but negatively correlated with EC and lipid peroxidation, hence these parameters are good indicators to estimate the quality of seed and their performance in the field.

## **Genetic variability and diversity analysis for morpho-physiological traits associated with grain yield in cultivated rice (*Oryza sativa* L.)**

*Pratibha Das*

An investigation was carried out for assessing genetic variability, correlation, path coefficients and genetic divergence in a set of 60 rice genotypes currently under cultivation in the North Bank Plain Zone of Assam, which is rich in various forms of cultivated indigenous rice types. Analysis of variance conducted for seventeen yield, yield components and a set of morpho-physiological traits revealed a significant difference for all of them. Highest GCV was observed for chlorophyll 'a' content followed by panicle length and biological yield. Heritability in broad sense was highest in days to 50 *per cent* flowering, followed by days to maturity and 100-grain weight. Genetic advance as percent of mean was observed highest in harvest index followed by biological yield and filled grains per panicles. The traits harvest index, biological yield, spikelets per panicle and filled grains per panicles having high heritability coupled with high genetic advance could be considered for selection for obtaining high genetic gain. Character association studies revealed that 100-grain weight, spikelet per panicle, number of filled grain per panicle, spikelet fertility, biological yield and harvest index exhibited positive and significant association with grain yield. Highest positive direct effect on grain yield was exhibited by total chlorophyll content followed by chlorophyll 'b' and biological yield, while negative direct effect was highest in chlorophyll 'a' content followed by chlorophyll a:b ratio and spikelets per plant. Using Mahalanobis-D<sup>2</sup> statistics, genotypes were grouped into eight clusters. The intra and inter-cluster distances indicated a wide range of genetic diversity with highest inter-cluster distance between cluster VI and cluster VII, while, the lowest inter-cluster distance was observed between cluster I and cluster III. Cluster V was identified with highest intra-cluster D<sup>2</sup> value. Three clusters *viz.*, VI, VII and VII were monogenotypic. Hundred-grain weight (25.2 %) had the highest contribution towards genetic diversity followed by days to 50 *per cent* flowering (23.56 %) and Biological yield (21.07 %). Cluster VI ranked first followed by cluster v and cluster III in terms of cluster means.

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Based on diversity of genotypes and their *per se* performances for different traits genotypes were selected for inclusion as parents in hybridization programme. The cultivars *viz.*, Haccha, for earliness, Nepali Sakowa for grain weight, Cheni Sakowa for panicle length, Betguti for leaf area index, Gitesh for harvest index, Komal Dhan for grain yield per plant, Bora Dhan for effective tillers per plant were identified as promising parents for hybridization to obtain desirable segregants and exploitation of heterosis.

## **Genetic variability of root traits of different classes of rice (*Oryza sativa* L.) in Assam**

*Priyanka Bairagi*

Root characters for plant selection have been major breeding objectives for development of stress tolerant varieties in rice. Therefore the present investigation was conducted for comparative study of root traits and some yield attributing traits in different classes of rice (Ahu, Sali, Bao and Hybrid) in Assam. The study revealed presence of genetic variability among the genotypes for all the root and yield attributing traits. Bao varieties showed maximum root development throughout its growth period upto maturity in comparison to the other classes of rice. Highest phenotypic coefficient of variation and genotypic coefficient of variation was observed for the root length, root volume and root: shoot ratio. Heritability in broad sense was found to be high for root length, plant height, root volume and root: shoot ratio. Genetic advance as percentage of mean was found to be maximum for the root: shoot ratio, root volume and root length. High heritability along with high genetic advance as percentage of mean indicates presence of additive gene action and simple selection procedure can be adopted for improvement of yield. Correlation coefficient revealed positive association of fresh root weight, root: shoot ratio, total tillers per plant, effective tillers per plant with grain yield per plant respectively at genotypic level. Higher genotypic correlation coefficient indicates less influence of environmental effects on traits. Genotypic path analysis revealed 1000-grain weight, fresh shoot weight showed highest positive direct effect on grain yield. D2 analysis revealed total 11 numbers of clusters and cluster I and cluster VII showed highest numbers of genotype (5 each). Contribution of traits to total divergence was observed highest for root length followed by root volume and plant height. Inter cluster average distance was found to be maximum between cluster VIII and XI; IV and VIII and intra cluster average distance was found to be maximum for cluster I followed by cluster VII and cluster II. Clustering pattern of the genotypes revealed it did not follow any particular pattern with respect to the origin of the genotypes. Parental lines selected from cluster IV, VIII and XI can be used for hybridization.

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## **Assessment of genetic variability and screening of soybean cultivars against major diseases in Assam**

*Priyankee Dutta*

The present investigation was carried out at Instructional cum Research farm, AAU Jorhat during 2018 and 2019 to study the performance of 40 genotypes of Soybean for yield and other yield attributing traits and also to screen them against major diseases in Assam under greenhouse condition. The experiment consisted of 3 checks namely JS335, BRAGG, JS9305 and it was laid out in Randomised Block Design. Pooled analysis of variance was estimated over the two years and genotypic and phenotypic coefficient of variation using the mean squares which also helped in estimating broad sense heritability ( $h^2$ ) and genetic advance expressed as % of general mean. In addition, correlation and path analyses were computed between seed yield/plant and its components being days to 50% flowering, days to maturity, plant height, number of branches/plants, number of pods/plant 100-seed weight, Pod length, number of seeds/pod and oil content. Results showed significant differences among all studied traits. RVSM2011- 35 recorded the highest value of seed yield over the two years indicating that this genotype is promising and could be recommended for Assam. Highest values of genotypic and phenotypic coefficient of variation was obtained for seed yield, number of seed/pod and oil content indicating a wide range of variation which provided a good scope for yield improvement. Also, high values of heritability and genetic advance (% of mean) were recorded for seed yield/plant, oil content, number of branches, days to 50% flowering, plant height, number of pods /plant, 100 seed weight and number of seed/pod indicating that these traits have more chances for soybean yield development among the tested genotypes. Significant genotypic correlation coefficients were detected for almost all the characters except plant height and oil content which revealed importance of these characters in determining yield. Path analysis showed that the traits number of seeds/pod and 100 seed weight were the most directly contributing traits to seed yield/plant and as such could be used as selection criteria in the present soybean breeding programme. In addition, the genotypes were screened for resistance against Collar rot and Rhizoctonia rot and no genotypes were found to be immune or completely resistant. HIMSO1688, PS1347, BRAGG, JS335

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however showed moderate resistance against collar rot while PS1637, JS21-71, MACS1566, SL1191, HIMSO1688, PS24, RSC11-17, MAUS734, Dsb33, NRC138, PS1347, NRC139, SL1171, MAUS732, NRC148, RVSM2011-35, VLS97, NRCSL2, KDS1009, BAUS100, BRAGG and JS335 showed moderate resistance against Rhizoctonia rot under green house.

## **Evaluation of maize (*Zea mays* L.) hybrids at high plant density for important yield attributes**

*Ramesh Kanna M*

The present investigation was conducted with nine genotypes in RBD during *Rabi*, 2019-20 at the ICR farm, AAU, Jorhat with the objectives to characterise maize hybrids at high plant density, estimate genetic variability and to determine genetic association and path coefficients among the hybrids for different morphological and physiological traits. All the characters studied exhibited significant genotypic mean squares in ANOVA except anthesis silking interval (ASI) as well as 100 kernel weight (100KW) at both plant density levels while kernel rows per ear (KR/E) at 60 cm x 20 cm and ears per plant (E/P) at 50 cm x 20 cm. The genotype mean square across the spacing was significant to highly significant for all the traits except ears per plant. The mean square due to genotype x spacing was significant to highly significant for the traits days to 50% silking (D50%S), ears per plant (E/P), leaf area index at 60 DAS (LAI 60DAS), leaf area index at 90 DAS (LAI 90DAS), harvest index (HI) and grain moisture content (GMC). The hybrids namely, PAC 751, CP 333 and PAC 751 ELITE at 60 cm x 20 cm, PAC 751, CP 838 and ADV 759 at 50cm x 20cm and PAC 751, CP 333 and PAC 751 ELITE at across spacing were found to be the three best hybrids to possess a high estimate of desirable traits such as days to 50% pollen shed (D50% PS), days to 50% silking (D50% S), days to 100% dry hush (D100% DH), plant height (PH), ear height (EH), ear diameter (ED), LAI (60 DAS), LAI (90 DAS), grain yield per plant (GY/P) and grain yield per hectare (GY/HA). High heritability coupled with high genetic advance was observed for the traits PH, EH, EL, K/R, CHLR, LAI 60 DAS, LAI 90 DAS, HI, GY/P and GY/HA in both the spacings and it indicated the preponderant role of additive gene action for these traits. Simple selection methods such as mass selection may improve the population with respect to these traits. Significant genetic association of GY/P and GY/HA with D50% PS, D50% S, D100% DH, K/R, LAI 60 DAS and LAI 90 DAS indicated that grain yield could be improved indirectly by selecting superior plants for easily heritable traits like D50% PS, D50% S, D100% DH and K/R at both the spacings. Genotypic path analysis revealed that the characters

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D50% PS and EH had the highest positive direct effects on grain yield per hectare while D50% PS had the highest negative direct effect on grain yield per hectare at both the spacing. The residual was found to be very low at both the spacings reflecting that the independent characters under study contributed to the variation in GY/HA to a great extent, which inherently suggested the characters taken in the investigation contributed a large extent of the variability in the population.

## **Evaluation of some indigenous rice varieties for seed morphology and cooking quality characteristics**

*Rajasree Rajkhowa*

Assam as well as North-east India is traditionally a rice growing area. The local/indigenous varieties have been grown in the state since time immemorial and by now most of them are getting lost due to the change in biodiversity. Conservation of such varieties are highly needed as they can be grown with minimum possible input and have a considerable demand in local and international market. With the increasing awareness people tends to be more health conscious and more interested on the nutritional quality of the food. Hence if we utilize these local varieties in organic farming conditions with lowest input nature, it will benefit the farmers as well as the consumers. This local/indigenous varieties are having many such desirable properties can meet the consumer preference and market demand if utilized organically. In the present investigation, fifty (50) traditional rice genotypes were collected from different regions of North-East, characterized according to the DUS test guidelines of PPV&FR act of 2001 at Assam Agricultural University, Jorhat. Cooking quality parameters of the traditional rice genotypes were also analyzed and all the tested parameters showed significant variations among the varieties. Also a correlation was established between the seed morphological and cooking quality characters of the varieties. A rapid and reliable technique to verify the identity and to assess the purity of seed lots is important in seed quality assurance program. Based on the overall study, sixteen (16) genotypes, *viz.*, Beji, Beto Baw, Bhogali Bora, Black Rice, Bordhan, Borsolpuna, Dhusuri Bao, Dolmora Bao, Gezep Sali, Joha Big, Jum Beji, Kutkuti Sali, Nekeru, Ronga Bordhan, Rongadhakekua Baw, Xoru Seni Lahi were found to exhibit unique features of morphology and cooking quality. The identification of such germplasms is the source of preservation and conservation in addition to being the source of genetic resources for the future crop improvement programs.

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# **Performance evaluation of pre-sowing seed treatments using bio agents in transplanted aromatic rice for organic condition**

*Shamima Nashrin*

Rice is staple food for most of the World's population and a major source of income for farmers in developing countries. Assam being one of the centers of origin is endowed with a wide range of variability for rice. Among the specialty rice group of Assam, aromatic rice of this region occupies a major share in production and trading, specially small grained aromatic *Joha* rice, because of its wide acceptability in local and in exotic market. Organic agriculture is a rapidly developing all around the world and commercial production of agro products has become a lucrative venture. Looking at the present scenario of organic rice production, the present investigation was taken with the objectives to mitigate different challenges of field establishment at early seedling growth period, envisioned with higher productivity. Seed enhancement techniques are pre-sowing seed treatments that lead to a physiological state which enables the seed to germinate in a more efficient manner and imparts better field establishment. Seed treatment with bio-agents has emerged as an alternative to chemical inputs with many fold advantages of mitigating biotic and a-biotic stresses in field condition more precisely in organic condition. In the present study five locally prepared commercial organic bio-formulations *Organic-Metajal*, *Organic-Trichojoal*, *Organic-Beauverijal*, *Azospirillum* spp. and *BIO Phos*, liquid PSB formulation were used to treat the seeds along with two root treatment in 30 days old seedlings (using *Azospirillum* spp.) and evaluated the early seedling growth and yield performance of "*Keteki Joha*" a high yielding aromatic rice variety in organic condition. In the present investigation *Org-Metajal* exhibited better germination and vigour indicators in laboratory condition whereas in field condition *Org-Trichojoal* is found to be better performer. *Org-Trichojoal* was found to be highest performer in regards to early vigour, seedling growth and yield parameter in field condition. However *Org-Metajal*, *Organic-Beauverijal*, *Azospirillum* spp. and *BIO Phos* are also found to be effective in improving growth and yield as compared to the control. The present study implies the cost effectiveness of these bio-

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agents which is reflected in higher productivity, hence higher net return. Simple and user friendly methodology of application of the bio agent as formulated in the study will enable easy adaptation of the bio-agents by the farming community.

## **Evaluation and background selection of Bacterial Blight introgressed lines in Ranjit Sub-1**

*Sruthi R*

Rice is one of the important staple cereals which is consumed as a main part of diet by more than half of world's population. Rice production in India accounts to more than 40% of country's grain production. Rice is a major crop of Assam and it plays a major role in state's economy. Ranjit is the most popular variety of Assam, which is grown in more than fifty percent of the *sali* rice growing areas of the state. Ranjit Sub-1 is a flood resistant variant of Ranjit. Rice yield is prone to a number of diseases, of which bacterial blight is a widespread one. It is a vascular disease caused by *Xanthomonas oryzae* pv. *oryzae* and leads to yellowing and drying of the leaves. Host plant resistance is considered as the effective, economical and environment friendly strategy for controlling bacterial blight. Marker assisted backcross breeding was followed to introgress the resistant genes xa5, xa13 and Xa21 to Ranjit Sub-1 background. The cross was made between ISM and Ranjit Sub-1, where ISM was taken as donor parent and Ranjit Sub-1 as recurrent parent. In the present study ten BC2F3 lines along with three checks Ranjit, Ranjit Sub-1 and ISM were evaluated for field performance, disease resistance, foreground and background selection. The experiment was conducted in randomized block design with three replications and the field performance was evaluated based eight morphological traits. Three lines showed mean yield comparable to that of the recurrent parent. Phenotypic screening for disease reaction was done by artificially inoculating the lines with Xoo strain and measuring the lesion length. Out of the 10 BC2F3 lines, 8 lines showed resistance reaction. Foreground selection was carried out for three resistant genes and Sub-1 QTL. In the foreground selection, five lines showed three resistant gene combination, three lines showed two resistant gene combination, two lines showed presence of single resistant gene and Sub-1 QTL was present in three lines. Based on field performance, disease screening and foreground selection, three lines were selected for background selection. Background recovery was done using sixty polymorphic SSR markers and the lines showed 70.16 to 82.46% background recovery of the recurrent parent genome.

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**Major Adviser: Dr. Sanjay Kumar Chetia**

## **Assessment of genetic variability and association analysis for morpho-physiological attributes in Sesame (*Sesamum indicum* L.)**

*Subrat Das*

Sesame (*Sesamum indicum* L.) is a high value oilseed crop owing to its multifarious dietary uses, health benefits and industrial applications. The productivity of this crop is comparatively low in India. In Assam it is grown as a minor oilseed crop and it occupies only 3.8 % of the total area under oilseed crops in the state. Considering the enormous gap between the potential and realized yields, there is ample scope for enhancement of its productivity through breeding efforts. The present investigation was undertaken to evaluate 32 sesame genotypes during *Kharif* 2019 under RBD with 3 replications at the experimental field of Plant Breeding & Genetics, B. N. College of Agriculture, Biswanath Chariali. The objectives of the investigation were to study genetic variability, character association through correlation and path analysis and also to assess the genetic diversity in the accessions for twelve morpho-physiological traits. Analysis of variance revealed highly significant differences among the genotypes for all the characters studied. Moderate to higher values of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were recorded for all the characters under study except days to maturity and relative leaf water content. Moderate to high heritability estimates were shown by all the traits under study. High heritability coupled with moderate to high genetic advance as per cent of mean (GAM) was observed for all the characters except days to maturity and relative leaf water content indicating effectiveness of selection for improvement of these traits. Seed yield per plant exhibited moderate heritability coupled with high genetic advance as per cent of mean. Correlation and path analysis revealed that the characters *viz.*, days to maturity, plant height, number of primary branches per plant, number of capsules per plant, leaf area index, relative leaf water content, chlorophyll content and harvest index had positive direct association effect along with significant positive correlation with seed yield. Based on the *per se* performance the genotypes *viz.*, SGP-26, RT-54, TKG-55 and PKG-21 exhibited better performance with respect to seed yield per plant and most of the

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other yield attributing morpho-physiological characters. Using Mahalanobis D<sup>2</sup> statistics, the genotypes could be grouped into eight (8) clusters. The maximum intra-cluster distance was found in cluster III followed by cluster II and cluster VI. The clusters V, VII and VIII had only one genotype each. The maximum inter-cluster distance was recorded between cluster III and VIII, while minimum distance was observed between clusters V and VII. Among all the characters, seed yield per plant had highest contribution towards the genetic diversity. Based on the *per se* performance, inter-cluster distances and mean performance of clusters for different traits genotypes *viz.*, SGP-26, TKG-55 and PKG-21 belonging to cluster III and ALS-6 and ALS-7 belonging to cluster II are expected to produce desirable segregants for yield and other yield attributing traits after hybridization. Similarly, the genotypes RT-54 belonging to cluster I and JT-14 belonging to cluster IV may be selected for the crossing programme. Thus, an efficient hybridization programme may be formulated which could pave the way for obtaining basic genetic materials to undertake further selection in sesame.

# **Genetic variability in Rice bean (*Vigna umbellata* Thunb.) for important quantitative characteristics and their relationship with grain and forage yield**

*Suchitra Balmiki*

Ricebean (*Vigna umbellata* Thunb.) is a minor and multipurpose grain legume crop which is mainly cultivated for food, fodder and green manure by the poor farmers in the marginal areas. It plays a major role in human, animal and soil health improvement. It is a good source of protein and essential amino acids and it also acts as a good cover crop, helps in preventing soil erosion and also has the ability to fix nitrogen. The current experiment was conducted in the Instructional-Cum-Research Farm, Assam Agricultural University, Jorhat during *Rabi* 2018 to study the genetic variability and yield performance of fourteen rice bean genotypes grown in Randomized Block Design with two replications. The analysis of variance revealed that mean squares due to genotypes was significant for all the characters. The estimates of genotypic coefficient of variation and phenotypic coefficient of variation were observed to be high for stem length, leaf-stem ratio, productive racemes per plant and seed yield per plant. High heritability coupled with high genetic advance as per cent of mean was observed for stem length, leaf area, 100 seed weight, pod length, seed breadth, leaf-stem ratio, productive racemes per plant and seed yield per plant indicating the preponderant influence of additive gene effects. The correlation studies revealed that green forage yield per plant was significant to highly significant and positively correlated with plant height, primary branches per plant, secondary branches per plant, stem length, leaf area, pod length, seed length, seeds per pod, leaf-stem ratio, productive racemes per plant, pods per raceme, days to 50% flowering, days to maturity, seed yield per plant and dry matter yield per plant. Therefore, indirect selection may be done via these traits to improve the productivity of genotypes for green forage yield. The results from the path analysis revealed that plant height, primary branches per plant, days to maturity, seeds per pod and pod length were the most important characters which could be used as selection criteria for effective improvement of dry matter yield of rice bean through indirect selection. In case of qualitative traits, all the rice bean genotypes under study

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were semi-erect type and showed indeterminate growth. All the genotypes had yellow-coloured flowers and the flowers were observed to be in cluster. The hilum shape of the seeds of all the genotypes were observed to be concave except for genotypes JCR-14-1 and Bidhan Rice bean-1, which had seeds with straight hilum. The seeds of all the genotypes were non-pigmented. Therefore, the above observations concluded that only hilum shape could differentiate the genotypes.

## **Performance evaluation and character relationship in a set of genotypes of Yellow Sarson (*Brassica rapa* L.)**

*Supriya Kaushik*

Rapeseed (*Brassica rapa* L.) is one of the most important oilseed crops of the country occupying considerably a large acreage. Rapeseed includes brown sarson, yellow sarson, toria and gobi sarson (*B. napus*). Because of the advantage of short maturity duration, the farmers in Assam and other North-eastern states have been cultivating predominantly the toria and yellow sarson. In the present study, a set of fourteen yellow sarson genotypes including eleven newly developed lines and three varieties, was evaluated during year *Rabi* 2018-19 and 2019-20 to study mean performance for seed yield, duration and related traits and reaction to natural incidence of aphids and Alternaria blight, to estimate genetic variability parameters and to study character relationships. Observations were recorded for fourteen yield attributing characters. The pooled analysis of variance of the experiments revealed significant variation due to genotypes, environments and genotype-environment for majority of the characters. JYS15-2, JYS14-3, JYS14-2 and YSH401 were high yielders per hectare over the two years. All the genotypes were susceptible to Alternaria blight disease and susceptible or highly susceptible to aphid (*Lipaphis erysimi*) infestations. Medium genetic coefficient of variation was observed for most of the traits. Heritability and genetic advance were high for the character seed yield per hectare. On the basis of genetic correlation and path analysis days to 50% flowering, harvest index, number of siliquae on main shoot and siliqua density were found as important yield attributes. On the basis of D2 analysis the genotypes were grouped into four clusters, using the Tocher's method. Siliqua density, days to maturity, number of seeds per siliqua, main shoot length, seed yield per plant and plant height contributed 61 percent variation towards divergence. Hybridization between genotypes from diverse clusters is likely to yield transgressive recombinants.

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## **Evaluation of selected F<sub>3-4</sub> lines of Tomato crosses (*Solanum lycopersicum* x *Solanum pimpinellifolium*) for morpho-metric traits**

*Upasana Bordoloi*

In the present investigation fifty selected F<sub>4</sub> progenies from inter-specific crosses with wild tomato *Solanum pimpinellifolium* were evaluated along with five check varieties in an augmented RBD during *Rabi*, 2018-19. Observations were recorded for nine morphometric traits. Significant genotype variation was observed for all the traits. The progenies from the cross between Arka Abha and *Solanum pimpinellifolium* were good performers in comparison to the other progenies. High to moderate estimates of genotypic as well as phenotypic coefficient of variation were observed for all the traits under study except fruit equatorial diameter and days to maturity. High heritability along with high genetic advance as percent mean was observed for average fruit weight, fruit polar diameter, number of branches per plant, plant height, fruits per cluster, fruit yield per plant, fruit equatorial diameter etc. Association studies revealed significant positive correlation of fruit yield per plant with number of branches per plant, fruit polar diameter and days to maturity. Fruit yield per plant was negatively correlated with fruits per cluster, fruit equatorial diameter and average fruit weight. Highest positive direct effect on fruit yield was shown by number of branches per plant followed by fruit equatorial diameter. The characters fruit polar diameter and average fruit weight showed negative direct effect on fruit yield per plant.

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**Abstract of M.Sc. thesis**

**Department: Plant Breeding and Genetics**

**Major Adviser: Dr. Prabalee Sarmah**



# **Molecular screening of Citrus germplasm for simultaneous detection of *Candidatus Liberibacter* species associated with citrus greening disease**

*Amitha Paul*

An effort was made to screen the Citrus germplasm maintained at the Citrus Research station (CRS), Tinsukia, Assam to identify the prevalence of *Ca. Liberibacter* species associated with citrus greening disease (CGD) and to understand the differential reaction of various varieties to CGD. Overall, 32 germplasm were screened comprising 16 species, 1 hybrid and 1 unidentified cultivar. The severity of CGD based on symptomatology showed that; major parts of the germplasm were infected with CGD. The conventional PCR assay with two pairs of primers of these varieties showed that, only three (3) varieties namely; Khasi Papeda, Trifoliate Orange and Citrange are free from CGD infection. The presence of Citrus Psyllid insects in symptomatic trees, further amplification of its DNA with the specific primer confirmed the probability of vector mediated the spread of CGD in the field. Further differentiations of Asian and African strains by PCR and RFLP assays confirmed the absence of African strains. Similarly, comparative quantification of infected (10 samples) and suspected healthy (3 varieties) were done by Real time PCR to differentiate the known *Ca. Liberibacter* species in a singleplex reaction. The assay confirmed that the suspected healthy accessions were resistant and the others were infected with only *Ca. Liberibacter asiaticus*. The sequence similarity and evolutionary divergence analysis of the CGD isolates under current study showed sequence similarity with the „*Ca. L. asiaticus*“ isolates (Asian-common isolates) from Southeast Asia, rather than the other diverse atypical Indian isolates present in the rest part of the country.

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**Abstract of M.Sc. thesis**

**Department: Plant Pathology**

**Major Adviser: Dr. Palash Deb Nath**

# **Bioassay of toxicity of green synthesized silver nanoparticles on biocontrol agents and mammalian cells**

*Arti Kumari*

The present study was conducted to ascertain the interaction of silver nanoparticles (AgNPs) with beneficial microorganisms and mammalian cells. AgNPs were biogenically synthesized mediating *Trichoderma asperellum*. Biosynthesized AgNPs were characterized using UV-Vis spectrophotometer, Dynamic Light Scattering (DLS), Zeta Sizer, Fourier-Transform Infrared Spectrophotometer (FTIR) and Nanoparticle Tracking Analyzer (NTA). The toxicity of AgNPs were evaluated at 50, 100 and 200 ppm concentration against biological control agents viz., *Trichoderma harzianum*, *Beauveria bassiana* and *Bacillus thuringiensis* and mammalian cell line (Vero cells). Results showed that AgNPs at 200 ppm concentration caused highest inhibition in the mycelial biomass content of *T. harzianum* and *B. bassiana* i.e. up to 31.54 % and 28.40% respectively. Biochemical analysis showed that the total soluble sugar and total soluble protein content of both fungi declined with increasing concentration of AgNPs. Biological control agents like *T. harzianum* showed early sporulation when exposed to AgNP as compared to control. On the other hand, AgNPs at all the tested concentration did not show any inhibitory effect to *B. thuringiensis*. The study on uptake of NPs by Vero cells revealed rapid uptake of AgNPs in a concentration and time dependent manner. Highest uptake of NP was observed at 200 ppm concentration after 8 hrs of exposure and lowest at 50 ppm after 1 hr exposure. Similarly, cellular fluorescence microscopic study also revealed increase in AgNP uptake with highest intensity of fluorescence observed at 200 ppm. Staining the Vero cells using May-grunwald and Giemsa stain showed no alteration in cellular morphology even at 200 ppm. Morphological study done by Scanning Electron Microscope (SEM) showed distortions in cellular structure at 200 ppm AgNP. Another study on cytotoxicity of AgNPs on Vero cells showed mild toxicity in a dose dependent manner. The percent viability of Vero cells was found to be highest at 50 ppm (75.27%) and lowest at 200 ppm (72.81%). The highest per cent cytotoxicity (28.22%) on Vero

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cells was recorded at 200 ppm and lowest (12.15%) at 50 ppm. Present study showed green synthesized AgNPs posed mild toxicity on fungal biocontrol agents and Vero cells and no toxicity against *B. thuringiensis*.

## **Study on fungal diseases of Gerbera (*Gerbera jamesonii* Bolus ex. Hook F) in Assam**

*Bishal Saikia*

Gerbera (*Gerbera jamesonii* Bolus ex. Hooker F) belongs to Asteraceae family, is a spectacular and very popular commercial cut flower grown around the world, under a wide range of climatic condition. Random survey conducted in the gerbera growing areas of the districts viz., Jorhat, Kamrup (R) and Karbi Anglong revealed the incidence of few fungal diseases of gerbera viz., *Alternaria* leaf spot, *Botrytis* blight, *Colletotrichum* leaf spot, and *Fusarium* wilt. Based on the per cent disease incidence and per cent disease index as well as on nature of occurrence *Alternaria* leaf spot and *Botrytis* blight of gerbera were selected for further studies. Based on symptomatology, cultural, morphological and molecular characterization the isolated fungal pathogens were identified as *Alternaria alternata* (Fr.) Keissler and *Botrytis cinerea* (Pers.; Fr.) which were also confirmed by the National Centre of Fungal Taxonomy (NCFT), New Delhi. Pathogenicity test was conducted by pin-prick method and Mycelial Bit Inoculation Technique (MBIT) and confirmed the Koch's postulates. *In vitro* efficacy test of different botanicals, biocontrol agents and fungicides singly and in combination against *A. alternata* and *B. cinerea* was conducted. *Allium sativum* (10% conc.), and *T. harzianum* recorded maximum mycelial growth inhibition of 86.66% & 74.44% and 76.41% & 81.38%, respectively. Similarly, *in vitro* efficacy of fungicides evaluated alone and in combination against *A. alternata* and *B. cinerea* revealed that Hexaconazole (0.1%) and Carbendazim (0.1%) caused maximum mycelial growth inhibition of 100.00% and 88.77% respectively. In pot experiments the efficacy of botanical, biocontrol agent and chemical alone and in combination against *A. alternata* and *B. cinerea* was tested. Hexaconazole (0.1%) was found most effective against *A. alternata* which recorded lowest disease incidence (14.55%) and per cent disease index (13.26%) with highest per cent disease control of 82.05% and 84.22%, respectively. In case of *B. cinerea*, Carbendazim (0.1%) recorded lowest disease incidence (11.97%) and per cent disease index (8.57%) with highest per cent disease reduction of 84.14% and 88.95%, respectively in pot experiment. In field condition also Hexaconazole (0.1%) recorded lowest disease incidence (16.52%) and per cent disease index (11.76%) with

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highest per cent disease reduction (79.43% and 85.59%) of leaf spot caused by *A. alternata*. In case of *B. cinerea*, Carbendazim (0.1%) recorded lowest disease incidence and per cent disease index of 14.48% and 12.83% with highest per cent disease reduction of 81.41% and 84.07% respectively. The yield attributing characteristics and growth parameters of gerbera were found to be superior when treated with *T. harzianum* [Org-Trichojal (@ 5ml/l)].

## **Study on incidence, detection and characterization of Brinjal Little Leaf (BLL) disease in Assam**

*Dibya Sree Dutta*

The present investigation was conducted to know the incidence, symptom development, molecular detection and characterization of Brinjal little leaf (BLL) disease in Assam, together with the leafhoppers associated with natural transmission of the disease. Roving survey was conducted during 2018 to 2020 in seven major brinjal growing districts of Assam namely, Biswanath, Darrang, Golaghat, Jorhat, Nagaon, Sibsagar and Sonitpur. The disease incidence was observed in all the surveyed locations. Highest disease incidence was recorded in Sibsagar district (23.63%) followed by Golaghat (21.68%), Biswanath (12.91%), Nagaon (12.72%), Jorhat (10.90%), Sonitpur district (5.66%) and the lowest disease incidence was observed in Darrang (3.62%) district. The BLL disease infected plants exhibited a wide range of symptoms such as reduction in the leaf size, stunted growth, yellowing of leaves, phyllody, witches' broom and mummification of fruits. Four different types of leafhoppers viz., *Amrasca biguttula biguttula* (Ishida), *Exitianus indicus* (Dist.), *Hishimonus phycitis* (Dist.), *Nephotettix nigropictus* (Stal) were collected during the survey with average population of 3.42, 3.14, 4.85 and 2.85 numbers per five net sweeps respectively.

The Brinjal little leaf disease was successfully transmitted by the leafhopper *Hishimonus phycitis* (Dist.) and dodder with transmission efficiency of 80.00 per cent and 60.00 per cent respectively. The disease severely affected both growth and yield attributing parameters of brinjal plants which was observed to be varied depending on the age of the plant at infection. The highest reduction in plant height (72.16%), leaf size (84.54%), petiole length (92.69%), internode length (72.94%), no. of fruits per plant (73.33%), fruit weight (80.48%) and fruit yield per plant (94.79%) over healthy plant (control) was observed when plants were infected at 65-70 days after transplanting (DAT). As the age of the plant at infection increased the effect on growth and yield attributing parameters also reduced significantly.

Total genomic DNA extracted from symptomatic and asymptomatic brinjal plants collected from different districts of Assam were subjected to PCR assays using phytoplasma specific universal primers. All the symptomatic brinjal plants yielded an

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expected amplicon size of ~1.5 kb from PCR confirming the presence of BLL phytoplasma. No amplification was obtained from asymptomatic brinjal plants. Plants such as datura, mustard, tomato and *Tita bhekuri* (*Solanum violaceum*) present in and around the infected brinjal fields also tested positive for phytoplasma indicating them as potential reservoir hosts of BLL phytoplasma in Assam. Sequencing and phylogenetic analysis has revealed that the Brinjal little leaf phytoplasma detected under the present investigation was associated with '*Candidatus* Phytoplasma trifolii' (16SrVI) (clover proliferation group).

Studies on the effect of tetracycline hydrochloride antibiotic in remission of BLL disease symptom elucidated that the effect was purely temporary remission of symptoms.

# **Enhancement of microbial load in *Bhut chilli* (*Capsicum chinense* Jacq.) rhizosphere by bioformulation application and management of bacterial wilt disease (*Ralstonia solanacearum*)**

*Dipankar Das*

Bacterial wilt caused by *Ralstonia solanacearum* is one of the most destructive and widespread bacterial diseases of solanaceous crop plants in the tropics, subtropics, and warm and temperate region of the world. *In vitro* studies of bioagent combinations of six bioformulations were conducted against the pathogen. The antagonistic potential of the bioagents were tested *in vitro* singly and in combination against *R. solanacearum* adopting dual culture method using TTC as basal medium. The inhibition zones (mm) of bio-agents singly and in combination and per cent inhibition of target pathogen were recorded and analyzed. The highest inhibition (82.63%) against *R. solanacearum* was recorded against BIOGREEN-5 (a combination of five bioagents, viz., *T. viride*, *M. anisopliae*, *B. bassiana*, *P. fluorescens* and *B. thuringiensis*) followed by BIOTIME (a combination of three bioagents, i.e, *T. harzianum*, *M. anisopliae* and *P. fluorescens*) with 74.50% inhibition. Based on the results of the *in vitro* experiment, two talc-based bioformulations and one liquid bioformulation were selected for the management of bacterial wilt of bhut chilli. These effective bioformulations were further evaluated under field conditions for their efficacy against bacterial wilt disease when applied as seedling root treatment, soil application and spray application under field conditions. Similarly, other yield attributing characters, viz., plant height, no. of leaves, no. of primary branches, root dry weight, shoot dry weight, root fresh weight, no. of fruits per plant and fruit weight was highest in the plants treated with BIOVEER (*T. viride*). Significantly highest reduction of bacterial wilt incidence (14.06%) and highest yield (4.27 t/ha) of bhut chilli was recorded in the treatment comprising talc-based formulation of BIOVEER followed by BIOGREEN-5 and BIOTIME-L. The microbial population of the pathogen increased significantly at harvest in all the treatments as compared to before experimentation. Correlation studies recorded negative correlation (-0.96) between bacterial wilt incidence and yield of bhut chilli.

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**Major Adviser: Dr. P. K. Borah**



## **Increasing the yield attributing character of different species of pleurotus through hybridization**

*Karishmi Riba*

Interspecific hybridization studies were carried out between *Pleurotus sajor-caju*, *P. sapidus* and *P. flabellatus* for obtaining better quality strains. Out of 48 crosses, only five inter specific crosses of *P. sajor-caju* x *P. sapidus* and four inters specific crosses of *P. sajor-caju* x *P. flabellatus* were compatible. Inter specific crossing between *P. sapidus* and *P. flabellatus* failed to show any compatible reaction. The compatible crosses were tested for evaluating their growth characteristics on MEA media and the cross SC2S1 have shown significantly higher mycelial growth rate (8.89 cm) which was followed by the cross SC1S1 (8.66 cm). The obtained hybrid crosses have shown more dense and regular growth with floccose, cottony and aerial mycelial texture and also showed off-white, pure white and yellowish white in colony colour. Out of nine dikaryotic strains, the cross SC2S1 (*P. sajor-caju* x *P. sapidus*) was the best strain among all the obtained hybrid strains and its parental strains in terms of number of days required for spawn run (11.50 days), number of days required for pin head formation (15.50 days), days required for harvesting (18.50 days), total number of fruiting body (214.00), weight of the individual fruiting body (20.00 g), total yield per bag (0.95 kg) and biological efficiency (95.00%). Whereas in terms of stipe diameter, the cross SC2F2 (*P. sajor-caju* x *P. flabellatus*) has shown maximum stipe diameter (3.50 cm) as compared to other dikaryotic strain and its parental strain and among the dikaryotic strain the cross SC1S2 (*P. sajor-caju* x *P. sapidus*) have shown significantly higher stipe length (6.41 cm), which was also higher than their respected parents. Maximum cap size (6.73 cm) was recorded in the cross SC1F2 (*P. sajor-caju* x *P. flabellatus*) which was significantly higher than the other dikaryotic strain and its parental strain. During sensory evaluations, the product B (*P. sajor-caju* x *P. flabellatus*) was rated better than the global mean in overall acceptance (8.56), taste (8.90), flavour (7.90), colour (7.40) and appearance (8.13), with highest score in all the sensory parameters followed by Product A (*P. sajor-caju* x *P. sapidus*). While the lowest score was obtained by *P. sapidus* (product D) followed by *P. flabellatus* (product E) and *P. sajor-caju* (product C).

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**Major Adviser: Dr. D.K Sarmah**

## **Detection, incidence and molecular characterization of Papaya ringspot virus (PRSV)**

*Lonmow Gohain*

The present investigation was conducted to know the incidence, detection and molecular characterisation of Papaya ringspot virus (PRSV) Assam. A roving survey was conducted between 2018-2020 growing seasons in four districts of Assam namely Jorhat, Tinsukia, Dibrugarh and Majuli. During the survey, PRSV infected plant exhibited symptoms like chlorosis, mosaic, puckering, vein clearing, filiform leaves, leaf distortion, shoestring, chlorotic ringspot on leaves, blistering and PRSV infected stem exhibited oily spots, fruits exhibited water-soaked lesions which later turn yellow-orange and develop prominent ringspot symptom, malformation of fruits. The disease incidence was observed in all the surveyed locations. Highest disease incidence was recorded in Jorhat district (78.47%) followed by Majuli (75.00%), Dibrugarh (61.66%) and Tinsukia (49.99%) district respectively. Representative samples were collected from the surveyed districts of Assam for further analysis. PCR analysis was done to amplify the specific DNA fragments from PRSV infected and healthy samples. PCR results revealed that the PRSV specific primer pair yielded an amplicon size of 300 bp. The results revealed that a total of 44 samples out of 62, tested positive for PRSV. The highest incidence was observed in Jorhat (83.92%) followed by Majuli (80.00%), Dibrugarh (65.26%) and Tinsukia (51.40%). PCR product of PRSV infected sample of Jorhat district viz., Jorhat isolate was sequenced and compared with the known PRSV isolates worldwide using nucleotide BLAST programme at National Centre for Bio Informatics (NCBI) and Mega X software. The sequence similarity of PRSV Jorhat isolate showed similarity of 89.00 per cent to 96.30 per cent. The phylogenetic analysis revealed that the PRSV Jorhat isolate is closely similar to that West Bengal isolate Accession no. LC462714.1.

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**Department: Plant Pathology**

**Major Adviser: Dr. Phuleswar Nath**

# **Residue analysis of carbendazim used for controlling contaminants of oyster mushroom (*Pleurotus* spp.)**

*Lunisha Pegu*

The present investigation, entitled “Residue analysis of carbendazim used for controlling contaminants of oyster mushroom (*Pleurotus* spp.)” was undertaken to evaluate the incidence of contamination of the microflora on mushroom beds and amount of residue present in the Mushroom fruiting body harvested from the beds treated with formaldehyde and carbendazim. Different species of *Pleurotus* viz., *P. sajor-caju*, *P. sapidus* and a Commercial hybrid was used for the experiment. The different concentration levels of formaldehyde and carbendazim was at the rate of 500 ppm formaldehyde + 10 ppm carbendazim, 750 ppm formaldehyde + 20 ppm carbendazim, 1000 ppm formaldehyde + 30 ppm carbendazim, 1250 ppm formaldehyde + 40 ppm carbendazim, 1500 ppm formaldehyde + 50 ppm carbendazim, 1750 ppm formaldehyde + 60 ppm carbendazim, 1000 ppm formaldehyde, 40 ppm carbendazim were applied for managing the contaminants. The results revealed that the incidence of contamination was restricted on the combined application of chemicals in case of *Trichoderma* spp., but in case of *Coprinus* spp. the lowest chemical combination was ineffective against the organism. The investigation revealed that the residue of carbendazim present in mushroom fruiting body was least in the concentration at the rate of 40 ppm carbendazim in *P. sajor-caju*, 70 ppm carbendazim combined with 2000 ppm formaldehyde in *P. sapidus* and 70 ppm carbendazim combined with 2000 ppm formaldehyde and 40ppm carbendazim in Commercial hybrid. And the maximum residue was found in the concentration at the rate of 40 ppm carbendazim and highest at the rate of 30 ppm carbendazim combined with 1000 ppm formaldehyde in *P. sajorcaju* and *P. sapidus*, 40 ppm carbendazim combined with 1250 ppm formaldehyde in Commercial hybrid.

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**Department: Plant Pathology**

**Major Adviser: Dr. D. K. Sarmah**

# **Bioformulation of Organophosphate Degrading Bacteria and Plant Growth Promoting Microbes for pesticide degradation *vis-à-vis* management of bacterial wilt pathogen *R. solanacearum***

*Shenaz Sultana Ahmed*

The introduction and extensive application of xenobiotics, more precisely, the chemical pesticides have left diversified hazards on both, environment and human health via accumulation of pesticides residues. The most widely used group of pesticides belonging to the organophosphorous (OP), accounting to 38% of the global pesticide market. Continuous and excessive use of OP contaminated the agroecosystem due to accumulation of their residues. The microbial degradation of residues of OP is considered as an environmentally benign and economically preferred option. The present investigation was carried out to identify efficient OP degrading bacteria and evaluate their compatibility alongside PGPMs with emphasis on biocontrol potential against *Ralstonia solanacearum*, a soil borne pathogen responsible for wilt disease of brinjal, paving the way to development of a suitable delivery mechanism for pesticide biodegradation and biological management. A total of 10 bacterial isolates were isolated from pesticide contaminated agricultural soils having OP pesticide (chlorpyrifos) degrading potential. The most efficient ones displaying the potential growth up to 1000ppm of chlorpyrifos were studied for their growth analysis spectrophotometrically and establishing their degrading potential via High Performance Liquid Chromatography (HPLC). The selected isolates were subjected to morphological, biochemical and molecular characterization, which identified them as *Achromobacter marplatensis* (*Am*) and *Pseudomonas azotoformans* (*Pa*) having compatibility for *vice-versa*. This was accompanied with *in vitro* study further establishing the compatibility of efficient OPDBs with PGPMs such as *Pseudomonas fluorescens* (*Pf*) and *Trichoderma harzianum* (*Th*). These studies facilitated the development of bioformulation containing PGPMs and OPDBs, finally evaluated for its efficacy against bacterial wilt of brinjal and degradation of OP pesticide. The potted experiment showed that combination of *Pa*

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+ *Pf* + *Th* displaying lowest percent wilt incidence (PWI) of 5% coupled with significantly highest root biomass (5.35g/plant), shoot biomass (36.39g/plant), root length (27.88 cm/plant), shoot length (81.42 cm/plant), leaf number (83.20/plant), fruit number (5/plant), branches number (8.80/plant) and yield (1.42kg/plant) applied as seed treatment+seedling root dip+ soil application. The bioformulation consisting of *Am* + *Pa* + *Pf* + *Th* was observed most effective with 85% degradation of OP at 45 days after application followed by bioformulation of *Am* + *Pf* + *Th* with 70% degradation and *Pa* + *Pf* + *Th* with only 60% degradation. Such studies would be instrumental in providing novelty in bioremediation of pesticide contaminated soil as well as biological management of bacterial wilt disease with a single formulation.

## **Evaluation of antifungal activity of essential oil against grey mould of tomato caused by *Botrytis cinerea***

*Sudharshan K. R.*

Grey mould is one of the most destructive diseases of tomato in field and in greenhouse, causing considerable yield loss both in pre-harvest and post-harvest produce. The incitant fungus of grey mould of tomato was identified and confirmed as *Botrytis cinerea* based on cultural and morphological studies of the fungus. The present investigation was made to find an alternative to synthetic fungicides currently used in the control of devastating fungal pathogen *Botrytis cinerea*. Antifungal activities of essential oils obtained from Garlic clove, Artemisia leaves and Jatropha seeds in their seven different concentrations (25, 50, 75, 100, 250, 500 and 1000 ppm) were investigated against *B. cinerea*. Garlic essential oils at 75 ppm and above concentrations were found to be significantly superior resulting complete inhibition (100%) of the mycelial growth of the pathogen. Artemisia oil at 1000 ppm recorded the highest inhibition (62.65%) among the different concentrations tested over control. Among all three essential oils, jatropha oil was found to be least effective against *B. cinerea* resulting only 8.66 per cent inhibitory effect even at 1000 ppm. Based on the *in vitro* test, garlic essential oils at 75, 100 and 250 ppm were further tested in pot condition. Both protective and curative spray of garlic oil (250 ppm) was found highly effective in reducing the disease incidence and disease index, and in increasing the yield of tomato. However, better control was achieved when essential oil applications were made 24 hrs after pathogen inoculation (curative activity).

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**Major Adviser: Dr. Hiranya Kr. Deva Nath**

## **Management of fruit rot of *Capsicum chinense* Jacq. with fungal bio-formulations**

*Sunita Dutta*

Fruit rot of *Capsicum chinense* Jacq. is one of the most destructive diseases causing severe damage to the fruits in the field and considerable losses during storage, transit and marketing. The causal organism was identified as *Colletotrichum gloeosporioides* (Penz.) Penz. and Sacc. The present investigation was aimed at managing the disease by using fungal bio-formulations. The efficacy of three fungal liquid bio-formulations viz., Org-Trichojal, Org-Beauverijal and Org-Metajal alone and in combination with each other and captan @ 0.2 % as fungicidal check were tested using poisoned food technique against the pathogen. Amongst the bio-formulation treatments, the effect of combination of the three bio-formulations was found to be significantly superior over rest of the treatments and was selected for further studies. Standardization of media for co-culture of three bio control agents viz., *Trichoderma harzianum*, *Beauveria bassiana* and *Metarhizium anisopliae* was carried out where the bio-control agents were allowed to grow in five different liquid media. The results showed that *Trichoderma harzianum* and *Beauveria bassiana* grew best in Malt Extract Broth media whereas the growth of *Metarhizium anisopliae* was best in Czapek Dox Broth media. Malt Extract Broth and Czapek Dox Broth media were further tested alone and in combination to standardize a co-culture media suitable for all the three bio-control agents. The results showed that the highest fresh weight, dry weight and surface coverage of the mycelial mat were recorded in Czapek Dox Broth media, when all the three bio-control agents were grown together. The effect of the bio-formulation on seed germination, root length, shoot length and vigour index of *C. chinense* were further evaluated and compared with captan 0.2% and control. Results revealed that seed treatment with fungicide captan @0.2% and seed treatment with bio-formulations resulted in higher germination, root length, shoot length and vigour index compared to untreated control. The bio-formulation was evaluated in pot condition for their effect in managing the disease and was compared with captan @ 0.2%. The seed treatment + foliar spray with captan @ 0.2% showed the lowest disease incidence (DI) and per cent disease index (PDI) which was followed by seed treatment + soil treatment + foliar

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spray with bio-formulation, the effects of which were statistically *at par*. Growth parameters, yield and yield attributing characters were also recorded where the combined application of bio-formulation as seed treatment, soil treatment and foliar spray showed the best results.



## **Management of seed-borne mycoflora of greengram through botanicals**

*Suveta T. S.*

Studies were made to record the seed-borne mycoflora of greengram during storage and their management through botanicals. Greengram seeds stored after treatment with eight different botanicals and one fungicide (Carbendazim) showed the occurrence of twelve different fungal species belonging to seven genera, *Acremonium hansfordii*, *Aspergillus flavus*, *Aspergillus foetidus*, *Aspergillus fumigatus*, *Aspergillus niger*, *Aspergillus oryzae*, *Aspergillus sclerotiorum*, *Curvularia pallescens*, *Fusarium oxysporum*, *Penicillium oxalicum*, *Rhizopus oryzae* and *Syncephalastrum racemosum*. Six mycoflora viz., *A. hansfordii*, *A. foetidus*, *A. oryzae*, *A. sclerotiorum*, *P. oxalicum* and *S. racemosum* constitute new host record for Assam and India. Two methods viz., agar plate and blotter paper methods were employed for the isolation of mycoflora where nine fungal species were recorded in both the methods and the other three fungi were recorded only in blotter paper method. Among the botanicals tested, *Azadirachta indica* (44.50%), *Piper nigrum* (41.31%) and *Acorus calamus* (39.74%) were significantly effective in suppressing the storage mycoflora of greengram seeds. The greengram seeds were also infested by pulse beetle *Callosobruchus chinensis*. The seeds treated with *Acorus calamus* (77.41%), *Annona squamosa* (73.10%) and *Eucalyptus globulus* (72.69%) significantly inhibited the pulse beetle. After 9 months of storage, the germination percentage and seedling vigour of greengram were highest in the seeds treated with *Piper nigrum* (88.00% and 978.38 respectively) followed by *Azadirachta indica* (87.20% and 977.34 respectively) and *Acorus calamus* (86.80% and 953.93 respectively). The storage duration showed remarkable decrease in total soluble sugar, protein and phenol content of greengram seeds.

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## **Economics of Sericulture with Special Reference**

*Barsha Das*

The study entitled, “Economics of Sericulture with reference to Jorhat District of Assam” was conducted in order to a) see the present status of sericulture; b) assess the income and employment generation from cocoon and raw silk production and c) identify the problems encountered by the sericulture farmers in Assam. Both secondary and primary level information and data were used to accomplish the stated objective. Secondary data were collected from the published and unpublished sources of the Government and other agencies while primary data were collected directly from 100 purposively selected sample farmers with the help of a set of pre-tested schedule and questionnaire. Compound growth rates were computed on the basis of 10 years time series data and simple tabular analysis was carried out for all relevant parameters.

The findings of the study clearly indicate that sericulture continues to be an important livelihood options for a sizeable number of families in different districts of Assam. The area under *eri* showed a positive growth of 12.40 per cent while *muga* and mulberry indicated a negative growth of (-) 2.30 and (-) 13.92 per cent, respectively. However, production of cocoon and silk yarns of all three types of variants registered a positive growth, though not significant, possibly due to increase in productivity. There were marked variation in area, production and productivity of *eri*, *muga* and mulberry across the districts of Assam during 2017-18 to 2019-20, as per the available statistics. In terms of cocoons, Kokrajhar was the highest *eri* and mulberry producing districts while Lakhimpur was the highest *muga* cocoon producing district in Assam. Kokrajhar was again leading in case of *eri* and *muga* silk yarn production whereas Lakhimpur emerged as the highest *muga* silk producing district. The study also reveals that all three variants of silk are grown by the sericulture farmers of Jorhat district.

Per hectare per annum income generated by *eri* rearers was worked out at Rs. 1,66,838 while that of *muga* and mulberry were Rs. 96,577 and Rs. 55,946, respectively. As against this, the employment generation was found to be highest in *muga* with 1075 man days per hectare per annum followed by *eri* with 580 man days and mulberry with 336 man days per hectare per annum. Cost and return analysis further indicates that the benefit cost ratio of cocoon production from *eri*, *muga* and mulberry were computed at

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2.25:1.00, 1.31:1.00 and 1.87:1.00, respectively, clearly indicating that sericulture continues to remain a profitable proposition over the years.

Though the farmers involved in the process had long years (10 to 20 years) of working experience, they had to face a number of impediments, for which possibly the venture could not make much headway till date. The problems identified were mainly related to leaf production, cocoon production and of marketing. To be specific, occurrence of diseases, unavailability of rearing equipments and recurrent pest attack were some issues of major concern, as reported by the sericulture farmers. Besides, absence of proper market and market intelligence, exploitation by the middlemen and price fluctuation were identified as grievous problems encountered by the farmers. Redressal of the problems under reference is a must to promote sericulture in this part of the country, which can very well be taken care of by strategic planning on the part of Government and its implementation in true sense of the term. Looking at the prospects of the vocation, focused intervention may be recommended in the form of appropriate technological backstopping for disease and pest control, input support, credit provisioning on easy terms and well thought out capacity building programme. Equally important will be to develop an efficient market mechanism to channelize the products so as to ensure a fair price for the farmers. Aggressive promotional campaign and simultaneously, sensitizing and supporting the farmers by the line Departments and other agencies can bring in desirable changes in the lives and livelihoods of sericulture farmers of Assam.

# **Study on constraints in adoption of improved sericultural technologies by the farmers in Jorhat district of Assam**

*Dipankar Hatibaruah*

Sericulture has been practiced traditionally in Jorhat district and a large portion of rural people earn their livelihood from the sericulture sector. The present study entitled “Constraints in adoption of improved sericultural technologies by the farmers in Jorhat district of Assam” is aimed to identify the problems faced by farmers in adoption of improved technology for enhancement of production & productivity at farmers level in the district. The study was conducted with a sample size of 120 respondents from the Jorhat and Majuli sub divisions of undivided Jorhat district of Assam. A multistage purposive cum random sampling design was followed for selection of the respondents. The data collected by personal interview from period of September, 2019 to February, 2020 with the help of a pre-tested structured research schedule on dependent, independent and descriptive variables were subjected to statistical analysis of frequency, percentage, mean, standard deviation, Karl Pearson’s co-efficient of correlation and chi-square test for interpretation and testing hypothesis.

The study revealed that majority of the sericulture farmers of the study area belonged to middle age group (60.00%), high school passed (34.17%) and belonged to Other Backward Class (OBC) caste (30.84%). Most of the respondents have small size family (60.83%) and exclusively of farming category (45.83%) as their main occupation. Majority of the respondents are marginal farmers (61.67%) having operational land holding of below 1 hectare. The annual income of most of the respondents (37.50%) were in the range of Rs.35001 to Rs.75000/-. In respect of adoption of sericulture practices, it was observed that 50% of the respondents involved in eri culture, 25% in muga culture and 25% in mulberry culture. Majority of the respondents have medium level of source of extension contact (67.50%), medium level of risk bearing ability (78.33%) and medium level of decision making ability (79.17%) and 42.50 % of the farmers got training exposure to sericulture practices. In respect of adoption of improved sericulture technologies, it was found that the adoption level was

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medium for majority of the respondents (76.67%) in eri culture, (66.67%) in muga culture and (76.67%) in mulberry culture. The correlation study between adoption behaviour of the sericulture farmers with the socio- economic profile of the rearers revealed that annual family income have positively and significantly related with the adoption behaviour of eri silkworm rearers and from the results of chi square test the variable family occupation are associated with the adoption behaviour of eri rearers.. In 6 case of muga culture the relationship between the adoption behaviour of muga rearers with socio-economic profile of the rearers was non significant. In mulberry culture, education and decision making ability have negative and significant relations with the adoption behaviour of the mulberry rearers. Lack of knowledge about training and pruning of host plants in adoption of host plant cultivation technology, improper maintenance of temperature and humidity, lack of regular technical guidance , non availability of protected storage house in villages, non availability of suitable and big market nearby villages, lack of improved reeling and spinning machine, lack of awareness on improved technology adoption, high cost of rearing and other sericulture production technologies and lack of timely guidance are the major constraints faced by the farmers of Jorhat district for adoption of improved sericulture technologies.

The study thus revealed that because of non awareness of improved sericulture technologies as well as poor living condition the adoption level of sericulture technologies of among the farmers of Jorhat district is very limited and there is still a gap in dissemination and adaptation of improved sericultural technologies in pre and post cocoon sector among the farmers for growth and development of sericulture in acreage of food plants, rearing of silkworm and production and productivity of cocoon and silk. Hence, in order to extend the adoption rate in these areas action plan may be taken by the government agencies and extension personnel by adapting the progressive rearers and trained them in the line of improved sericulture technologies to improve the adoption level of new production technologies in sericulture sector.

# **Effect of zinc chloride (ZnCl<sub>2</sub>) supplementation on larval growth and economic cocoon characters of eri silkworm, *Samia ricini* Boisd. (Lepidoptera: Saturniidae)**

*Nanita Bora*

An investigation on effect of zinc chloride (ZnCl<sub>2</sub>) supplementation on nutritional efficacy, larval growth and economic cocoon characters of eri silkworm, *Samia ricini* Boisd. was carried out during spring and autumn season in the Department of Sericulture, Assam Agricultural University, Jorhat during the year 2019-20.

The study revealed that fortification of castor leaves with zinc chloride showed a significant impact on nutritional efficacy, larval growth and cocoon parameters of eri silkworm *Samia ricini* Boisd. Zinc chloride ingestion cause significant increase in ingesta, digesta of eri silkworm and by decreasing the excreta liberation and consumption index it accelerates the approximate digestibility (AD), efficiency conversion of ingesta (ECI) and efficiency conversion of digesta (ECD) to body biomass of the larvae. Zinc chloride supplementation at lower concentration (2µg/ml) found to have more pronounced effect followed by 5µg/ml, 10µg/ml and 15µg/ml concentrations than control. The larvae reared on 2µg/ml zinc chloride fortified castor leaves manifested better in respect of full grown and mature larval weight, pupal weight, weight of silk gland, silk gland tissue somatic index (SGTSI), cocoon weight, shell weight, shell ratio, effective rate of rearing (ERR), larval and pupal duration. The larvae reared in spring season exhibited better in respect of larval growth and cocoon characters with higher rate of approximate digestibility (AD), efficiency of conversion of ingesta (ECI) and digesta (ECD) to body biomass of the larvae, while in autumn season the larval and pupal duration were shorter with lower rate of ingesta, digesta, excreta and consumption index.

Thus from the present investigation it could be inferred that fortification of castor leaves with zinc chloride solution is effective for improvement of larval growth and cocoon characters of eri silkworm. Lower concentration (2µg/ml) of zinc chloride is

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more effective and exert promontory role than other doses for improving larval growth and cocoon parameters of eri silkworm, *Samia ricini* Biosd. Spring was found to be more suitable season than autumn rearing for rearing of eri silkworm in terms of nutritional efficacy, larval growth and cocoon characters of the silkworm except the larval and pupal duration which were found to be shorter in autumn season.

## **Sucking pests and their natural enemies in mulberry ecosystem in Jorhat district of Assam**

*Nilutpal Saikia*

Study on sucking pests and their natural enemies in mulberry ecosystem were carried out during 2018-2019 at Regional Sericulture Research Station, Central Silk Board, Jamuguri, Jorhat, Govt. Sericulture Farm, Titabar and Assam Agricultural University, Jorhat. Five species of sucking pests were prevalent in different mulberry growing localities of Jorhat district of Assam. *Paracoccus marginatus* was dominant among the five species of sucking pests, viz., *Maconellicoccus hirsutus*, *Pseudodendothrips mori*, *Paracoccus marginatus*, *Aleurodicus dispersus*, *Cloviapuncta*. Three species of coccinellid predators viz., *Coccinella septempunctata*, *Coccinella transversalis* and *Micraspis discolour*, one species of lepidopteran predator viz., *Spalgis epius* were found to associated with *Paracoccus marginatus*. Among these natural enemies, *Spalgis epius* was relatively most abundant. The appearance and peak activity of the coccinellids predator *Coccinella septempunctata*, *Coccinella transversalis*, *Micraspis discolour* and one lepidopteran predator *Spalgis epius* was synchronized with that of *Paracoccus marginatus*. These four predators showed a strong significant positive association with the papaya mealybug population. Rainy days, evaporative rate, wind speed and bright sunshine hour showed significant negative correlation while temperature (maximum and minimum), relative humidity (morning and evening) and rainfall showed a significant positive correlation with papaya mealybug during 2018-2019. The multiple regression analysis revealed that the combined effect of abiotic and biotic factors accounted for 98-99 per cent variation in the *Paracoccus marginatus* population during both the crop seasons.

During 2018-2019, numbers of rainy days showed a significant negative relationship with the adult and larval populations of *Coccinella septempunctata*, *Coccinella transversalis*, *Micraspis discolour* and *Spalgis epius*. The multiple regression analysis was computed to get the information on the interaction of weather and *Paracoccus marginatus* population on the reproduction and abundance of coccinellid and lepidopteran predators.

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Studied on the biology of lepidopteran predator, *Spalgis epius* revealed that the larval period, pupal period and adult longevity for male and female were 10.07, 3.15 and 4.43 days, respectively.

**Effect of botanical and chemical bed disinfectants  
on larval growth and economic cocoon characters  
of mulberry silkworm, *Bombyx mori* L.  
(Lepidoptera: Bombycidae) rearing**

*Pompi Kowar*

An investigation on effect of botanical and chemical bed disinfectants on larval growth and economic cocoon characters of mulberry silkworm, *Bombyx mori* L. (Lepidoptera: Bombycidae) rearing was conducted in the rearing room of Department of Sericulture, College of Agriculture, AAU, Jorhat during the period of 2019-20.

The present study revealed that application of bed disinfectants had positive influence on the larval growth and economic cocoon characters of mulberry silkworm race, (CSR6 × CSR26) × (CSR2 × CSR27). Bed disinfectant Ankush manifested better result in regards of disease incidence, larval parameters, cocoon yield and cocoon parameters as compared to other two bed disinfectants Sericillin, Turmeric rhizome powder and their combinations. Performance of Sericillin was next to Ankush. However, combination of bed disinfectants like Ankush + Sericillin, Ankush + Turmeric rhizome powder and Sericillin + Turmeric rhizome powder showed better results compared to Turmeric rhizome powder alone. All the bed disinfectants showed better results compared to untreated larvae. Considering the seasons, performance was better in the late spring season.

Thus, from the present investigation it can be inferred that double hybrid mulberry silkworm race, (CSR6 × CSR26) × (CSR2 × CSR27) reared on S1635 variety treated with bed disinfectants play a major role in reducing the silkworm diseases as well as improving the larval growth and productivity of cocoon crop.

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## **A study on the extent of livelihood security of the sericulture farmers in Kamrup district of Assam**

*Pulak Rabha*

The study entitled “A study on the extent of livelihood security of the sericulture farmers in Kamrup district of Assam” was carried out at Assam Agricultural University, Jorhat during the year 2019-20 with a sample of 120 sericulture farmers in Kamrup district of Assam. Respondents were selected randomly from 3 (three) purposively selected blocks. Statistical techniques like frequency, percentage, mean, standard deviation, Karl Pearson's co-efficient of correlation and multiple regression analysis were used for analyzing data, drawing inferences and testing hypotheses. The study revealed that majority (43.33%) of the respondents belonged to middle age group and 36.67 per cent were illiterate. Most of the farmers (45.83%) belonged to small size family and 69.17 per cent had pucca house. In case of operational land holding, majority (34.17%) of the respondents possessed small size of land holding. Most of the farmers (33.95%) had annual income of ranging from Rs. 75,000-1,00,001. It was found that majority (75.00%) of the farmers had medium level of extension contact, moderate level of risk bearing ability (61.67%) and moderate level of decision making ability (59.17%). As regards to training exposure, only 23.33 per cent of the respondents had received training. It was observed that different types of livelihood options were adopted by the farmers along with sericulture to increase their income. Most of the sericulture farmers (35.00%) practiced “Sericulture + paddy + plantation crops” followed by “Sericulture + paddy + piggyery” (15.83%) and “Sericulture + paddy + fruits” (12.50%) as their sericulture based livelihood options. The education, family size, house type, operational land holding and decision making ability have significant relationship on livelihood options practiced by the sericulture farmers. It was observed that majority (37.20%) of the respondent's opted ‘Insurance scheme’ as a measure for potentiality and ‘Integrated farming’ (20.83%) as a measure for profitability of sericulture for sustainable livelihood generation in Kamrup district. Majority (60.83%) of the farmers’ opted ‘Cocoon + silk yarn’ as their most profitable sericulture based perceptions. The present study thus revealed that sericulture has immense potential in generating livelihood for every

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section of society in Kamrup district of Assam irrespective of gender and caste. There is a significant scope for the livelihood opportunities from sericulture in the district which may be drawn as an appropriate policy decision to facilitate, upscale and secure their livelihood. Though sericulture has been remained always as a subsidiary cottage industry it would be a good option for livelihood opportunity in the district as well as in the state.

## **Seasonal variation on larval, cocoon and yarn parameters of eri silkworm (*Samia ricini* Boisduval) reared on *Ailanthus* species**

*Raktim Ranjan Borah*

An experiment was undertaken to evaluate the impact of different seasons on larval growth, cocoon and yarn parameters of eri silkworm *Samia ricini* Boisduval reared on *Ailanthus* species viz., borpat (*Ailanthus grandis*) and borkesseru (*Ailanthus excelsa*) in the Department of Sericulture, Assam Agricultural University, Jorhat during the year 2018-19.

The present investigation revealed that seasons had significant effect on all larval, cocoon and yarn parameters except twist per inch. Host plants had also significant effect in all the parameters except yarn size, elongation percentage and twist per inch. Among the different seasons, the highest full grown larval weight and matured larval weight was observed during autumn season while the shorter larval duration was found in late summer season. Between the host plants, borpat leaves registered significantly shorter larval duration with higher full grown and matured larval weight compared to borkesseru leaves. The highest cocoon yield percentage was found in the autumn season followed by spring, early summer and late summer season. Between the two *Ailanthus* species, significantly higher cocoon yield percentage was found on borpat leaves. For all the cocoon parameters viz., cocoon weight, shell weight, pupal weight and shell ratio percentage autumn season and borpat leaves exhibited better performance while early summer season and borkesseru leaves showed the lowest values. However, lowest value in regards of shell ratio percentage was recorded in spring season. Yarn size was registered highest in the autumn season whereas the lowest yarn size was registered in the early summer season. The highest breaking load and tenacity of the eri silk yarn was observed in the spring season whereas the lowest was recorded in the autumn and spring season respectively. Maximum elongation percentage of eri silk yarn was found in early summer and minimum was observed in autumn season.

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It can be concluded that late summer season and borpat leaves performed better in regards of larval duration. But, larval weight and cocoon parameters were found better in autumn season and in borpat leaves. Varied effect of season and host plant was noticed in regards of yarn characters. Thus, it can be inferred that both the plants are suitable for rearing eri silkworm in different seasons with slight variation in performance.

## **Study on regional variations on cocoon and yarn characteristics of muga silkworm during commercial seasons**

*Shilpa Saikia*

An experiment was carried out in the Department of Sericulture, Assam Agricultural University, Jorhat during the year 2018-2020 to assess regional and seasonal variations on cocoon and yarn characteristics of muga silkworm.

Cocoons were procured from private rearers of Jorhat, Kamrup and Lakhimpur districts of Assam in spring and autumn season. The three muga growing regions and two commercial seasons had significant impact on cocoon and fibre parameters such as cocoon size, cocoon weight, pupal weight, shell weight, shell ratio, length, weight and size of silk filament. Cocoons of Kamrup exhibited better result in respect of cocoon and fibre characteristics as compared to Lakhimpur and Jorhat district. Cocoons of autumn season registered significantly higher values than spring season. Season and region had no significant effect on non-breakable filament length. Variation was observed in these three regions and two commercial seasons in terms of reelability percentage, raw silk recovery percentage and silk yield. Kamrup district showed better reeling performance with more reelability percentage, raw silk recovery percentage and silk yield compared to other two regions in both the seasons. The reelability performance of autumn season cocoons was better than that of spring season cocoons. Denier or size of silk filament and silk yarn, breaking load and elongation percentage of muga silk were recorded significantly higher in Kamrup followed by Lakhimpur and lowest was observed in Jorhat district. Considering the seasons, autumn season exhibited better performance in these parameters except elongation percentage which was recorded highest in spring season. However, significantly higher tenacity of silk yarn was found in Jorhat district compared to other two regions. Interaction effect due to region and season was observed to be non-significant in all aspects except single cocoon filament size.

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Thus, it could be inferred that significant differences were noticed in respect of all the parameters in all the three regions in spring and autumn season. Kamrup was found to be better in terms of cocoon, fibre and yarn parameters except the tenacity which was higher in Jorhat district. Autumn season exhibited better performance in respect of all the parameters whereas elongation percentage was maximum in spring season



# **Nutrient availability in soil and yield of tomato as influenced by manure sources and rice stubble management**

*Anupama Das*

A field experiment was conducted in ICR farm, AAU, Jorhat from December, 2019 to April, 2020 to evaluate nutrient availability in soil and yield of tomato after winter rice (variety - Ranjit) as influenced by different organic manure sources with and without rice stubble incorporation. The experiment was conducted in a split plot design comprising individual plot size of 2.5 m x 2.1 m with four replications. Rice stubble was either removed or incorporated in the main plot, and each main plot was divided into five sub plots fertilized with different composts or recommended fertilizer dose (RDF). The nutrient management treatments comprised of unfertilized plot, RDF (farmyard manure 2 t ha<sup>-1</sup> one week before planting followed by 75:60:60 N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O kg ha<sup>-1</sup> applied at planting, with N in two equal splits), farmyard manure 2 t ha<sup>-1</sup> (FYM), poultry manure 2 t ha<sup>-1</sup> (PM) and vermicompost 2 t ha<sup>-1</sup> (VC). The composts were applied in two equal splits at planting and at 30 days after planting (DAP). The soil pH was significantly higher up to 56 DAP in poultry manure fertilized plots where soil exchange acidity was lowest among all the treatments. The NH<sub>4</sub>-N and NO<sub>3</sub>-N contents, and P and K availability in soil was highest with application of RDF, while the lowest values were observed in the unfertilized plot. The NH<sub>4</sub>-N, NO<sub>3</sub>-N and available P contents of soil significantly increased in VC and PM applied plots compared to FYM or unfertilized plots and were at par with RDF. However, the available K content of soil was significantly higher in RDF at 28 and 56 DAP compared to all other treatments. The exchangeable cations and soil enzyme activity at 28 DAP and 56 DAP showed significant increase in RDF, PM and VC. The highest tomato fruit yield was observed with RDF, which differed significantly over all the treatments, and was followed by PM and VC fertilized treatments. Incorporation of rice stubbles had a positive effect on nitrogen mineralization, availability of phosphorous, potassium, exchangeable cations, soil enzyme activity and yield of tomato, but the interaction with nutrient management was not significant.

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**Major Adviser: Dr. Nilay Borah**

# **Effect of Tillage and Herbicide (Pretilachlor) Application on Soil Biological Properties in Winter Rice**

*Dipankar Sonowal*

The study on the “Effect of Tillage and Herbicide (Pretilachlor) Application on Soil Biological Properties in Winter Rice” was conducting in the year 2019-20 which forms a part of the long term trial under AICRP on Weed Management that was established during 2016 at ICR farm of Assam Agricultural University, Jorhat-13. The experiment was laid out in randomized block design replicating three times with five treatments viz., T1 - Conventional Tillage (Transplanted) ; T2\_ Conventional tillage (Transplanted + Herbicide), T3 - Conventional Tillage (Direct-Seeded + Herbicide) ; T4 - Minimum Tillage (Direct-Seeded + Herbicide), T5 - Minimum Tillage (Direct-Seeded+ Herbicide+ Residue retained on the surface) with plant residue incorporation. Ranjit and Basundhara was used as the rice variety in transplanted and direct seeded rice respectively. Results of the study showed the significant improvement in weed management through herbicides in turn significant improvement of soil microbial activity and microbial biomass carbon. The soil physico-chemical properties viz., bulk density, porosity, water holding capacity, pH, available nitrogen, phosphorus, potassium, calcium and magnesium and organic carbon were determined from surface soil (0-15 cm) samples collected after the harvest of winter rice. Minimum tillage (MT) was found to improve almost all the physico-chemical properties of soil including bulk density, porosity, WHC, CEC and pH as compared to conventional tillage (CT) system. MT with application of herbicide significantly increased soil organic carbon (SOC) content and available N, K, Ca and Mg while its effect was found to be non-significant on available P in the soil. Biological parameters were analysed from surface soils collected periodically at 0, 3, 7, 15, 23, 30, 45, 60 days after application of the herbicide and at harvest in winter rice. In the present study, herbicide application resulted in inhibition of beneficial microbes viz., Bacteria, Fungi, Azotobacter, Azospirillum and phosphate solubilising bacteria up to 7 days after which it increased towards harvestings. Application of pretilachlor in winter rice showed a decline in

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dehydrogenase and  $\beta$ -glucosidase activity at initial stage while it increased the activity of acid phosphatase and microbial biomass carbon. Significantly higher enzyme activities were recorded in treatments receiving MT, herbicide along with residues retained on the surface. Studying the analytical chemistry of pretilachlor, observed that degradation of pretilachlor in soil followed the first order kinetics. Hence the persistence of pretilachlor in soil, rice straw and grains was observed at below detection limit at crop harvest.

## **Soil-Site Suitability Evaluation for Major Crops in Sarupathar Block of Golaghat District, Assam**

*Duhanti Gogoi*

A study was conducted in the Sarupathar block of Golaghat district, Assam in order to characterize and classify some soils and to evaluate their suitability for few major crops. Six profiles were collected for the purpose from different parts of the Sarupathar block and the properties of the soils were studied in detail. The site characteristics like physiography, present land use, drainage condition, slope and other relevant information were recorded during the time of profile collection. The soils were dark grayish brown (10YR 4/2) to very pale brown (10YR 7/3) in colour and sandy loam to clayey in texture. The structure of the soils were mostly sub angular blocky except in soils of rice profiles (P1, P2 and P3) where the structure of surface horizon was massive. The sand, silt and clay content of the soils ranged from 14.4 to 35.6, 32.5 to 58.6 and 18.8 to 41.2 per cent respectively. Bulk density and particle density of the soils ranged from 1.14 to 1.38 g cm<sup>-3</sup> and 2.10 to 2.39 g cm<sup>-3</sup> respectively, whereas porosity of the soils varied from 34.3 to 51.5 per cent. Organic carbon content of the soil was varied from low to high (0.12 to 1.26 per cent). It was invariably highest in surface horizon and thereafter regularly decreased with depth in all the soils. Soils were very strongly to slightly acidic with a pH range of 4.9 to 6.35. Exchangeable H<sup>+</sup> and Al<sup>3+</sup> ranged from 0.15 to 0.65 and 0.86 to 2.81 cmol(p<sup>+</sup>)kg<sup>-1</sup> respectively. Exchange acidity of the soils was varied from 1.07 to 3.22 cmol(p<sup>+</sup>)kg<sup>-1</sup> and more than 80% of this acidity is contributed by Exchangeable Al<sup>3+</sup>. The Exchange Acidity was found to be mostly influenced by organic carbon. Among the exchangeable cations, Ca<sup>2+</sup> is the most dominant exchangeable cation followed by Mg<sup>2+</sup>, Na<sup>+</sup> and K<sup>+</sup>. The divalent cations maintained a positive relationship with clay. The CEC of the soils is comparatively low (7.2 to 11.9 cmol (p<sup>+</sup>) kg<sup>-1</sup>). It is mostly regulated by clay fractions. The base saturation ranged from 24.2 to 47.7 per cent. Based on the morphological and physico-chemical characteristics, soils were classified as inceptisol except the soil of P4 which was classified as entisol. At the subgroup level, P1, P2 and P3 were classified as Oxyaquic Dystrudept, soils of P4 as Typic Udorthent, P5 as Typic Dystrudept and P6 as Aquic Dystrudepts. The soils were rated as good except the soils under P4 which was

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rated as excellent as per the Storie Index Rating. The soil site suitability was evaluated for 17 crops (maize, pigeon pea, sunflower, sesamum, potato, chilli, tea, arecanut, citrus, banana, lemon grass, pepper, vanilla, ginger, turmeric, cardamom and oil palm) following three approaches. Based on Simple Limitation Method, majority of the soils were found to be marginally suitable for the crops under the present condition. Some soils showed moderate suitability for crops like pigeon, tea, citrus, banana and oil palm. The soils can be improved to moderately suitable and in few cases to highly suitable after specific intervention. Similar observations were also encountered in respect of maize, potato, tea and banana where suitability evaluation was also carried out by employing the Scoring and Parametric approach. The parametric approach was observed to be more precise in evaluation of suitability class and identifying the specific production constraints.

## **Distribution of micronutrients under different land uses in soils of Golaghat district of Assam**

*Jatiprasad Barala*

An investigation was carried out to study the depth-distribution of available micronutrients and their relationship with soil physico-chemical properties in soils of Golaghat district of Assam. Soil samples were collected at 0-20 cm, 20-40 cm, 40-60 cm, 60-80 cm and 80-100 cm depth under five land uses *viz.* rice, vegetable, sugarcane, bamboo and tea. Results indicated that sand, silt and clay content of the soils showed a significant variation among depths. The highest content of sand (59.53%), silt (51.13%) and clay (43.17%) were found at 80-100 cm, 20-40 cm and 80-100 cm under bamboo, vegetables and sugarcane land use, respectively. The soils were very strongly to medium acidic in reaction with a pH range of 4.70 to 5.73 and significantly the highest value of pH was recorded at 80-100 cm under all land uses. Organic carbon content of the studied soils was found higher in surface layer and decreased significantly with increasing soil depths. The significantly highest (13.27 g kg<sup>-1</sup>) and lowest content of organic carbon (1.47 g kg<sup>-1</sup>) in soil were observed under tea and bamboo land use, respectively. The exchangeable Ca<sup>2+</sup>, Mg<sup>2+</sup>, Na<sup>+</sup> and K<sup>+</sup> content was higher in soils of rice as compared to other land uses. The significantly highest and lowest mean values of both cation exchange capacity and per cent base saturation were observed under rice and bamboo land use, respectively.

The content of available micronutrients showed a significant variation among different depth under different land uses. The content of available micronutrients was higher in surface layers and decreased with depths. The value of DTPA-extractable Fe, Mn, Zn and Cu content of the studied soils ranged from 10.28 to 80.28, 2.02 to 29.18, 0.08 to 0.77 and 0.12 to 1.76 mg kg<sup>-1</sup>, respectively under different land uses indicating the sufficiency of Fe, Mn and Cu. Content of DTPA- Zn was sufficient at 0-20 cm depth under rice and tea whereas deficiency was observed at lower depths in all the land uses. Among the land uses, surface layer of rice land use recorded significantly the highest concentration of DTPA-Fe, Mn, Zn and Cu as compared to other land uses. Significantly the highest content of boron was exhibited at surface layer in all the land uses and significantly the highest content of HWS-B (0.58 mg kg<sup>-1</sup>) was observed at 0-

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20 cm depth under tea land use. Most of the soils were found below critical limit except sugarcane and tea at 0-20 cm depth.

DTPA-extractable micronutrients and HWS-B correlated positively and significantly with soil organic carbon, cation exchange capacity and per cent clay but negatively and significantly with soil pH. Clay showed a significant and positive correlation with DTPA-Mn, DTPA-Zn and DTPA -Cu. Step-down multiple regression analysis revealed that organic carbon, pH and clay were the dominant factors accounting for maximum variability in available micronutrient contents.

## **Soil acidity components and its influence on available phosphorus in soils of East Karbi Anglong district of Assam**

*Jemima Ahmed*

The study on “Soil acidity components and its influence on available phosphorus in soils of East Karbi Anglong district of Assam” was carried out with the objectives 1) To find out soil acidity components and available phosphorus in soils of East Karbi Anglong. 2) To assess the relationship between soil acidity components and available phosphorus. In total 99 geo-referenced surface soil samples (0-15cm) were collected from various elevations (ranging from 83m to 470 m amsl) in East Karbi Anglong district of Assam. All the soil samples were classified in to three different elevation level each containing 33 samples each, viz., Toposequence-1 (TSQ-1) <100m amsl, Toposequence-2 (TSQ-2) 100-150m amsl, Toposequence-3 (TSQ-3) >150m amsl. The pH, available P, OC, CEC and BS% of the collected soil samples varied from 4.0 to 5.6, 5.5 to 11.4 kg P ha<sup>-1</sup>, 7.3 to 21.3 g kg<sup>-1</sup>, 8.6 to 12.7 cmol (p+) kg<sup>-1</sup> and 15.83% to 26.34% respectively. Ca<sup>2+</sup> was found to be the dominant cation followed by Mg<sup>2+</sup>, K<sup>+</sup> and Na<sup>+</sup> in all the collected soil samples. Sand, silt and clay content of the soils varied from 35.2% to 43.9%, 29.9% to 38.9% and 17.7% to 30.6%, respectively. Among the forms of soil acidity, total potential acidity [7.1 to 13.46 cmol (p+) kg<sup>-1</sup>] was the most dominant form of acidity in soils of East Karbi Anglong district of Assam. It was followed by pH dependent acidity [6.45 to 11.3 cmol (p+) kg<sup>-1</sup>], extractable acidity [1.2 to 4.91 cmol (p+) kg<sup>-1</sup>], total acidity [1.53 to 4.51 cmol (p+) kg<sup>-1</sup>], exchange acidity [0.87 to 3.97 cmol (p+) kg<sup>-1</sup>], exchangeable Al<sup>3+</sup> [0.57 to 2.75 cmol (p+) kg<sup>-1</sup>] and non exchangeable acidity [0.15 to 1.19 cmol(p+) kg<sup>-1</sup>]. All the forms of soil acidity were significantly different among all the three toposequences (P >0.05) and found to increase with elevations in the following order TSQ-3 > TSQ-2 > TSQ-1. Available phosphorus was also found to be significantly different in all the three different toposequences (P >0.05). All the forms of acidity was found to be positively and significantly correlated with each other. Available phosphorus was found to be significantly and negatively correlated with all the forms of acidity, viz., total acidity (r=

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-0.808\*\*), exchange acidity ( $r = -0.743^{**}$ ), exchangeable  $Al^{3+}$  ( $r = -0.813^{**}$ ), extractable acidity ( $r = 0.809^{**}$ ), non exchangeable acidity ( $r = -0.807^{**}$ ), total potential acidity ( $r = -0.850^{**}$ ), pH dependent acidity ( $r = -0.817^{**}$ ).

## **Symbiotic Effectiveness of Common Bean (*Phaseolus vulgaris* L.) *Rhizobium* grown in Soils of Assam**

*Jyotirupa Kalita*

Nodulation promiscuity and sparse nodulation in common bean (*Phaseolus vulgaris* L) are two important intrinsic characteristics besides soil chemical factors for low nitrogen (N<sub>2</sub>) fixation compared to other grain legumes. The symbiotic effectiveness of *Rhizobia* in nodulation is significant in *Rhizobium* strain selection programme to avoid the risk of sub optimal nodulation or nodulation failure. The present study was carried out to screen the effective native *Rhizobia* isolates from field grown common bean for their symbiotic effectiveness. Root nodules and rhizosphere soil were collected from thirteen different common bean growing sites representing three districts viz: Jorhat, Golaghat and Karimganj of Assam for isolation of *Rhizobium* and to assess their symbiotic effectiveness. Prior to isolation of *Rhizobium*, the nodulation characteristics of field grown common bean were assessed in correlation with selected soil chemical parameters. The study established the significant variation of nodule number (15.33 -173.67 /plant) and nodule dry weight (8 to 77.67 mg /plant) across the sites and the variation could be attributed to soil organic carbon (r=0.75\*, r=0.82\*) and available P<sub>2</sub>O<sub>5</sub> in the rhizosphere (r=0.56\*, r=0.57\*) respectively. The frequencies of purified *Rhizobia* isolated from the nodules using differential Yeast Extract Mannitol Agar containing congo red (YEMA-CR) media, similarly varied significantly (5.38 to 8.58 log cfug-1) with typical colony characteristics across the sites. Growth in YEM broth exhibited the maximum population ranges (7.29 - 8.60 log cfu mL-1) at 48h, while optical density at 550nm (0.016-0.035) remains maximum at 72h of incubation. Optimum growth was exhibited by the isolates at pH7 and temperature 30o C. Differences in response to intracellular and extracellular enzymes activities, carbon sources utilization, amino acids utilizations, intrinsic antibiotic resistance and release of polysaccharides were observed for isolated *Rhizobia*.

The assesment of changes in shoot root ratio (-54.29 to 180.00), nitrogen content in shoot (4.76-19.01 mg plant-1), nodule number (11.40-70.80), nodule dry

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weight (0.02 to 0.20g), nodule score (3.60-7.00), symbiotic efficiency (213.00-852.00) and relative strain efficiency (3.98-41.3) in 'Leonard Jar' assembly exhibited the symbiotic effectiveness of few promising (R01, R06 and 18P) isolated *Rhizobium*. The linear correlation between shoot dry weight and shoot nitrogen content with nodule dry weight ( $r=0.65^*$ ), further establishes the fully functional N<sub>2</sub> fixation system as a result of effective nodulation.

# **Morphometric evaluation and soil loss estimation of a transect of Subansiri watershed in Lakhimpur district of Assam**

*Kamal Kishor*

The present investigation was carried out with the objectives to compute morphometric parameters of the drainage streams of Subansiri river basin and to evaluate soil erosion status in the basin area. The Subansiri watershed is located in the Lakhimpur district which is part of the North Bank Plains of Assam. The studied watershed encompasses 118.67 sq. km area and it lies between 94007' E to 94018' E Longitude and 27021' N to 27036' N Latitude with the elevation ranging from 86 to 124 m. Based on total variation in satellite data three distinct physiographic units of the studied watershed were delineated which includes: piedmont plain (29.75 sq. km), alluvial plain (63.05 sq. km) and flood plain (25.87 sq. km). The morphometric parameters were evaluated through measurement of linear, areal and relief aspects. The 1st, 2nd, 3rd and 4<sup>th</sup> order streams had stream numbers of 24, 5, 2 and 2, respectively. The mean bifurcation ratio for the studied area was evaluated to be 2.77. The areal aspects like circulatory ratio (0.70), elongation ratio (0.50), form factor (0.20) and shape factor (5.09) were estimated and the estimated value indicated elongated shape of the watershed. The computed relief aspects *viz.* relief ratio (0.0015), ruggedness number (0.05) and relative relief (0.082) indicated higher infiltration and lower runoff. Sixty surface soil samples (0-15 cm) along with equal no. of core samples representing all the three physiographic units were collected using handheld GPS of Garmin Etrex 20. The surface as well as core samples were analyzed for various physico-chemical properties. The texture of the studied soils varied from loamy sand to silty clay loam, sandy loam being dominant. There was a decreasing trend of total sand as well as an increasing trend of silt and clay from piedmont plain to flood plain. The bulk density, particle density and porosity of soils of the studied watershed area ranged from 1.01 to 1.61 Mg m<sup>-3</sup>, 2.19 to 2.88 Mg m<sup>-3</sup> and 30.29 to 61.85 %, respectively. The hydraulic conductivity of the soils varied from 0.44 to 5.86 cm hr<sup>-1</sup>, while the water holding capacity ranged between 5.65 to 49.53%. The field capacity, permanent wilting point

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and the available water content varied from 8.03 to 36.46 %, 2.65 to 14.98 % and 0.54 to 24.57 %. Among the physiographic units the piedmont plain soils recorded the highest value of hydraulic conductivity and flood plain showed the highest values of water holding capacity, field capacity, permanent wilting point and available water. The value of macro aggregates, micro aggregates and mean weight diameter of the studied soils varied from 20.20 to 79.54 %, 20.46 to 79.80 % and 1.13 to 3.91 mm, respectively. The pH of the studied soils was extremely acidic (4.15) to slightly acidic (6.69). The organic matter content of the soils ranged between low (5.38 g kg<sup>-1</sup>) to high (27.83 g kg<sup>-1</sup>). The available nitrogen, available phosphorus and available potassium content 10 varied from low to medium (137.98 to 464.13 kg ha<sup>-1</sup>), low to medium (15.96 to 55.25 kg ha<sup>-1</sup>) and low to medium (35.63 to 331.45 kg ha<sup>-1</sup>), respectively. Based on the estimated values of soil physico-chemical properties, various soil erodibility indices were computed. In the studied soils, the value of silt/clay ratio, clay ratio and modified clay ratio varied from 0.33 to 4.40, 1.46 to 13.25 and 1.36 to 11.73, respectively. The critical level of soil organic matter of all the studied soils was less than 5 per cent which indicated their vulnerability to soil erosion. The dispersion ratio in the studied soils varied from 0.05 to 0.42 with a mean value 0.26. The values of erosion ratio and erosion index were found to be varying between 0.01 to 0.48 and 0.02 to 0.62, respectively. It was observed that 80.59 sq. km (67.91 %) area had dispersion ratio value more than 0.15 which could be considered as erodible. Nearly 51.64 sq. km (43.52 %) area of the watershed had erosion ratio values more than 0.10 indicating their susceptibility to erosion. The erosion index values were more than 0.18 in about 44.51 sq. km (37.51 %) area. The soil loss of the studied area varied from very slight to very severe (0.87 to 67.95 t ha<sup>-1</sup> yr<sup>-1</sup>) with an average value of 12.38 t ha<sup>-1</sup> yr<sup>-1</sup>. The soil loss showed a significant positive correlation with very fine sand ( $r = 0.402^{**}$ ) and elevation ( $r = 0.509^{**}$ ). The soil loss exhibited positive correlation with various erodibility indices viz., silty/clay ratio ( $r = 0.159$ ), clay ratio ( $r = 0.251$ ), modified clay ratio ( $r = 0.249$ ). However, the significant positive correlation of soil loss was noticed with dispersion ratio ( $r = 0.633^{**}$ ), erosion ratio ( $r = 0.405^{**}$ ) and erosion index ( $r = 0.502^{**}$ ). The soil loss along with dispersion ratio, erosion ratio and erosion index exhibited decreasing trend from the piedmont plain to flood plain

## **Profile distribution of potassium in some soils of Sarupathar block of Golaghat district, Assam**

*Karabi Das*

The present investigation was carried out with the objectives to characterize and classify the soils and to study the profile distribution of different forms of potassium in some soils of Sarupathar Block of Golaghat District, Assam. Horizonwise soil samples from five pedons in different locations viz., P1 (rice), P2 (rice), P3 (rice), P4 (vegetable) and P5 (upland trees) were collected. The soil colour (moist) varied considerably ranging from dark yellowish brown (10YR 4/4) to very pale brown (10YR 7/4) with dominant hue of 10YR in all the pedons. The colour value ranged from 4 to 7 and chroma ranged from 1 to 8. Mottles of higher chroma (6-8) were seen in subsurface horizons of P1, P2 and P3 and dominant hue of the colour of mottles was 7.5YR. A textural variation ranging from loam to silty clay was observed in surface horizons and sandy clay loam to clay was observed in sub-surface horizons. The structure of the soils varied from very fine to medium, weak to strong and sub angular blocky except for the surface horizon of P3 pedon where structure was massive. The sand content in the soils varied from 7.6 to 46.5 per cent, silt varied from 22.3 to 52.8 per cent and clay varied from 16.1 to 49.8 per cent. The value of bulk density for different pedons ranged from 1.35 to 1.50 Mg m<sup>-3</sup>. Organic carbon tended to decrease with depth in all pedons except for P4. The pH values were in acidic range in all the pedons and the pH values were lower in the surface horizons as compared to the subsurface horizons. Ca<sup>2+</sup> was found to be the dominant cation followed by Mg<sup>2+</sup>, Na<sup>+</sup> and K<sup>+</sup> in all the pedons except in P5, where the sequence was Mg<sup>2+</sup>>Ca<sup>2+</sup>>Na<sup>+</sup>>K<sup>+</sup>. CEC of the soils ranged from 7.5 to 14.2 cmol (p+) kg<sup>-1</sup> soil and per cent base saturation (PBS) ranged from 14.27 to 47.02. Available N and available P<sub>2</sub>O<sub>5</sub> ranged from 65.80(L) to 487.60(M) and 8.21(L) to 28.78(M) kg ha<sup>-1</sup>, respectively. The studied soils were classified as Aquic Dystrudepts (P1), Oxyaquic Dystrudepts (P2), Typic Endoaquepts (P3), Typic Udifluvents (P4) and Typic Dystrudepts (P5) at subgroup level. Water soluble K status of the soils was found in the range of 0.85- 8.45 mg kg<sup>-1</sup>. Exchangeable K status of the soil samples was found to be in the range of 10.65 - 92.45 mg kg<sup>-1</sup>. Available K status of the soil samples was recorded in the range of 15.55 - 100.90 mg kg<sup>-1</sup> in the studied pedons and contribution

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to total K was 0.15-0.76 per cent. Status of non-exchangeable K was found in the range of 172.70 - 296.60 mg kg<sup>-1</sup> which contributed 0.93-3.93 per cent of total K. No specific trend was seen in any of the profile in case of non-exchangeable K content. Lattice K status was found in the range of 4365.30 – 19966.85 mg kg<sup>-1</sup>. The mineral pool of K is the main source of total K which accounts more than 90 per cent of the total K. The value of total K in the studied soils was found in the range of 4580 – 20200 mg kg<sup>-1</sup>. The results indicated that the pH of the soil samples showed significant positive relationship with nonexchangeable K ( $r = 610^{**}$ ). The organic carbon content of the studied soils showed positive and significant correlation with water soluble K ( $r = 416^*$ ). The cation exchange capacity of the soils showed a significant positive relationship with exchangeable, available, lattice and total forms of potassium. Highly significant and negative correlations were observed between exchangeable, available, lattice and total forms of potassium with total sand content of the soils. Clay showed significant positive relationship with exchangeable, available, lattice and total forms of potassium. Available K showed a significant and positive correlation with exchangeable K ( $r = 0.994^{**}$ ), lattice K ( $r = 0.517^{**}$ ) and total K ( $r = 0.520^{**}$ ). The correlation coefficient between forms of potassium indicated that exchangeable K had significant positive correlation with lattice K ( $r = 0.569^{**}$ ) and total K ( $r = 0.571^{**}$ ). A highly significant and positive correlation was also found between lattice K and total K ( $r = 0.999^{**}$ ) in the studied soils of Sarupathar block of Golaghat district.

## **Effect of liming on soil acidity components and available nutrients in Upper Brahmaputra Valley Zone of Assam**

*Manoharmayum Monica Devi*

A laboratory incubation study was conducted to investigate the effect of lime ( $\text{CaCO}_3$ ) on the acidity components and nutrients availability in soils of Upper Brahmaputra Valley Zone (UBVZ) of Assam. Fourteen (14) geo referenced surface (0-15 cm) soil samples were collected from Sibsagar and Jorhat districts of UBVZ of Assam. Soils were treated with three different levels of lime estimated on the basis of lime requirement (LR) of the soils *viz.*, LR10, LR25 and LR50 and their initial soil properties were recorded before liming. After that samples were incubated in laboratory conditions for different periods of time *viz.*, 15, 30, 60 and 90 days after liming (DAL) maintaining the soil moisture at Field Capacity (0.33 bar). Then at four (4) DAL soils were analysed for soil acidity components *viz.*, total acidity, exchange acidity, exchangeable (Ex)  $\text{Al}^{3+}$  and exchangeable (Ex)  $\text{H}^+$  and available nutrients *viz.*, N,  $\text{P}_2\text{O}_5$ ,  $\text{K}_2\text{O}$ , Fe, Mn, Zn, Cu, and B. The correlation between soil properties with the acidity components and available nutrients were determined statistically by simple correlations. The effect of doses of lime (LR) and days after liming (DAL) on acidity components of the soils and the available nutrients were determined statistically by analysing the data in factorial CRD design using CoStat-Statistics Software. The soils of UBVZ of Assam were highly to moderately acidic (pH range 4.27 to 5.34) with sandy loam to silty clay loam in texture and high content of organic carbon ranged from 0.72 to 2.59%. The exchangeable (Ex.) Ca and Mg value ranged from 1.40-2.64  $\text{cmol}(\text{p}+)/\text{kg}$  and 0.7-2.0  $\text{cmol}(\text{p}+)/\text{kg}$ , respectively with CEC from 7.8 to 14.2  $\text{cmol}(\text{p}+)/\text{kg}$  and BS from 25.03 to 43.76%. Application of lime brought about a marked increase in soil nutrients (N,  $\text{P}_2\text{O}_5$ ,  $\text{K}_2\text{O}$  and B) and decrease in soil acidity (total acidity, exchangeable acidity, Ex.  $\text{Al}^{3+}$  and Ex.  $\text{H}^+$  and micronutrient cations (Fe, Mn, Zn and Cu). The different forms of acidity *viz.*, total acidity, exchange acidity, exchangeable  $\text{Al}^{3+}$  and exchangeable  $\text{H}^+$  decreased after application of lime from 15(DAL). Total acidity decreased from 1.41  $\text{cmol}(\text{p}+)/\text{kg}$  to 0.77  $\text{cmol}(\text{p}+)/\text{kg}$  from LR10 to LR50 at 15 DAL.

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The highest significant decrease in total acidity was observed with LR50 and lowest in LR10. With the highest quantity of application of lime i.e. liming @ LR50 the total acidity of the soils were found to be 0.77 cmol(p+)/kg at 15DAL and 0.63 cmol(p+)/kg at 90 DAL. Application of lime brought about significant decrease in exchange acidity of the soils with increase in DAL. The highest decreased was observed at 90 DAL. Then, from 60 to 90 DAL the magnitudes of exchange acidity of the soils became more or less equal with application of lime @ LR10, LR25 and LR50. The exchangeable Al<sup>3+</sup> also significantly decreased at 30 days of DAL. The highest decrease was recorded at 90 DAL with LR50 indicating persistence of effect of liming till 90 days of incubation. Effect of levels of lime and DAL on exchangeable H<sup>+</sup> of the soils were similar as exchangeable Al<sup>3+</sup>. The nitrogen content of the soil increased from initial value of 189.22 kg/ha to 263.24, 269.79 and 284.03 kg/ha with application of lime @ LR10, LR25 and LR50, respectively at 15 DAL. The progressive increased in available nitrogen started from 15 DAL and continued till 30 days. Initially, soil phosphorus was low (20.91 kg/ha) which increased tremendously at 15 DAL and then its availability was maximum with application of lime @ LR50 (53.23 kg/ha). The highest available K<sub>2</sub>O content of the soils was observed with liming @ LR50 (142.77 kg/ha) at 30 DAL the soils. Micronutrients content of the soils (Fe, Mn, Zn and Cu) started declining with application of lime. After 15 DAL, the available iron content decreased from 98.49 to 50.93 mg/kg, 43.97 mg/kg and 34.54 mg/kg in LR10, LR25 and LR50 and the effect persisted till 90 days of incubation. The declining trend of available Mn was very sharp. The initial value of 42.41 mg/kg declined to 5.19, 3.95 and 2.96 mg/kg in LR10, LR25 and LR50 at 15 DAL. Available Mn content at 90 DAL was 8.91 mg/kg i.e. much lower than Mn content before liming. The initial Cu content of the soils (2.34 mg/kg) decreased to 1.05, 0.81 and 0.99 mg/kg with application of lime @ LR10, LR25 and LR50, respectively at 15 DAL. The available Zn content was lowest at 15 DAL, then it started increasing and reached its maximum at 60 DAL. After that it was also found to be decreased at 90 DAL. However, initial boron content of the soils (0.47 mg/kg) increased to 1.06, 1.09 and 1.07 mg/kg at 15 DAL in LR10, LR25 and LR50, respectively. The content of available B was maximum at 15 DAL and minimum at 90 DAL. Correlation between soil physico-chemical properties and soil acidity components revealed that OC had positive correlation with total acidity ( $r=0.638^*$ ) and exchange acidity ( $r=0.551^*$ ) while BS% had negative significant correlation with total acidity ( $r=-0.540^*$ ). Exchangeable calcium was significantly correlated with total acidity ( $r=-0.751^{**}$ ), exchange acidity ( $r=-0.610^*$ ) and exchangeable H<sup>+</sup> ( $r=-0.557^*$ ) while Ex Mg had significant negative correlation with exchangeable H<sup>+</sup> ( $r=-0.596^*$ ). However, micronutrient cations showed positive and anions showed negative correlation with acidity components of the soils. Exchangeable Fe exhibited significant positive correlation with total acidity ( $r=0.639^*$ ), Ex. Mn with total acidity ( $r=0.534^*$ ) and exchangeable Al<sup>3+</sup> ( $r=0.611^*$ ) while Ex. B had significant negative correlation with total acidity ( $r=-0.537^*$ ). The findings of the present investigation leads to the conclusion that in soils of UBVZ of Assam had wide range of soil physical and

chemical characteristics, values of soil acidity components, lime requirement values and available macro and micro nutrients. Even then the application of lime @ as low as 10 percent of LR (LR10) was found effective in enhancing the macronutrients and micronutrient B availability and reducing the soil acidity viz., total and exchange acidity and Ex. Al<sup>3+</sup>. The residual effect of lime was found to persist till 90 days after liming. However, magnitude of the effect of liming was increasing with increase in application of lime@ from LR10 to LR25 and to LR50.

# **Nutrient availability, soil acidity and tomato yield as influenced by FYM-lime-wood ash mixture and rice stubble management**

*Prantika Kakati*

A field experiment was conducted in ICR farm, AAU, Jorhat from December, 2019 to April, 2020 to evaluate the forms of acidity, nutrient availability in soil and yield of tomato in winter rice-fallow as influenced by different nutrient management practices with and without rice stubble incorporation. The experiment was conducted in a split plot design with four replications. Rice stubble was either removed or incorporated in the main plot, and each main plot was divided into five sub plots with nutrient management practices. The nutrient management comprised of unfertilized plot, FYM 2 t ha<sup>-1</sup> (FYM) one week before planting followed by 75:60:60 N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O kg ha<sup>-1</sup> (RDF) applied at planting, with N in two equal splits (RDF+FYM), half of the lime requirement 21 days before planting ( $\frac{1}{2}$ LR) followed by FYM at planting ( $\frac{1}{2}$ LR+FYM),  $\frac{1}{2}$ LR followed by FYM mixed with wood ash 2 kg ha<sup>-1</sup> ( $\frac{1}{2}$ LR+FYM-wood ash), and FYM as mixture with lime 20 kg ha<sup>-1</sup> and wood ash 2 kg ha<sup>-1</sup> in two splits at planting and 30 days after planting (FYM-lime-wood ash). Application of lime ( $\frac{1}{2}$ LR) significantly increased soil pH and decreased exchange acidity, total acidity and exchangeable Al<sup>3+</sup> in soil. The NH<sub>4</sub>-N, NO<sub>3</sub>-N and available P and K content in soil were significantly increased by rice stubble incorporation only at 56 days after planting (DAP) of tomato. Application of RDF+FYM maintained significantly higher content of NH<sub>4</sub>-N, NO<sub>3</sub>-N, available P and K in soil throughout the growth stages of tomato. However, there was no significant effect on nutrient content in soil between  $\frac{1}{2}$ LR+FYM with or without wood ash and FYM-lime-wood ash. The exchangeable Ca<sup>2+</sup> and Mg<sup>2+</sup> in soil significantly increased due to application of  $\frac{1}{2}$ LR+FYM compared to unfertilized or RDF+FYM but did not differ with FYM-lime-wood ash, while the same were unaffected by rice stubble incorporation. Application of RDF+FYM or rice stubble incorporation significantly increased exchangeable K<sup>+</sup> in soil. The urease, dehydrogenase, acid phosphatase activities and microbial biomass carbon in soil increased significantly with rice stubble incorporation. Except for microbial biomass

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carbon, no significant difference was observed for enzyme activities in soil between RDF+FYM and application of lime with FYM, irrespective of dose and method of application. The various growth parameters and yield of tomato were significantly enhanced due to rice stubble incorporation. Application of RDF+FYM produced highest yield, diameter, fresh and dry weight and moisture content and significantly higher nutrient uptake of tomato among the nutrient management practices, while the highest B:C ratio was observed with application of FYM-lime-wood ash. The available nutrient status of soil at harvest of tomato was significantly enhanced with rice stubble incorporation or nutrient management compared to rice stubble removal or the unfertilized plot, respectively.

## **Distribution of micronutrients in soils under Horticultural crops of Assam**

*Srinivasulu Kumbha*

An attempt has been made for assessment of the distribution of available micronutrients in soils and their effect on physico-chemical properties of the soils under different horticultural crops of Assam. Seventy-five (75) soil samples were collected at 0-20 cm, 20-40 cm, 40-60 cm, 60-80 cm and 80-100 cm depth under five horticultural crops viz. banana, arecanut, khasi mandarin, coconut and assam lemon. Results indicated that sand, silt and clay content of the soils showed a significant variation among depths. The significantly highest content of sand (64.63%), silt (51.73%) and clay (41.70%) were found at 0-20 cm, 80-100 cm and 80-100 cm under khasi mandarin, banana and arecanut, respectively.

The soils were very strongly to medium acidic in reaction with a pH range of 4.50 to 6.1 and the highest pH (6.1) was recorded at 80-100 cm depth in A3 under arecanut. Organic carbon content of the studied soils was found higher in surface layer and decreased significantly with increasing soil depths. The significantly highest and lowest mean value of organic carbon was recorded in profile of arecanut (7.79g kg<sup>-1</sup>) and khasi mandarin (3.95 g kg<sup>-1</sup>), respectively. The exchangeable Ca<sup>2+</sup>, Mg<sup>2+</sup>, Na<sup>+</sup> and K<sup>+</sup> content and per cent base saturation was low in surface layers and gradually increases with increasing depth. The significantly highest and lowest mean values of cation exchange capacity in soils were observed under arecanut and khasi mandarin, respectively.

The content of available micronutrients showed a significant variation among different depth under different horticultural crops. The content of available micronutrients was higher in surface layers and decreased with depths. Among the crops, soils from arecanut and khasi mandarin recorded the highest and lowest mean value of DTPA Fe, DTPA -Mn and DTPA-Cu, respectively. The mean value of DTPA-extractable Fe, Mn, and Cu content of the studied soils ranged from 4.10 to 147.25, 3.60 to 81.37 and 0.37 to 1.62 mg kg<sup>-1</sup> under different crops, respectively indicating the sufficiency of Fe, Mn and Cu in soils. Content of DTPA- Zn was sufficient under all crops except khasi mandarin at 0-20 cm depth and assam lemon under 60-100 cm depth.

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The highest content of boron was exhibited at surface layer and significantly the highest content of HWS-B (0.65 mg kg<sup>-1</sup>) was observed at 0-20 cm depth under arecanut. Most of the soils were found below critical limit except at 0-20 cm depth.

DTPA-extractable micronutrients and HWS-B correlated positively and significantly with per cent clay, soil organic carbon and cation exchange capacity but negatively and significantly with sand and soil pH. Step-wise multiple regression analysis revealed that organic carbon was the dominant factors accounting for maximum variability in available micronutrient contents in soil.

## **Soil properties in termite mounds under different land uses**

*Sushmita Konwar*

A study was carried out to assess the physical, chemical and biological properties of termite mound soils under five land uses viz., Fallow, Horticulture, Bamboo, Tea and Forest. Three mounds from each of the land uses were selected and three soil samples were collected from the base, centre and top of each of the termite mounds. One composite soil sample was collected from the adjacent soils from each of the land uses. A total of 50 soil samples were collected for the study. The impact of the mounds of termites on their adjacent properties of soil was also investigated. The termite mound soil was found to be higher in bulk density and water holding capacity compared to surrounding soil. They were also richer in clay, organic carbon, and concentrations of N, P, K, S, Ca, and Mg and enzymatic activities than their adjacent soils. Total acidity, Potential acidity and Exchangeable Al<sup>+</sup> were found to be lower in the mounds as compared to the adjacent soils under all the land uses. No definite pattern was observed for the variation of the micronutrients between the mounds and the soils adjacent to it. A two-tailed paired t-test was carried out to compare the variation in soil properties of the mounds with respect to the five land uses. Bulk Density in the termite mounds in case of Fallow soil was observed to be significantly lower as compared to that of Horticulture, Bamboo, and Tea. Bulk Density of the termite mounds under Forest soil was however significantly lower than that of Fallow. Water Holding Capacity (WHC) was significantly higher in the termite mounds under Horticulture (30.77%), Bamboo (32.06%), Tea (30.96%) and Forest (32.42%) as compared to that of Fallow (28.33 %). The organic carbon content of the termite mounds was significantly lower in Fallow land use. Although non significant, low organic carbon was observed in forest, compared to Fallow, Horticulture and Bamboo land use. The CEC in the termite mounds under Horticulture system was significantly higher than Fallow system. Available P was significantly higher in the termite mounds under Horticulture land use compared to Fallow, Tea and Forest. All the acidity components were found to be comparatively higher under fallow ecosystem. Based on the SQI calculated by combining all the studied physical, chemical and biological parameters, it was observed that soil under

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**Major Adviser: Dr. Gayatri Goswami Kandali**

Horticulture land use (SQI 12.35) is highly enriched by the termite mounds compared to Tea (SQI 11.80), Bamboo (SQI 10.40), Forest (SQI 9.80) and Fallow (SQI 5.71). So, Horticulture land use has more aggradation followed by Tea, Bamboo and Forest. Aggradation is more in all the land uses compared to Fallow.



# **Morphometry and Soil Erodibility of a transect of Ranganadi Watershed in Lakhimpur district of Assam**

*Tilak Prasad Panika*

The Ranganadi river, which originates in Arunachal Pradesh, joins the Subansiri-Brahmaputra river system at Khichikagaon of Lakhimpur district of Assam. The Ranganadi watershed area experiences frequent flood and seasonal water logging that often inundate the vicinity of the watershed. The present investigation was undertaken to compute morphometric parameters of the drainage streams of Ranganadi watershed and assessment of soil erosion status in a transect of the watershed area.

The study area covered a total of 12174 hectares and were divided into piedmont plain of 4192 hectares (34.43%), alluvial plain of 4808 hectares (39.49%) and flood plain of 3174 hectares (26.08%) physiographic units. The transect had elevation ranging from 112 m to 70 m. A total of 60 samples were drawn with 16 in piedmont, 19 in alluvial plain and another 25 in flood plain area. Morphometrically the transect is elongated in shape and has 3rd order stream distribution. The areal and relief aspects projected the area to be moderately prone to erosion.

Texturally the soils varied widely from sand to clay loam with the sand content ranging from 62.79 per cent in piedmont to 59.17 per cent in flood plain and 57.36 per cent in alluvial plain. A decreasing trend in silt from piedmont plain to flood plain was noticed. Similarly, clay content showed highest for alluvial plain, which is followed by flood plain and the lowest by piedmont plain. A decreasing trend for bulk density was observed from piedmont plain to the flood plain. Similarly, particle density was observed highest at alluvial plain (Mean value = 2.61 Mg m<sup>-3</sup>) and lowest at the piedmont plain (Mean value = 2.51 Mg m<sup>-3</sup>). Porosity was found highest at alluvial plain with mean value of 47.05 and lowest at the piedmont plain with mean value of 44.61. A decreasing trend was observed for hydraulic conductivity from piedmont plain to flood plain. It was negatively correlated with clay ( $r = -0.735^{**}$ ), bulk density ( $-0.390^{**}$ ) and organic matter ( $r = -0.154$ ). Similarly, water retention properties showed wide ranging variability. The soils ranged from extremely acidic (4.15) to slightly acidic

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(6.14). The Organic matter content was found highest in the alluvial plain soil (Mean value of 1.53 g kg<sup>-1</sup>) which was followed by flood plain (Mean value of 1.49 g kg<sup>-1</sup>) and lowest was observed in the piedmont plain (Mean value 1.45 g kg<sup>-1</sup>). The available N varied from low to medium (175.36 to 463.35 kg ha<sup>-1</sup>) whereas, the amount of available P<sub>2</sub>O<sub>5</sub> found low to high (20.77 to 69.25 kg ha<sup>-1</sup>) and available potash was found low to medium (29.03 to 168.67 kg ha<sup>-1</sup>). The macroaggregate content was observed highest in the alluvial plain followed by flood plain and the piedmont plain.

The silt/clay ratio of the soils of the studied watershed showed no definite trend with respect to different physiographic units. The clay ratio showed decreasing trend from piedmont plain (9.74) to alluvial plain (7.16) and flood plain (7.40). The DR showed significant positive correlation with sand ( $r = 0.545^{**}$ ), while it had significant negative correlation with silt ( $r = -0.560^{**}$ ) and clay ( $r = -0.327^{*}$ ). The 6 erosion ratio was highest in alluvial plain and the lowest was observed in the flood plain areas. The soil erosion in the piedmont plain ranged from slight to severe. Likewise, in the alluvial plain, soil erosion ranged from slight to severe and for the flood plain soils, it ranged from slight to moderately slight erosion. A decreasing trend for soil loss from alluvial plain soil (8.52 t ha<sup>-1</sup> yr<sup>-1</sup>) to piedmont plain (7.37 t ha<sup>-1</sup> yr<sup>-1</sup>) soils and the lowest was observed in flood plain (3.39 t ha<sup>-1</sup> yr<sup>-1</sup>). Soil loss showed negative correlation with sand, HC, macroaggregate and mean weight diameter. Similarly, it showed positive correlation with silt, clay, water retention parameters and erodibility indices.

In all the three physiographic units, the estimated soil loss was dominated by slight level showing 20, 11.67 and 33.33 per cent samples falling in the class. Overall a total of 65 per cent samples showed slight soil loss. The entire area is free from very severe (>40 t ha<sup>-1</sup>) class of soil loss. It was observed that with lower elevation, the severity of soil loss decreases. About 22 hectares (0.18%) susceptible to severe soil loss and under the moderately severe class, the total area was 50 hectares (0.41%) and in moderate class, the total area was 1047 hectares (8.60%). The highest area of 5550 hectares (45.59%) showed moderately slight soil loss, while 5505 hectares (45.22%) area showed slight erosion problem. From the study it could be suggested that erosion control measures need to be undertaken in the watershed to prevent deterioration of soil health.

## **Scope of Augmenting Farmers' Income in Small Tea Plantations – A Case Study in Golaghat Sub Division of Golaghat District**

*Anganjyoti Swarup*

The study entitled “Scope of Augmenting Farmers’ Income in Small Tea Plantations- A case study in Golaghat Sub Division of Golaghat district” was undertaken with the following objectives to study the socio-economic status of the small tea growers, to examine the existing farming systems and resource utilization pattern and to identify the constraints and suggesting measures for augmenting the farm income. The present study was conducted in five Sub Divisions of Golaghat district, i.e. Golaghat East Development Block, Golaghat North Development, Golaghat Central Development Block, Kakodonga Development Block and Morangi Development Block. The sample selection was done using stratified random sampling technique, for which information was collected from primary sources and secondary sources. Primary data were collected through interview technique with structured interview schedule prepared by the researcher. The socio economic status study of the small tea growers revealed that the age group of population between 15 to 60 year was maximum which constitutes 64.54 per cent of total, where 39.98 per cent is male and 24.56 per cent is female and lowest in above 60 age group of 12.97 per cent where 7.40 per cent is male and 5.57 per cent is female. Education status of the population was highest in graduate level which constitutes of 54.09 per cent of total, where 33.10 per cent is male and 20.99 per cent is female. Occupation status of maximum respondents are engaged in tea farming constitutes 16.81 per cent as full time and 7.57 per cent as part time of total samples under the age group of 15-60 years. The study resulted in identification of six types of farming systems *viz.* FS I (Tea, Field and Horticultural Crops), FS II (Tea, Field and Horticultural Crops, other Plantation Crops and Allied Activities such as Fishery/dairy cattle), FS III (Tea and other Plantation Crops), FS IV (Tea and Allied Activities such as Fishery/dairy cattle), FS V (sole Tea) and FS VI (Tea, Field and Horticultural Crops and Allied Activities such as Fishery/dairy cattle) amongst which FS II was the only farming system adopting all the types of considered components of farming system with 26.81 per cent respondents. Number of growers adopting FS I was highest which is 31.80

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percent of the total number of growers, whereas growers adopting FS VI&FS V has the lowest numbers of growers i.e. 5.75 and 7.66 percent of the total respectively. Operational area wise the growers of FS II has the highest area of 118.74 ha and FS VI has the lowest area of 31.09ha. The land utilization was found highest in case of tea plantation i.e. 73.45 percent of the total and quite lowest in other plantation crops and fishery. In case of labour utilization, it was maximum in all the components of farming systems and it was observed highest in tea cultivation accounting for 528.74 mandays per hectare per year. The production rate of tea was quite lowest across all the farming systems of Golaghat district which was found to be ranging from 9199.16 to 13462.36 kg green leaf per hectare per year in FS V and FS II respectively. Intergroup analysis amongst the farming system illustrated that the FS II with all the considered components of farming systems achieved the highest benefit cost ratio of 2.36 and lowest benefit cost ratio was obtained by FS V of 1.50 with only tea as its component. From the above results, conclusion was drawn that FS II adopting all the necessary components of farming systems suitable in the study area, like tea, field and horticultural crops, other plantation crops and allied activities and utilizing all the remaining unutilized land was the most efficient mode of farming system compared to the other groups. This successful reasons behind this system was that all the components were dependent on one another, it gave continuous income round the year, recycling of bi products was applicable and cost was minimized for input use.

# **Impact of Gas Flaring on Soil Health and Growth of Tea Plants Adjacent to Oil Field in Merbil Majuli OCS 6 (West) in Dibrugarh District of Assam**

*Anubrat Borah*

An experiment was conducted to study the impact of gas flaring on soil health and growth of tea plants adjacent to oil field in Merbil Majuli OCS 6 (WEST) in Dibrugarh district of Assam during 2019-2020. The study was designed with Randomized Complete Block Design (RCBD) accommodating five levels under distance and two levels under seasons.

Soil and plant samples were collected randomly at an interval of 35-55 m, 55-75 m, 75-95 m, 95-115 m and 130-150 m (control site) starting from the gas flaring point in rainy and autumn seasons. The experimental plot was laid out at 35 metres away from the flare pit due to the presence of a road in between the flare site and the selected tea garden.

Plant physiological and soil physico-chemical properties were studied and observed that the gas flaring had adverse effect on growth and development of tea plants viz. physiological parameters such as relative turgidity, water saturation deficit, stomatal count, chlorophyll etc., growth parameters like plucking point density, number of branches and biochemical parameters such as caffeine and polyphenol content and soil physical parameters viz., bulk density, porosity, hydraulic conductivity etc. and chemical parameters such as pH, available nutrients, electrical conductivity etc. In this experiment, plant parameters viz. relative turgidity (82.22%), stomatal count (17.33 nos./microscopic field), leaf area (31.38 cm<sup>2</sup>), Chlorophyll-a content (0.52 mg/g fresh weight), Chlorophyll-b content (0.31 mg/g fresh weight), Total caffeine content (1.40 %), polyphenol content (21.65 %), Plucking point density (21.5 nos./2500 cm<sup>2</sup>), Number of branches (9 nos./plant) were found to be decreased at distance (35-55 m) away from the gas flaring site which significantly increased with distances. Water saturation deficit of tea leaves were recorded highest (17.78%) at distance (35-55 m) and decrease with distances away from the gas flaring site. Soil physical properties viz.,

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soil temperature (28.5°C) decreased with distances and soil moisture (11.83%) increased with distances away from the gas flaring site. Soil chemical properties like soil organic carbon (0.81%), available nitrogen (242.83 kg/ha), available phosphorus (13.79 kg/ha) and available potassium (254.00 kg/ha) were found to be decreased at distance (35-55 m) away from the gas flaring site which significantly increased with distances. Bulk density, Soil porosity, Hydraulic conductivity, Soil pH and Electrical conductivity of soil had no significant affect of gas flaring with respect to both distances and seasons.

## **Impact of oil field effluent on soil health and growth in small tea farms of Shalmari OCS-1, Dibrugarh district of Assam**

*Eimon Bharadwaj*

The study entitled “Impact of oil field effluent on soil health and growth in small tea farms of Shalmari OCS-1, Dibrugarh district of Assam” was undertaken this to study the impact of spillage in the tea plantations in nearby oil fields with probable effect on soil health and the growth of the tea crop with the following objectives to study the effluent released from the oil fields on the physiology of tea crop with respect to growth and to study the impact of effluent on soil physicochemical properties in tea plantation.

The present study was conducted in Shalmari No. 1 near Tingkhong tea estate of Dibrugarh district. The site is nearer to Oil Collecting Station (OCS) number 1 with well number 17, 25, 30, 44. Sample collection was divided into two parts i.e. plant and soil samples. Samples for plant and soil were carried out in two tea growing seasons viz. Rainflush, and autumn flush. Samples were collected at an interval of 0-21 m, 21-42 m and 42-63 m and beyond 63m (control site) starting from the effluent spilling point for the affected plot. For one season, a total of twelve samples were collected with respect to four distances and within each distances three replication were used in the entire investigation period. A total of twenty-four samples were collected in both the season. Plant sample was collected manually while soil sample was done by soil augur. Both for soil and plant, a total of 48 samples were collected. The laboratory works were carried out in the Department of Tea Husbandry & Technology and Department of Soil Science, Assam Agricultural University, Jorhat, Assam. Values obtained from the samples from different parameters were statistically analysed. Also, correlation analysis was done to see the significant variation and similarities amongst the parameters.

The present investigation reveals oil effluent spillage as a major factor for plant growth and soil quality deterioration in Shalmari-1, Dibrugarh field and the impact was more pronounced in the vicinity of drilling point adversely affecting plant physiological, growth and biochemical parameters also soil physical and chemical parameters. Plant

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parameters like water saturation deficit increased from 8.9 to 18.85 % in crude oil affected site while decreased the relative turgidity, stomatal count, plucking point density, number of primaries, chlorophyll, caffeine and polyphenol content in the tea plants grown in the contaminated site. Bulk density of the soils of contaminated site was increased as compared to the control site from 1.22 to 1.33 Mg m<sup>-3</sup>. Also, there was increase in pH, organic carbon and available nutrients in the contaminated site. However, soil porosity, hydraulic conductivity, electrical conductivity was low in the contaminated area as compared to control site.



# **Impact of oil field effluent on soil health and growth in small tea farms of Shalmari OCS-1 (North), Dibrugarh district of Assam**

*Jayshree Konwar*

Assam is one of the most popular destinations for tea (*Camellia sinensis* (L.) O. Kuntze) and it produces more than half of the country's total production. The Upper Assam region of the Brahmaputra valley is also a prime centre for crude oil drilling industry in India. During crude oil exploration a vast amount of drilling mud or oily sludge is generated which spread through rain and flood to the nearby cultivated fields including tea. The oily sludge adversely affects the soil health and also reduces the crop yield. The present investigation was aimed to study the physicochemical properties of soil and growth of tea in a tea garden of Shalmari situated near Oil Collecting Station (OCS-1) in Dibrugarh district, Assam. Different plant and soil properties were analysed using standard statistical procedure in two tea growing seasons *viz.*, Rain flush and Autumn flush. Soil samples were collected from randomly selected sites from a distance of 11m from the oil pit and at an interval of 0-21m, 21-42m, 42- 63m. For each distance three replications were selected. In each replication four soil samples were collected randomly and mixed to make a composite sample. Another three samples were collected from the unpolluted control plot *i.e.* 63-100m away from the pit site. Leaf samples were also collected in similar way. For one season, twelve samples each of soil and plants were collected. After the treatments the results revealed that the water saturation deficit was found higher near the oil pit. The relative turgidity, stomatal count, leaf area, specific leaf weight of tea leaves increased with distance from the pit site. Polyphenol, caffeine and chlorophyll content of the tea leaves was found to be low near the oil pit site. The number of branches and plucking point density of the tea plants was found to be lower near the oil pit and it gradually increased with distance. However, the soil particle analysis does not show any variation with respect to both distance and season. The bulk density, organic carbon, electrical conductivity was found to be high near the oil pit site but porosity and hydraulic conductivity was low in the vicinity of the oil pit. The soil pH was increased near the pit site making the soil medium acidic. Available N

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and K<sub>2</sub>O was found significantly very high near the pit site and substantially decreased with distance. Conversely, available P<sub>2</sub>O<sub>5</sub> significantly reduced near the pit site. The study revealed that most of the plant and soil parameters were found to be not affected beyond 63m from the pit point. Measures should be taken to reduce the adverse affects of oil effluents on tea plantations.

# **Impact of Gas Flaring on Soil Health and Growth of Tea Plants Adjacent to Merbil Majuli, OCS-6 (South) in Dibrugarh District of Assam**

*Kalparanjan Bhuyan*

Gas flaring is a major contributor to the emission of toxic gases and other gaseous pollutants into the atmosphere. The study entitled “Impact of gas flaring on soil health and growth of tea plants adjacent to Merbil Majuli, OCS-6 (South) in Dibrugarh district of Assam”. The present research work was conducted to study the impact of gas flaring released in nearby oil fields with probable effect on soil health and growth of tea plants. During the experiment, samples for the plant and soil were carried out in two tea growing seasons *viz.* rain flush and autumn flush. The experimental plots were laid out at 11 metres away from the gas flaring point due to the presence of a road in between the flare site and the selected tea garden. Plots were selected at an interval of 20 metres within the experimental design i.e. D1 (11-31m), D2 (31-51m), D3 (51-71m), D4 (71-91m) and DC (120-140m) where, DC denotes control plot. Plant samples were collected from 4 different plants for each parameter separately at each replication and for both the seasons and soil samples were collected from 4 different spots selected randomly in each replication. The present investigation revealed that the gas flaring had adverse effect on growth and development of tea plants and physico-chemical properties of tea soils in Merbil Majuli, OCS 6 (South), Dibrugarh district. The impact was more pronounced in the vicinity of flaring point. Gas flaring had adversely affected some physiological parameters of tea plants such as relative turgidity, water saturation deficit, stomatal count, chlorophyll etc., growth parameters like plucking point density, number of branches and biochemical properties of made tea such as caffeine and polyphenol content. Soil physical parameters such as bulk density, porosity, hydraulic conductivity etc. and chemical parameters such as pH, available NPK, electrical conductivity etc. were also found to be adversely affected by gas flaring. In this experiment, the results showed that during both rainy and autumn season plant physiological parameters *viz.* relative turgidity (83.33 % and 80.95 % respectively), stomatal count (17 nos./microscopic field and 16 nos./microscopic field respectively), leaf area (31.61 cm<sup>2</sup> and 31.15 cm<sup>2</sup> respectively), specific leaf weight (0.008 mg/cm<sup>2</sup> and 0.007 mg/cm<sup>2</sup>

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respectively), chlorophyll-a content (0.55 mg/g fresh weight and 0.48 mg/g fresh weight respectively), chlorophyll-b content (0.30 mg/g fresh weight and 0.31 mg/g fresh weight respectively), total caffeine content (1.44 % and 1.32 % respectively), total polyphenol content (22.24 % and 23.36 % respectively), plucking point density (21 number/2500 cm<sup>2</sup> and 21 number/2500 cm<sup>2</sup> respectively) were found to be significantly low at distance D1 (31-51 m) which was close to the flare site. Water saturation deficit of tea leaves were also significantly high (16.66 % and 19.04 % respectively) during both the season at distance D1 (31-51 m) and decreased at distances away from the gas flaring site. Soil temperature (25.23oC and 26.22oC respectively) increased significantly near the flare site (D1:31-51 m) and causing significant reduction of soil moisture (11.71 % and 11.93 % respectively) at both the season. Soil organic carbon (0.80 % and 0.79 % respectively), available nitrogen (245.66 kg/ha and 242.66 kg/ha respectively), available phosphorus (13.80 kg/ha and 13.81 kg/ha respectively) and available potassium (255.00 kg/ha and 254.33 kg/ha respectively) were also decreased significantly near the flare site (D1:31-51 m) both at rainy and autumn season. The study revealed that the gas flaring did not have any significant affect on bulk density, soil porosity, hydraulic conductivity, soil pH and electrical conductivity of soil with respect to both distances and seasons. Most of the plant parameters were found to be affected by gas flaring beyond 91 m from the gas flare point and the soil parameters were not affected beyond 71 m. This implies that tea plants are safe at or beyond 91 m from the gas flaring point and produce economic yield. Measures like growing barrier crops, improving drain status and shade status, etc. should be taken to reduce adverse impact of gas flaring on tea plantation.

# **Impact of oil field effluent on soil health and growth of tea in small tea farms in proximity of OCS-2 in the Digholia area of Dibrugarh district of Assam**

*Preetisha Dutta*

Oil contamination causes serious environmental concern and adversely affects the plant as well as soil environment due to the release of toxic by-products. In the upper Assam districts of Dibrugarh and Tinsukia, a number of Oil Collecting Stations have been set up by the premier oil producing company *viz.*, Oil India Limited. In the proximity of these Oil Collecting Stations lies a large number of oil drilling pits where various drilling operations are being carried out. On the vicinity of these drilling pits, a number of people living in adjoining villages own their small tea gardens. During heavy rains these pits containing crude oil often overflow. Hence, the aim of the present study was to investigate the impact of oil field effluent on soil health and growth of tea plants during two growing seasons.

In the present investigation, a detailed study to understand and assess the adjacent soils and tea plants was attempted. The site of selection was small tea farms adjacent to the oil drill site in the Digholia area of Dibrugarh, Assam. The garden was planted with clone TV 22 and the age of plantation was 15 years. Samples for analysis were drawn at random from varying distances, *viz.* at 21 m, 42 m and 63 m from the oil drilling site. Samples were also collected from tea sections that was further away from the drill site, *viz.* beyond 80 m from the oil drilling site and unaffected by the spill of crude oil, which was homogenous and contiguous to the garden with clone TV 22 of same age. Standard analytical procedures were followed to determine various plant physiological parameters, *viz.* Relative Turgidity, Stomatal Count, Leaf Area Measurement, Water Saturation Deficit, Specific Leaf Weight, Total Chlorophyll Content, Caffeine Content and Total Polyphenol Content and Yield parameter, *viz.* Plucking Point Density and Number of Primaries/branches as well as soil physico-chemical parameters, *viz.* Bulk Density, Soil Porosity, Hydraulic Conductivity, Soil

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particle analysis, pH, Organic carbon, Electrical Conductivity and Available Nutrients (NPK).

The results of the study revealed that Water Saturation Deficit increased near the oil drilling site and was higher during autumn flush whereas values of other plant parameters increased with an increased in distance from the oil drilling site. Soil porosity and hydraulic conductivity was low near the oil drilling site and increased significantly with an increase in the distance. The pH of soil was found to be more acidic near the spillage point while organic carbon content increased near the oil drilling site. The available Nitrogen and available phosphorous was found to increase with an increase in distance of the area from the oil pit. Conversely, Bulk Density, Electrical Conductivity and available K<sub>2</sub>O increased near the oil drilling site. There was no change in the texture of the soil with presence or absence of crude oil during both the seasons under investigation.

# **Impact of oil field effluent on some physico-chemical properties of soil and growth of tea in the plantation of small growers of Dibrugarh district of Assam**

*Pubali Neog*

A field experiment was carried out in September, 2019 and November, 2019 as Rain Flush and Autumn Flush respectively in No. 1 Shalmari Gaon, Dibrugarh, Assam near Oil collecting station (OCS)-1, Well number 17, 25, 30 and 44. The experiment was conducted in 4x2 Factorial Randomized Block Design with 3 replications under 4 distances *viz.*, 0-21m (D1), 21-42m (D2), 42-63m (D3), Beyond 63m (Dc) and 2 seasons, Rain Flush (S1) and Autumn Flush (S2) with tea clone TV22. The results showed that the physiological parameters *viz.*, Relative turgidity, Number of stomata, Leaf area and Total chlorophyll content measurement recorded the lowest value irrespective of flushing season in the tea grown within 21m distance from the pit and recorded highest value at the distance away from the oil pit. Water saturation deficit was recorded to have the highest value near the pit irrespective of flushing season and gradually increases at the distance away from the oil pit. Discounting the Flushing season the distance have not recorded any significant variation in case of Specific leaf weight. In case of quality parameters of tea, disregarding the Flushing season the tea grown in the vicinity of the oil pit recorded the lowest value of caffeine content (1.58%) and total polyphenol content (21.47%) and found to be significantly lower than the tea grown away from the oil pit. The growth parameters *viz.*, plucking point density and number of primaries per plant recorded the lowest value in the vicinity of the effluent pit which was significantly lower than tea grown at a distance away from the pit. The number of primaries was significantly positively correlated with plucking point density. In case of soil physical parameters, both porosity and hydraulic conductivity recorded lowest value of 45.64% and 0.25 cm/min, respectively, irrespective of flushing season in the vicinity of the effluent pit which was significantly lower than the tea grown soil at the distance away from the oil effluent pit. The bulk density of soil near the oil effluent pit recorded the highest value (1.31 Mg/m<sup>3</sup>) and it gradually decreases along with the

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**Department: Tea Husbandry & Technology**

**Major Adviser: Dr. Mridul Deka**

distance away from the oil effluent pit. Soil pH, organic carbon content and electrical conductivity recorded highest value in the vicinity of the effluent pit which was significantly higher than the soil at a distance away from the effluent pit. Regardless of the flushing season the available nitrogen of soil near the effluent pit recorded the highest value and it was significantly higher than the soil at a distance away from the effluent pit, which was significantly higher than the soil at a distance away from the effluent pit. Available phosphorous of the soil adjacent to the effluent pit recorded the lowest value and found to be significantly lower than the soil at a distance away from the effluent pit. Available potassium of tea grown soil near the effluent pit recorded the highest value (241.50 kg/ha) and found to be significantly higher than the tea grown soil at a distance away from the effluent pit. In some of the parameters the seasonal impact plays a significant variation. Among the physiological parameters *viz.*, Relative Turgidity, Stomatal count, Leaf area and total chlorophyll content measurement recorded a significantly higher value in the rain flush as compared to the autumn flush. In case of the water saturation deficit the seasonal influence seems to have recorded significantly higher in the autumn flush than the rain flush. The quality parameters including caffeine content and total polyphenol content seems to have significantly higher value in the rain flush than the autumn flush. The growth parameters *viz.* plucking point density and number of branches per plant recorded higher value in the rain flush than the autumn flush. In case of the soil physical parameters, except porosity all the parameters did not recorded any significant variation among the seasons. The porosity have recorded a significantly higher value in the autumn flush than the rain flush. Similarly the chemical parameters did not recorded any significant variation among the seasons. The Porosity and bulk density was found to have negative correlation.



# **Impact of Gas flaring on soil health and growth of tea plants adjacent to Kothaloni OCS North in Dibrugarh district of Assam**

*Rashmi Kalita*

Assam is known for natural resources like oil and its tea plantations. Both of these industries co exist near each other in the districts of upper Assam. On the extraction of crude oil, low pressure natural gases are released into the environment which is burnt in open air. This continuous flaring process exposes the tea plants to uninterrupted light throughout the day and night and an increase in temperature in the tea growing areas near the gas flaring sites. Therefore the present study was undertaken, which could be an aid to determine the extent of the effect of gas flaring on plant growth and health of tea growing soils. In the study, responses of some plant physiological and growth parameters and some soil physical and chemical parameters were studied on TV22 plants growing near gas flaring site of Kothaloni OCS North in No. 1 Naharani gaon in Dibrugarh district of Assam. The experimental plot was laid out in 5 x 2 factorial RCBD with two factors *viz.* different distances from the flare site and two seasons. The plant and soil samples were collected on early September and end October for rain and autumn flush respectively. The result of the study revealed that there was a gradual decline in relative turgidity, specific leaf weight, plucking point density, stomatal count, leaf area measurement, polyphenol content, chlorophyll content, caffeine content but an increase in water saturation deficit of the green tea leaves on plants existing at a distance moving closer to the flare pit. A significant increase in rain flushing season as compared to autumn was observed in all the plant parameters except water saturation deficit. Significant increase in soil temperature and decrease in soil moisture content was observed in distance closer to the flare pit. Distance from flare did not play significance in bulk density, porosity, soil pH, hydraulic and electrical conductivity, organic matter content and soil nutrient availability in tea growing soils under the conditions of the present investigation. Change in season seems to have no significant role in the soil physical and chemical characteristics.

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# **Impact of Gas Flaring on Soil Health and Growth of Tea Plants Adjacent to Kothaloni OCS South in Dibrugarh District of Assam**

*Ripsita Phukan*

A study entitled “Impact of gas flaring on soil health and growth of tea plants adjacent to Kothaloni OCS South in Dibrugarh district of Assam” was carried out in Kothaloni, No.1 Naharani, Dibrugarh, Assam during the year 2019-20. The study was conducted with Randomized Complete Block Design (RCBD) and analysis was done accommodating five levels of distances and with two seasons.

Soil and plant samples were collected from (40-50) metres, (50-60) metres, (60-70) metres, (70-80) metres and control site (150-160) metres away from the gas flaring site in rainy and autumn seasons. The experimental plot was laid out at 40 metres away from the flare pit due to the presence of a pond and a concrete barricade in between the flare site and the selected tea garden.

The observations were made for tea plant and soil physico-chemical parameters. As far as plant parameters are concerned, relative turgidity, stomatal count, specific leaf weight, leaf area measurement, water saturation deficit, caffeine content, quality parameters and plant growth parameters as well as soil physico-chemical parameters such as bulk density, porosity, hydraulic conductivity, soil temperature, soil moisture, pH, organic carbon content, electrical conductivity, available nutrients (NPK) were studied. From the study, mean plant parameters viz. relative turgidity (79.68%), stomatal count (19.66 no./mm<sup>2</sup>), specific leaf weight (0.007 g/cm<sup>2</sup>), tea leaf area (36.37cm<sup>2</sup>), chlorophyll-a content (0.96mg/g) and chlorophyll-b content (0.42 mg/g), caffeine content (2.35%), polyphenol content (21.37%), plucking point density (31.33 no./2500cm<sup>2</sup>) were found to be decreased at distance (40-50)metres away from the gas flaring site which significantly increased with distances. Water saturation deficit of tea leaves recorded highest (20.51%) at distance (40-50) metres which decreases with distances away from the gas flaring site. Soil physical parameters viz. soil temperature recorded highest (29.83°C) at distance (40-50) metres which decreases with distances and soil moisture recorded lowest (11.48%) at distance (40-50) metres which increases

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with distances away from the gas flaring site. Rest of the studied soil parameters *viz.*, bulk density, porosity, hydraulic conductivity, pH, organic carbon content, electrical conductivity and available nutrients (NPK) recorded non significant variations along distances and seasons.

The study suggested further research on the impact of gas flaring on effect of light intensity, biological properties of soil, tea yield, pest and disease infestation, etc.

## **Scope of Augmenting Farmers' Income in Small Tea Plantations - A case study in Titabor sub-division of Jorhat district**

*Shyamal Kishore Bordoloi*

The study entitled “Scope of Augmenting Farmers’ Income in Small Tea Plantations- A case study in Titabor Sub Division of Jorhat district” was undertaken with the following objectives: 1. To study the socio-economic status of the small tea growers 2. To examine the existing farming systems and utilization of resources 3. To identify the constraints and measures for augmenting the farm income. The present study was conducted in Titabor Sub division of Jorhat district, which include two development blocks *viz.* Titabor development block and Jorhat East development block. The sample selection was done using Stratified Random Sampling technique, for which information was collected from Primary sources and Secondary sources. Primary data were collected through interview technique with structured interview schedule prepared by the researcher. The socio economic status study of the small tea growers revealed that major section of the farmers belong to the age group 15-60 years (62.85%) where involvement of male was found to be highest (59.11%) and most of the farmers had educational qualification of HS standard (37.34%) where females constitute the highest (51.91%). The study on farming systems revealed that in the study area the researcher found five types farming systems *viz.* Tea, Field & Horticulture crops, Plantation crops excluding tea (FS-I), Tea, Field & Horticulture crops, Plantation crops excluding tea, Fishery (FS-II), Tea, Field & Horticulture crops, Fishery (FS-III), Tea, Field & Horticulture crops (FS-IV) and Tea, Plantation crops excluding tea (FS-V). Among the farming systems the no. of respondents was found to be highest in FS-I and lowest in FS-IV. The variable cost involved in various farming systems was found to be highest in FS-II (Rs. 163946.96 farm-1yr-1) and was lowest in FS-IV (Rs. 52420.20 farm-1yr-1) whereas after doing ANOVA single factor analysis of the Benefit Cost ratios, it was found that FS-II has the highest mean value (2.92) and FS-IV has the lowest mean (0.89) which was due to variation in inclusion of different components in the farming systems. Studying the various constraints, it was found that the number of physical

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constraints were highest and social constraints were lowest, from where it can be analysed that there is a great scope of overcoming the constraints as major constraints was found under physical category which can be rectified by following proper farming practices. Small tea growers of the study area had a wide scope of augmenting the income from their limited farm resources by following proper cultivation practices, moving towards organic tea cultivation, forming farmer producer company through which they can collectively bargain for inputs and sell the tea in a common platform. Involving high yielding varieties of other components, crop rotation, diversification of enterprise, proper utilization of fallow land and market consciousness can help in increasing the income from the other components other than tea.

## **Master of Fishery Science**

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- **Aquaculture**
- **Aquatic Environment Management (AEM)**
  - **Fisherise RespurceManagement (FRM)**

## **Effect of vermiwash on plankton production and growth performance of *Labeo catla* (Hamilton, 1822)**

*Dibakar Gogoi*

An experiment was conducted for plankton production by using different concentration of vermiwash for 45 days in 12 FRP tanks. Three treatments alongwith one control in triplicate were tried: fertilization with traditionally used fertilizer (control), fertilization with 5 ppt of vermiwash (T1), fertilization with 10 ppt of vermiwash (T2) and fertilization with 15 ppt of vermiwash (T3). The major aims of this research were to find out the effect of different concentrations (5ppt, 10ppt and 15ppt) of vermiwash on productivity of phytoplankton and zooplankton of fresh water. Sampling was done after 7, 15, 30 and 45 days after fertilization. Both qualitative and quantitative analysis of plankton density was recorded during the experimental period. A total number of 26 different genera of plankton groups were recorded in all the experimental tanks. Among that phytoplankton groups Bacillariophyceae (5 genera) and Chlorophyceae (7 genera) population were most abundant followed by Cyanophyceae (5 genera) and Euglenophyceae (2 genera). Zooplankton community comprised at seven (7) genera belonging to Rotifera (3), Cladocera (2) and Copepoda (2) were recorded in all the treatments along with the control. The highest number of plankton productivity was recorded in T3 i.e. fertilized with 15 ppt vermiwash. The second experiment was conducted with the best concentration of vermiwash i.e. T3 from the first experiment for the growth performance of *Labeo catla* fry for a period of 60 days in 6 FRP tanks where three FRP tanks were used as treatment and the rest three FRP tanks were used as control with traditionally used fertilizer. Each of the 6 FRP tanks were stocked with fry of *Labeo catla* with the average weight of  $1.32 \pm 0.09$  gm. Sampling was done at 15 days interval during the experimental period. Specific growth rate was highest ( $p < 0.05$ ) in treatment (2.12%) than control (1.34%). Average weight gain of catla fry was highest in treatment (257.6%) than control (125.4%). Average survivability value was highest in treatment (94.67%) than control (90.67%). Improved FCR value was observed in treatment (1.04) compared to control (1.24).

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# **Effect of Stocking Densities on the Growth Performance of Indian Major Carps and Water Quality Parameters in Short Duration Fish Culture**

*Hasina Momtaz*

The present study was conducted to compare the growth performance of the three Indian major carps (IMC) at different stocking densities under short duration fish culture technique. The experiment was carried out in equal size (5.64 m×3.75 m×1.2 m) rectangular cement cisterns in the fish farm of College of Fisheries, Raha for a period of 90 days. The cisterns were prepared two weeks prior to stocking with fish, following the guidelines mentioned in package of practices for composite fish culture. All the cisterns were cleaned and dried in sun and provided with 6 inches of soil bed. Lime was applied @500 kg/ha and the cisterns were filled with filtered groundwater to a depth of 1.0 m ± 5 cm. After 5 days of lime application, all the experimental cisterns were fertilized with a mixture of raw cow dung (RCD), mustard oil cake (MOC), single super phosphate (SSP) and vitamin-mineral @0.01 kg/m<sup>3</sup>, 0.035 kg/m<sup>3</sup>, 0.0025 and 0.02 kg/m<sup>3</sup> respectively. The liming and fertilization were repeated at every 10 days interval during the experimental period. For carrying out the experiment, three treatments with stocking densities @4 fish/m<sup>3</sup>, 5 fish/m<sup>3</sup> and 6 fish/m<sup>3</sup> were taken as T1, T2 and T3 respectively. TC with stocking density @1 fish/m<sup>3</sup> was considered as reference treatment to compare with the growth performances under different stocking densities. Each treatment was conducted in triplicate. The cisterns were stocked with yearlings of IMC and stocking ratio in all the cisterns were 40%, 50% and 10% of catla, rohu and mrigal respectively. During the experimental period, the fishes were fed with a mixture of rice polish, mustard oil cake (MOC) and premixed vitamin-mineral containing 24% crude protein @3% of body weight twice daily. The study showed that the growth performances of IMC under short duration culture varied significantly (p<0.05) at different stocking densities. Though the net weight gain, average daily growth rate, SGR and feed utilization of all the three species decreased with increasing stocking densities, the net yield and economic performances increased at higher stocking densities. The

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results indicated that the T2 treatment with stocking density @5 fish/m<sup>3</sup> showed highest yield and benefit-cost ratio and hence considered to be economically more profitable. The physico-chemical parameters of water like temperature, pH, dissolved oxygen, free carbon dioxide, hardness, alkalinity and nitrogenous wastes were examined at every 10 days interval. Though the values differed with stocking densities, they were observed to be within the tolerance limit for IMC in all the treatments throughout the experimental period.

# **Effect of stocking densities on growth performance and survivability of Amur Carp (*Cyprinus carpiohaematopterus*) in floating cage environment of a floodplain wetland of Morigaon District**

*Homen Saikia*

An experiment was conducted for a period of three months from October to December, 2020 at Jaluguti beel, District-Morigaon, Assam to determine the optimum stocking density of Amur Carp (fry of genetically improved common carp) reared in 12 nos of floating cages of size 48m<sup>3</sup> (6m x 4m x 2m), where 15 fish m<sup>-3</sup>, 20 fish m<sup>-3</sup>, 25 fish m<sup>-3</sup> and 30 fish m<sup>-3</sup> were set as the different stocking densities designated in treatment (T 1), (T 2), (T 3) and (T 4) respectively in triplicates. The mean initial length and mean initial weight of the fry used in the experiment were 1.90±0.05cm, 1.96±0.03cm, 1.90±0.05cm, 1.90±0.05cm and 0.17±0.01g, 0.18±0.01g, 0.17±0.01g and 0.17±0.01g for treatment (T 1), (T 2), (T 3) and (T 4) respectively. Whereas, the mean harvesting length and weight in treatment (T 1), (T 2), (T 3) and (T 4) recorded were 14.96±0.03cm, 14.66±0.03cm, 13.96±0.03cm, 13.36±0.03cm and 53.03±0.01g, 42.79±0.14g, 33.20±0.10g, 29.31±0.10g respectively. After three months of rearing, final length and weight gain was found to be highest at lowest stocking density treatment (T 1) and lowest at the highest stocking density treatment (T 4) with significance differences among the treatments (p<0.05). Further, specific growth rate (SGR) and survivability % were found to be the highest at lowest stocking density (T 1) and lowest at the highest stocking density (T 4) with significant differences (p<0.05) among the treatments. Feed conversion ratio (FCR) values were adversely affected with the increase in stocking density. FCR value was found to be the lowest as 1.74±0.03 in (T 1) and highest in (T 4) as 2.11±0.01. The concentration of Ammonia-nitrogen recorded under present study showed that it had an adverse impact on the fish growth. Ammonia concentration was found to be increased due to increased stocking density from (T 1) to

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(T 4 ) @ of 15m<sup>-3</sup> to 30m<sup>-3</sup> . The other water quality parameters recorded in the different treatments did not vary significantly and was almost in the acceptable range conducive for fish culture. Hence it can be assumed that due to higher stocking density there was an increase in Ammonia concentration which might be the reason for the reduction in growth of fish in (T 4 ). The gross yield 39.41±0.02 kg and benefit cost ratio (1.73) were found to be the highest in (T 2 ) among all the treatments. Thus, economics of operation was considered to be most important criteria in deciding the optimal stocking density for raising Amur Carp fry in cages in a seasonally open beels of Assam having similar ecological characteristics like Jaluguti beel.

# **Growth Performance and Digestive Physiology of Amur Carp (*Cyprinus carpio* var. *haematopterus*) Fingerlings Reared in Biofloc Zero Water Exchange System**

*Imlichuba Imchen*

A 90 days experiment was carried out to evaluate the effects of biofloc on the growth performance, digestive physiology of Amur carp fingerlings reared in zero-water exchange system. The experiment was conducted with three biofloc treatments and one control with triplicate maintained in 500 L FRP circular tanks. Three hundred fingerlings were randomly distributed in 12 tanks, with an average body weight of  $14 \pm 0.11$  g and were stocked at 25 fingerlings per tank and fed with pelleted feed at 100% daily feeding rate in control which was taken as 3.5% of the total body weight of fish, biofloc+75% daily feeding rate in T-I, biofloc+50% daily feeding in T-II and biofloc+25% daily feeding rate respectively. At the end of the experiment, the results indicate that the highest weight gain was observed in BFT 75% and control which was significantly higher ( $P < 0.05$ ) than the other treatment groups. Survival of the Amur carp was not affected in the different treatments and ranged between 94.67% and 100%. The nitrogenous compounds had a negative correlation with the biofloc value. The protease activity was highest in biofloc+75% which showed significant difference ( $P < 0.05$ ) compared to the control and other treatments. The lipase activity was higher in control, biofloc+75% and biofloc+50% as compared to biofloc+25% treatment, lipase activity showed no significant difference ( $P > 0.05$ ) between the treatments. The amylase activity was higher in control and biofloc+75% compared to the other treatments which showed significant difference ( $P < 0.05$ ) between the treatment tanks. Rotifers, cladocerans, copepod, microalgae were identified in all the biofloc treatment tanks. The results obtained in this experiment suggests that jaggery can be used to maintain the C:N ratio as well as the nitrogenous compounds and enhance the biofloc production which improved the water quality and resulted in the enhancement of growth performance and digestive physiology of the Amur carp fingerlings reared in zero-water exchange system with BFT 75% daily feeding rate.

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# **Effect of Diet on Growth, Haematology and Disease Resistance of Amur Carp (*Cyprinus carpio haematopterus*) Through Replacement of Rice Polish with Rice Beer Waste**

*Miss Astrica Phukan*

The objective of the research work was to determine the effect of feeding rate on growth performance such as specific growth rate, feed conversion ratio and protein efficiency ratio as well as haematological responses, such as RBC, WBC, Hb, Hct, MCV and MCHC and disease resistance of Amur carp (*Cyprinus carpio haematopterus*) against *Aeromonas hydrophila*. The experiment was conducted in cement cisterns with a water level of  $80 \pm 5$  cm for 120th days. Four different treatments viz. T-0, T-1, T-2 and T-3 were used in triplicates with 0%, 15%, 30% and 40% incorporation of rice beer waste respectively. Each tank ( $5.5\text{m} \times 4\text{m} \times 1\text{m}$ ) was stocked with 100 numbers of Amur carp fingerlings and were fed twice a day with pelleted diet. A fortnight interval physico-chemical parameters of water and growth of experimental fish were recorded and evaluated. In this study, Amur carp growth was significantly ( $p < 0.05$ ) higher in treatment T-3, which had 40% inclusion level of rice beer waste. Control with 0% inclusion of rice beer waste showed lowest growth of fish. The SGR (3.30 g), FCR (1.85) and PER (4.31) value showed comparatively better in T-3 treatment. Haematological parameters in different treatments were evaluated after the end of the experiment where treatment T-1 had the highest RBC count (3.20 million/mm<sup>3</sup>) and was significantly ( $p < 0.05$ ) different from all other treatments (T-2 and T-3). The maximum WBC count (13.30 thousands/mm<sup>3</sup>) was recorded in T-3, and the lowest (11.40 thousands/mm<sup>3</sup>) was found in T-1. The highest level of haemoglobin (7.93 g/dl) and hematocrit (27.38%) was found in treatment T-1, which had 15% inclusion rate of rice beer waste and was significantly ( $p < 0.05$ ) different from the other treatments. MCV value was found to be highest (133.67 fl) in control (0%) and highest value of MCHC (28.96 g/dl) showed in T-1 (15%), while the lowest MCHC was (26.57 g/dl) in

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T-2 (30%). At the end of the experiment, 120th days of experiment Amur carps were challenged with *A. hydrophila* at different dosages ( $10^{-2}$  to  $10^{-9}$  CFU/ml) to determine the mean lethal dose (LD50), which was calculated as  $10^{-7}$  CFU/ml. The fishes were challenged with the dose of *A. hydrophila* ( $2.53 \times 10^7$  CFU/ml) and RPS (Relative percentage survival) was calculated upto 10 days. The RPS value (51%) was the highest in treatment T-3. The present findings clearly indicated that incorporation with rice beer waste-supplemented diets not only influence fish growth but also interfere with hematological parameters and immunological response in Amur carp by enhancing non-specific defense mechanism in fish.

# **Effect of *Streblus asper* Lour. as Periphyton Substrate on Growth Performance of Jayanti Rohu (*Labeo rohita* Hamilton) and Amur Carp (*Cyprinus carpio* Haematopterus Temminck & Schlegel)**

*Mr. Kongkon Jyoti Bhuyan*

An experiment on comparative assessment of growth performance of Jayanti rohu and Amur carp in periphyton based aquaculture system was conducted for a period of 120 days in 12 rectangular cements tanks. Three treatments in four replicate were tried: only fertilization T0 (control), only periphyton as saura gach substrate T-I and periphyton plus supplementary feed (T-II). After liming and fertilizing each of the 12 cisterns, 24 fingerlings of Jayanti rohu and Amur carp (average initial weights of Jayanti rohu and Amur carp were  $20.27 \pm 0.45$  g and  $14.61 \pm 1.18$  g;  $11.48 \pm 0.11$  g and  $11.72 \pm 0.65$  g;  $14.53 \pm 1.72$  g and  $14.08 \pm 3.37$  g in T0, T-I and T-II respectively). Fishes were fed with rice polish and mustard oil cake at a ratio of 1:1 on a w / w basis and fortified with vitamin and mineral mixture at 1 % of total feed. Fishes showed significantly ( $p < 0.05$ ) higher mean weight gain in T-II, T0 and T-I ( $46.33 \pm 9.28$  g,  $44.52 \pm 8.75$  g and  $39.78 \pm 6.93$  respectively). The initial average weights were  $17.44 \pm 2.83$  g,  $11.6 \pm 0.12$  g and  $14.31 \pm 0.23$  g in T0, T-I and T-II respectively. The specific growth rate was found to be highest in T-II ( $2.30 \pm 0.07$  %) followed by T-I ( $2.18 \pm 0.20$  %) and T0 ( $1.84 \pm 0.09$  %). The survival rate of Jayanti rohu was significantly ( $p < 0.05$ ) higher in T-II ( $99.12 \pm 0.56$  %) followed by T-I ( $97.92 \pm 1.20$  %) and T0 ( $97.70 \pm 0.95$  %). The survival rate of Amur carp found to be higher in T-II ( $98.20 \pm 0.86$  %) followed by T-I ( $98.04 \pm 0.87$  %) and T0 ( $96.96 \pm 0.44$  %). compared to Amur carp, the survivality of Jayanti rohu was found to be higher in T-II. A total of 35 genera of periphyton were identified in the present study. Among them 24 genera of algal periphyton belonging to the Bacillariophyceae (8 genera), Chlorophyceae (10), Cyanophyceae (4) and Euglenophyceae (2) were identified as well as 11 genera of animal community belonging to Protozoa (2 genera), Rotifera (4), Copepoda (2), Cladocera (3) and macrobenthic

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invertebrate (1) were identified in treatment T-II. In T-I animal community groups were similar with T-II but in the case of Copepoda (1 genera) and Cladocera (2) were recorded in T-I from saura gach substrate. Study of water quality parameters in the different treatments trials revealed that some water quality parameters differed significantly (transparency, dissolved oxygen, ammonia- nitrogen, phosphate-phosphorous and periphyton biomass i.e. dry matter (DM), ash free dry matter (AFDM) and ash content) throughout the study.



## **Experimental Breeding Ofchanna Striatus (Bloch, 1793) Using Different Hormones Under The Agro-Climatic Condition of Assam**

*Rikki Bagra*

An experiment on induced breeding of *Channa striatus* in captivity using two different GnRH based synthetic hormones viz., Gonopro-FH and Ovafish and was injected intramuscularly. The experiment was conducted following a Completely Randomized Design (CRD). This study consists of three treatments i.e., low dose (0.2 and 0.4 ml/kg), medium dose (0.4 and 0.6 ml/kg), high dose (0.6 and 0.8 ml/kg) each dose with three replications for both the hormones. Brooders (2:1) male and female were injected with doses of 0.2 and 0.4, 0.4 and 0.6, 0.6 and 0.8 ml/kg body weight male and female respectively. All the doses induced the fish to breed. The efficacy of both the hormones was evaluated for the performance parameters such as spawning fecundity, fertilisation rate, hatching rate, latency period and incubation period were the highest ( $P < 0.05$ ) at medium dose (0.4-0.6 ml/kg). Outcomes of all the doses varied significantly with each other with the low doses of male female 0.2 and 0.4 ml/kg showed the least performance. Using Gonopro-FH more fecundity was achieved than compared to the Ovafish. Brooders injected with Ovafish has shown longer latency period of 23.73 to 27.73 hours and incubation period of 23.43 to 27.33 hours than the Gonopro-FH 21.46 to 25.46 hours and 22.5 to 25.33 hours respectively. With Gonopro-FH maximum fertilization rate was 88.68% and hatching rate was 86.06%, while for the Ovafish, fertilization rate was 87.09% and 79.43% of hatching rate was achieved. This study clearly shows that Gonopro-FH gave better results than the Ovafish in the captive breeding performance of *Channa striatus*.

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## **Effect of probiotic bacteria identified and characterized from gut of freshwater fish on growth performance of *Labeo rohita***

*Rubina Yasmin*

The present study was carried out to isolate, identify and characterize probiotic bacteria in the gut content of *Ctenopharyngodon idella* (Grass carp) and to study its effect on growth performance of *L. rohita* fingerlings by dietary administration for a period of 6 months. A total of 6 nos. of gram positive bacteria belonging to the genus, *Lactobacillus* spp. (3 nos.), *Bacillus* spp. (2 nos.) and *Staphylococcus* spp. (1 no.), were identified biochemically followed by molecular techniques. The identified isolates were subjected pH tolerance test, antibiotic sensitivity test, antimicrobial activity assay and enzymatic activity assay. The pH tolerance test performed showed that all the isolates were able to survive a low pH of 4.0. The pH range of the *Lactobacillus* spp. in the present study was found to be 4.0 to 9.0. The antibiotic sensitivity test showed that the isolates were sensitive towards Penicillin G, Ampicillin and Novobiocin. The *Lactobacillus* spp. was more sensitive towards all the antibiotics. The antimicrobial properties of the isolated bacteria was tested against two common bacterial fish pathogens *A. hydrophilla* and *P. putida* which showed that the strains of *Lactobacillus* spp. had inhibitory effect against both the pathogens. Two identified strains of *Lactobacillus* spp. were selected to evaluate its effect on the growth parameters of *L. rohita* fingerlings by dietary administration. The results showed that the growth of *Labeo rohita* was significantly increased by administration of *Lactobacillus* spp. fed with 5ml/kg of 106 cells/ml. The SGR% for *Labeo rohita* was found to be  $0.796 \pm 0.013$  and  $0.733 \pm 0.006$ , the average net weight gain was  $25.426 \pm 0.636$  g and  $21.629 \pm 0.106$  g, the average net length increment was  $11.453 \pm 0.243$  cm and  $10.089 \pm 0.169$  cm respectively for T1 and T2 with significant difference among the treatments (p-value  $< 0.05$ ) when compared with the control.

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The results of the present study conclude that *Lactobacillus* spp. isolated from the gut content of *Ctenopharyngodon idella* (Grass carp) could be used as a potential probiotic to improve the growth of *L. rohita*. It also open an arena to study the effect of single and conjoint *Lactobacillus* spp. in growth performance and immune response of fishes and its potential to be used in farmer's field in commercial basis.

# **Effect of Natural and Artificial Carotenoid for Colour Enhancement in Tiger Barb, *Puntigrus tetrazona* (Bleeker, 1855)**

*Shilparani Hazarika*

The present study was conducted to evaluate the effect of natural carotenoid (tubifex worm, bloodworm and turmeric powder) and artificial ( $\beta$ -carotene) carotenoid sources on colour enhancement, growth and survival of Tiger barb, *Puntigrus tetrazona*. The experiment was conducted for 90 days. All the carotenoid sources such as tubifex worm @ 100 % (T1D1) and 75 % (T1D2), bloodworm @ 100 % (T2D1) and 75 % (T2D2), turmeric powder @ 0.09 % (T4D1) and 0.2 % (T4D2) and  $\beta$ - carotene @ 0.015 % (T3D1) and 0.02 % (T3D2) were used in the experiment. Tubifex worm and bloodworm fed directly to the fishes, whereas other treatment diets incorporated with formulated feed containing 30 % crude protein. Diet without carotenoid supplementation served as control (T0). Each treatment diet was tried in triplicate. Ten numbers of fish were stocked in each aquarium and the fish were fed with experimental feed @ 2% of their body weight twice daily. At the end of the experiment, the total carotenoid content and the growth performance of fish were analysed. To measure the colour intensity total carotenoid was analysed by following the method of Olson (1979) and the digital analysis of fish skin was measured in Adobe Photoshop software. In the present study, the skin colour was significantly higher ( $P < 0.05$ ) in treatment (T1D1) ( $18.40 \pm 0.11 \mu\text{g/g}$ ) and the minimum was recorded in T0 ( $6.57 \pm 0.06 \mu\text{g/g}$ ) in terms of total carotenoid content and digital parameters (RGB and Lab scale). Among the treatments, the highest growth was recorded in T1D1 ( $1.76 \pm 0.03 \text{ g}$ ) but did not differ significantly ( $P > 0.05$ ) from T1D2, T2D1 and T2D2. Similarly higher weight gain ( $1.10 \pm 0.05 \text{ g}$ ), weight gain % ( $165 \pm 17.16$ ), SGR ( $1.01 \pm 0.06$ ) and lower FCR ( $2.76 \pm 0.16$ ) were observed in fish fed with diet T1D1. Among all the treatment diets, tubifex worm showed a more pronounced effect in terms of higher carotenoid content and growth performance, which was attributed to higher fat content of tubifex worm. Therefore, it is concluded that among all the tested diets, tubifex worm @100% level could be used in Tiger barb (*P. tetrazona*) diet as a pigment enhancer and growth promoter.

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**Abstract of M.Sc. Thesis**

**Department : Aquaculture**

**Major Advisor :**

## **Acute Toxicity Study of Silica Nanoparticles (SiO<sub>2</sub> -NPs) on *Cyprinus carpio* (Linnaeus, 1758)**

*Habiba Jahan Ahmed*

Silica nanoparticles (SiO<sub>2</sub> -NPs) are among the most widely used nanoparticles (NPs) in a variety of fields including medicines, consumer goods, biotechnological applications etc. Although studies on the toxicity of SiO<sub>2</sub> -NPs to human and mammalian cells have been published, the effects of SiO<sub>2</sub> -NPs on fish remain unknown. Therefore, the present study was intended to evaluate the acute toxicity, behavioural and hematological alterations in *Cyprinus carpio* (common carp) exposed to SiO<sub>2</sub> -NPs. The median lethal concentration (LC<sub>50</sub>) values were found to be 12553.05 mg l<sup>-1</sup>, 9142.07 mg l<sup>-1</sup>, 6637.24 mg l<sup>-1</sup> and 4479.11 mg l<sup>-1</sup> for 24 hour, 48 hour, 72 hour and 96 hour respectively, indicating SiO<sub>2</sub> -NPs to be relatively harmless. When exposed to lethal (96 hour LC<sub>50</sub>) concentration of SiO<sub>2</sub> -NPs, the fishes showed alterations in behaviour as well as hematological parameters. Behavioural changes such as abnormal opercular movement, imbalance swimming, hyperactivity, loss of buoyancy, lethargy, excess mucus secretion and fading of skin colour were observed during 96 hour of exposure. Hematological parameters like hemoglobin (Hb), packed cell volume (PCV) and total erythrocyte count (TEC) decreased with respect to control, while total leucocyte count (TLC) values increased initially and then decreased. The hematological indices such as mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) decreased while mean corpuscular hemoglobin concentration (MCHC) values increased with time in the present investigation. All the values were significantly different ( $p < 0.05$ ) during different exposure period except for MCHC values which did not exhibit any statistical difference ( $p > 0.05$ ). Overall, this report can be used in extending future research using fish as a model to assess the toxicity of SiO<sub>2</sub> -NPs to aquatic organisms.

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**Abstract of M.Sc. Thesis**

**Department : Aquatic Environment Management**

**Major Advisor :**

## **Assessment of Productivity and Fish Diversity of Dzii River of Kohima, Nagaland**

*Mr. Kedolhouse Kuotsu*

Dzii river is one of the important river of Nagaland, which flows through a length of about 35 km within the district of Kohima, before joining Sidzii river below Kijiimetouma village to form the Doyang river system. The present study was conducted for a period of 1 year starting from March, 2019 to February, 2020 with three sampling stations, elevation ranging from 867 MSL to 695 MSL, to evaluate the physico-chemical and biological parameters of the river system. The range of studied important physico-chemical parameters of Dzii river are surface water temperature (17-27o C), turbidity (4.9-97 NTU), water depth (0.75-1.5m), water velocity (0.20-0.75 ms<sup>-1</sup>), pH (6.4-7.8), total alkalinity (20-195 mgL<sup>-1</sup>), DO (6.37-11.41 mgL<sup>-1</sup>), COD (5.4-14.2 mgL<sup>-1</sup>), total hardness (62.72-190.85 mgL<sup>-1</sup>), TDS (43-165 mgL<sup>-1</sup>), EC (11.5-559 µScm<sup>-1</sup>), nitrate (0.011-0.214 mgL<sup>-1</sup>), phosphate (0.046-0.102 mgL<sup>-1</sup>), ammonia (0.009-0.035 mgL<sup>-1</sup>). The present study also revealed that primary productivity of the river system was below the productive range with GPP value ranging from 0.090 to 0.154 g C m<sup>-3</sup> d<sup>-1</sup> and NPP value from 0.041 to 0.071 g C m<sup>-3</sup> d<sup>-1</sup>. During the study period, a total 23 fish species belonging to 4 orders, 6 families and 13 genera were recorded. The order Cypriniformes was dominant with 17 species, followed by Siluriformes with 4 and 1 each from Anabantiformes and Synbranchyformes. Family Cyprinidae, contributes 60.86% of the total fish diversity of the river, which was found to be the most abundant family of fishes. According to IUCN conservation status (2017), of the 23 species, 1 species (*Tor putitora*) is Endangered (EN), 1 (*Schistura naganensis*) is Vulnerable (VU), 6 species are Not Evaluated (NE) and rest 15 are of Least Concern (LC).

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**Abstract of M.Sc. Thesis**

**Department : Aquatic Environment Management**

**Major Advisor :**

# **Effect of pH on Acute Toxicity of Synthetic Antioxidant Butylated Hydroxytoluene in Embryo of Zebrafish *Danio rerio* (Hamilton, 1822)**

*Nikimoni Borah*

BHT (3, 5-di-tert-butyl-4-hydroxytoluene) is a synthetic antioxidant which is used in food additive, cosmetics and plastic industries to increase the reliability of food and plastic. The production, use and release of these antioxidants can create contaminant source for aquatic ecosystem. Due to the global climate change temperature is increasing now a days and this increasing temperature impacts on water physicochemical parameters like dissolved oxygen level and pH, which could affect the toxicity of contaminants to aquatic organisms. Many toxins increase or decrease in toxicity due to water quality. The present study was undertaken to evaluate the effects of pH on toxicity of BHT in zebrafish (*Danio rerio*) embryo. Zebrafish embryos were exposed to five different level of pH (5, 6, 7, 8 and 9) with 6 different concentrations of BHT for 96 hour and lethal and developmental endpoints were assessed. LC50 values for 96 hour found in this study at pH 5 to 9 were 2.067 mg l<sup>-1</sup>, 2.453 mg l<sup>-1</sup>, 3.356mg l<sup>-1</sup>, 1.210mg l<sup>-1</sup> and 0.823mg l<sup>-1</sup> respectively. Developmental deformities observed in sub-lethal concentrations at pH 5 to 9 during 24, 48, 72 and 96 hour post fertilization were pericardial edema, yolk sac edema, deformed otolith, notochord deformation, accumulation of RBC and Spine deformities. In sub-lethal concentrations, heartbeat of zebrafish embryo increased at all pH and were significantly different (p<0.05) at pH 5, 8 and 9 when compared to control. Hence, the present study could be a best for future research using fish embryo as a model to determine the effect of other environmental parameters on acute toxicity of Butylated hydroxytoluene (BHT).

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**Abstract of M.Sc. Thesis**

**Department : Aquatic Environment Management**

**Major Advisor :**

# **Assessment of Environmental Integrity of Northern Plain Region of the River Umtrew (Digaru) in Meghalaya and Assam with special reference to its pollution status**

*Nishi Sarmah*

The current study presents an account of environmental integrity of northern plain region of River Umtrew (Digaru), Meghalaya and Assam. River Umtrew originates in Meghalaya traverses a distance of approximately 70 km and ultimately drains down to mighty Brahmaputra in Assam. Water and plankton samples were collected for twelve consecutive months (January 2019 to December 2019) from three stations of 30 km river stretch starting from Umtrew hydroelectric power site. During the study period, range of some of the important water quality parameters were: surface water temperature (16-32 °C), turbidity (4.4-69.5 NTU), dissolved oxygen (4.1-9.2 mgL<sup>-1</sup>), pH (6.5-7.9), total dissolved solids (24-238 mgL<sup>-1</sup>), total alkalinity (14-59 mgL<sup>-1</sup>), total hardness (20.02-65.06 mgL<sup>-1</sup>), BOD<sub>3</sub> (8.21-36.20 mgL<sup>-1</sup>), COD (14.40-60.08 mgL<sup>-1</sup>), nitrate (0.09-0.29 mgL<sup>-1</sup>), phosphate (0.028-0.45 mgL<sup>-1</sup>), total fecal coliform (7 to 1400 per 100 mL). A total 20 genera of plankton and some meroplanktonic forms like fish larvae and eggs were recorded from the river. Plankton density of the river was found to be poor and ranged between 8 and 48 unitsL<sup>-1</sup>. The study revealed that among the three stations environmental integrity of station 1 located near Umtrew Hydroelectric Project was maintained compared station 2 and 3 located near Burnihat industrial estate and Sonapur district hospital respectively. Consequently, pollution level of station 2 and 3 were also found to be higher compared to the 1<sup>st</sup> station. Discharge from Burnihat Industrial area, agricultural runoff and domestic waste discharge were identified as the main sources of pollution in stations 2 and 3. Total fecal count index indicated that surface water of the river falls under Category C having designated best use as drinking water with conventional treatment followed by disinfections. Principal Component Analysis revealed that among all the water quality parameters of the study, six parameters namely BOD<sub>3</sub>, COD, ammonia, alkalinity, turbidity and TDS are playing a distinctive role in determining the overall environmental condition of the river.

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**Abstract of M.Sc. Thesis**

**Department : Aquatic Environment Management**

**Major Advisor :**



# **Assessment of Acute Toxicity in Fresh Water Cypriniform *Cyprinus carpio* (Linnaeus, 1758) Exposed to a Commercial Neem based Biopesticide**

*Rituparna Borah*

Pesticides are the leading polluting agents of aquatic ecosystems. Pesticide residue in natural water bodies may affect indigenous ichthyofauna as well as human health. Azadirachtin, a pesticide derived from the neem tree (*Azadirachta indica*), is a highly effective and widely used pesticide. The present study investigated acute toxicity, behavioural and biochemical compounds in common carp (*Cyprinus carpio*) exposed to Azadirachtin. The acute toxicity test was performed according to the standard methods EPA (1996) and the 24, 48,72 and 96 hours LC 50 values of Azadirachtin for *Cyprinus carpio* were estimated as 3.924 mg/l, 2.858 mg/l, 2.075 mg/l and 1.414 mg/l respectively. The study also recorded the behavioural changes that were observed during 24, 48,72 and 96 hours of exposure period like hyper excitability, enhanced opercular movement, fin movement, enhanced mucus secretion, imbalanced swimming, loss of reflex, lethargy etc. Serum biochemical compound such as total serum protein, serum glucose and serum albumin were analyzed with 96 hours LC 50 value (1.414 mg/l) of Azadirachtin. Significant reduction in values was obtained for total serum protein and albumin while significant increase was observed in glucose. However, statistical significance ( $p < 0.05$ ) was observed during 24, 48, 72 and 96 hours for total serum protein, serum glucose and serum albumin.

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**Abstract of M.Sc. Thesis**

**Department : Aquatic Environment Management**

**Major Advisor :**

# **Acute Toxicity of Synthetic Pyrethroid Pesticide Cypermethrin in Developing Zebrafish (*Danio rerio*) (Hamilton-Buchanan, 1822) Embryo**

*Ruhul Amin*

Cypermethrin (CP) is a type II pyrethroid that is used to protect economically important crops such as cotton, fruits, and vegetables from a wide range of insects. Pyrethroid pesticides have been applied to agriculture and aquaculture since the 1970s to replace traditional pesticides. However, pyrethroids are approximately 1000 times more toxic to fish than to mammals and birds. In the present investigation, an attempt has been made to determine median lethal concentration (LC 50 ), effective concentration (EC 50 ) and Teratogenic Index of a 10% cypermethrin commercial formulation on developing zebrafish embryo. The 96-hour LC 50 value was calculated as 0.129 ppm and EC 50 value was found to be 0.028 ppm. The abnormalities like pericardial edema, yolk sac edema, tail deformity, decrease body, eye pigmentation and axial malformation (notochord bending) were observed in zebrafish embryo exposed to different concentrations of CP. The heartbeat and heart size changed significantly ( $P < 0.05$ ) at higher concentrations and exposure time. The Teratogenic Index (TI) was calculated to be 4.607 which implies that the compound may be a probable teratogen. As a result, the findings of this study show that cypermethrin can have a negative impact on the early developmental stages of zebrafish. The current study opens future scope for research on its acute as well as chronic effects.

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**Abstract of M.Sc. Thesis**

**Department : Aquatic Environment Management**

**Major Advisor :**

# **An Assessment of Carbon Sequestration of a Floodplain Wetland (48 No. Thekera beel, Morigaon District) of Central Brahmaputra Valley Zone, Assam**

*Rupam Jyoti Nath*

Floodplain wetlands are dynamic ecosystem and play a very important role in regulation of green-house gases by the mechanism of carbon sequestration. It also plays a vital role in carbon cycling, cycling of water and nutrients, food production for aquatic organism, provision of habitats, water purification, regulation of flows, and so on. The present study was carried out in a seasonally open floodplain wetland (48 No. Thekera wetland) in Morigaon district of Assam, to assess the estimated carbon sequestration rate of the wetland which was 1.57 Mg C ha<sup>-1</sup> yr<sup>-1</sup>. However, the total sediment organic carbon levels up to 10 cm depth in the wetland was 17.40 Mg C ha<sup>-1</sup>, which was 2.6 times higher than that deposited up to 10 cm depth in the upland reference soil (6.57 Mg C ha<sup>-1</sup>). The total C content was found to be 13.43 Mg C ha<sup>-1</sup> in 10-20 cm and 10.55 Mg C ha<sup>-1</sup> in 20-30 cm. The current study also revealed that sediment organic carbon decreased progressively with depth from 0 to 30 cm. SOC content of 48 No. Thekera beel ranged from 0.69 to 1.05% during pre-monsoon, 0.58 to 0.93% during monsoon, 1.11 to 1.32% during post monsoon, and 0.83 to 1.14% during winter seasons, where minimum value was recorded during monsoon and maximum value was recorded during post-monsoon.

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**Abstract of M.Sc. Thesis**

**Department : Aquatic Environment Management**

**Major Advisor :**

# **Study on Ichthyofaunal Diversity and Physicochemical Parameters Downstream of Hydroelectric Power Project Dam of Subansiri River, Assam**

*Imran Hussain*

The present study on ichthyofaunal diversity and physico-chemical parameters downstream of Subansiri river, Lakhimpur district of Assam was conducted for a period of 1 year from April, 2020 to March, 2021. Altogether 55 fish species belonging to 42 genera, 24 families and 10 orders were recorded from the river. The largest group Cypriniformes contributed 3 families (12.50%), 15 genera (35.71%) and 20 species (36.36%). The fish diversity of river Subansiri is mainly dominated by Barils (*Barilius bendelisis*, *Opsarius barna*), Barbs (*Puntius terio*, *P. sophore*, *P. chola*), Loaches (*Acanthocobitis botia*, *Lepidocephalichthys guntea*), carps (*Labeo gonius*, *L. calbasu*, *L. bata*, *L. rohita*, *Cirrhinus mrigala*) and miscellaneous species (*Nandus nandus*, *Glossogobius giuris*, *Chaca chaca* etc.). As per IUCN conservation status, 51 (92.72%) species were recorded as Least Concern, 2 (3.64%) species under near threatened, 1 (1.82%) species under vulnerable and 1 (1.82%) species under endangered category. Margalef's richness index (d) was found to be the highest in Monsoon at station 3 (9.098) and the lowest again at station 3 (7.942) in the pre-monsoon season. Buzas and Gibson's evenness index (E) was found to be the highest at station 1 (0.8359) in post monsoon and the lowest at station 1 in monsoon season (0.763). The Shannon-Weiner index (H') was found to be the highest in pre monsoon season at station 2 (3.668) and the lowest in post monsoon season at station 2 (3.479). The Simpson index ( $1 - \lambda$ ) was found to be the highest in pre monsoon season at station 2 (0.9702) and the lowest in post monsoon season at station 2 (0.9635). It indicates a diverse fisheries potential of the river and rich distribution of fishes across the river. Altogether 40 genera belonging to 34 families, 25 orders under 12 classes recorded from 3 different stations of Subansiri river. Bacillariophyceae formed the largest group with a contribution of 7 orders (28%), 10 families (29.41%) and 11 genera (27.5%). The planktonic groups of Subansiri mainly dominated by Naviculales (*Craticula*, *Frustulia*, *Navicula* and *Pinnularia*), Desmidiaceae

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**Abstract of M.Sc. Thesis**

**Department : Fisheries Resource Management**

**Major Advisor :**

(Closterium acutum, Closterium incurvum, Cosmerium and Penium), Fragilariales (Fragillaria, Synedra, Tabellaria flocculosa) and Cladophorales (Pithophora, Cladophora, Rhizoclonium) etc. The mean value with regard to physico-chemical parameters of river Subansiri were moderate surface water temperature, (14.6 °C - 24.0 °C), slightly acidic to moderately alkaline pH (6.05-8.14), dissolved oxygen (4.10 - 6.81 mg/l), total dissolved solids (55.6- 153.2 mg/l), specific conductivity (70.8-164.1  $\mu$ S/cm), moderate total alkalinity (35.64- 82.45 mg/l), water current (1.30- 2.15 m/sec) and water transparency (30.4-54.2 cm). Thus the different water quality parameters recorded indicate a favorable condition for the growth of aquatic organism nearly round the year.

# **Study on Ichthyofaunal Diversity and Physico-Chemical Parameters of a Floodplain Wetland (Jaluguti Beel, Morigaon District, Assam) of Central Brahmaputra Valley Zone**

*Sheetala Chintey*

The present study was conducted to evaluate the ichthyofaunal diversity and habitat ecology of Jaluguti beel, Morigaon district of Assam, for a period of one year from May, 2020 to April, 2021. A total of 46 fish species belonging to 33 genera, 19 families and 7 orders were recorded from the beel. The order Cypriniformes comprised of 3 families (15.79%), 14 genera (45.71%) and 20 species (43.48%) contributing to the total. Six families (31.58%), 7 genera (20%) and 9 species (19.57%) made up the order Perciformes. With 5 families (26.32%), 6 genera (17.14%) and 10 species (21.74%), the order Siluriformes contributed a significant portion to the total number and percentage composition of the beel, followed by Synbranchiformes with 2 families (10.53%), 3 genera (8.57%) and 4 species (8.70%), and the orders Clupeiformes, Osteoglossiformes and Beloniformes were represented by 1 family (5.26%), 1 genera (2.86%) and 1 species (2.17%) each. Fisheries of Jaluguti beel was mainly dominated by *Parambassis ranga*, *Chanda nama*, *Pachypterus atherinoides*, *Chela cachius*, *Salmostoma bacaila*, *Amblypharyngodon mola*, *Mystus bleekeri* and other miscellaneous species. Under IUCN conservation status (2021), the highest species were recorded under Least Concern (LC) category with a total number of 37 and contributed 80.43%. Under LC category, majority of the species belonged to the family Cyprinidae with 13 (28.26%) followed by Bagridae 4 (8.70%), Mastacembelidae and Channidae 3 (6.52%), Cobitidae and Ambassidae 2 (4.35%) each. Balitoridae, Notopteridae, Clupeidae, Heteropneusteidae, Schilbeidae, Synbranchidae, Nandidae, Gobiidae, Osphronemidae and Belonidae with 1 species contributed 2.17% each. Under Near Threatened (NT) category Siluridae and Cyprinidae contributed 3 (6.52%) and 1 (2.17%) species, respectively. Under Data Deficient category both Anabantidae and Cyprinidae

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**Abstract of M.Sc. Thesis**

**Department : Fisheries Resource Management**

**Major Advisor :**

contributed 1 (2.17%) each and under vulnerable, endangered and near threatened category contributed 1 (2.17%) each. Margalef's Richness Index (d), Pielou's Evenness Index (J), Shannon -Weiner Index (H') and Simpson Index (1- $\lambda$ ) indicated high fish diversity in the beel, with a more or less even distribution of fish genera indicating that the beel was in good condition for fish production. During the study period, a total of 20 genera of phytoplankton and 13 genera of zooplankton were recorded in the beel. Bacillariophyceae dominated among the phytoplankton and rotifera were dominated among the zooplankton group. The majority of physico - chemical parameters were found to be in a favorable range for aquatic species growth and reproduction. Water temperature of Jaluguti beel were ranged from 18.4 °C to 29.8 °C, water pH from 5.5 to 7.3, dissolved oxygen from 4.5 mg/l to 6.9 mg/l, total alkalinity from 42.10 mg/l to 68.10 mg/l, total hardness from 50.0 to 69.2 mg/l, specific conductivity from 83.7  $\mu$ S/cm to 110.0  $\mu$ S/cm, free carbon dioxide from 5.3 mg/l to 9.6 mg/l, turbidity from 3 NTU to 4.7 NTU, and ammonia-nitrogen were ranged from 0.14 mg/l to 0.19 mg/l Anthropogenic activities in the beel such jute retting, household and domestic wastage, dumping of salted water used in drying fish at beel periphery may pose threats to the fish diversity of the beel.

## **Master of Science (Home Science)**

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- **Extension and Communication Management**
  - **Family Resource Management**
    - **Food Science and Nutrition**
- **Human Development and Family Studies**
  - **Textile and Apparel Designing**



## **Knowledge, attitude and practice of students towards spiritual life skills**

*Birina Das*

The present research study entitled “Knowledge, attitude and practice of students of towards Spiritual Life Skills” was carried out in main campus of Assam Agricultural University, which is situated in the Jorhat district of Assam. The objectives of the study were: i) to study the preliminary information of the respondents ii) to measure the knowledge of the respondents about spiritual life skills iii) to find out the attitude of the respondents towards spiritual life skills and iv) to find out the practice of spiritual life skills among the respondents. A total of 126 students pursuing Master of Science and Doctor of Philosophy were selected as respondents from College of Agriculture and College of Community Science using Stratified Random Sampling technique. Knowledge Scale for measuring the knowledge of the respondents on Spiritual Life Skills and an Attitude Scale for measuring the attitude of the respondents towards Spiritual Life Skills were constructed by using item analysis, validity test and reliability test. In order to find out the practice of Spiritual Life Skills among the respondents, a questionnaire was developed based on the constructed and standardized Knowledge Scale. Data were collected by using the constructed questionnaire and analyzed using appropriate statistical techniques viz., frequency, percentage, mean, standard deviation, z test, Chi-square test, Phi Cramer’s V test and Pearson’s correlation analysis. The data revealed that 65.00 per cent were female and 35.00 per cent were male. 49.20 per cent of the respondents possessed open personality, 94.45 per cent of the respondents have an optimistic type of thinking. 69.06 per cent of the respondents preferred friendship of good and 76.98 per cent maintained a positive relationship with their sibling. The data further revealed that majority (51.67%) of the respondents have moderate knowledge level on spiritual life skills, similarly majority (62.50%) of the respondents belonged to the moderate category of practice level of spiritual life skills. 61.11 per cent, which is the majority of the respondents were found to have a favorable attitude towards spiritual life skills. Independent variables: ‘age’ of the respondents was found to be positively correlated with dependent variable ‘knowledge’ of the respondents but was not correlated to ‘attitude’ and ‘practice’ of the respondents. Higher

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**Abstract of M.Sc. Community Science**

**Department : Extension & Communication Management**

**Major Adviser: Dr. Daisy Hazarika**

the age of the respondents, higher was the knowledge of respondents on spiritual life skills. Positive correlation was also found between dependent variables: knowledge and attitude, knowledge and practice and attitude and practice of the respondents. The independent variables: 'sex', 'religious belief', 'spiritual belief', 'personality of the respondents' and 'meditating habit of the respondents' were found to be significantly associated with dependent variable 'knowledge' at 5% significance level. The independent variables: 'type of thinking' and 'sibling relationship' was found to be associated with dependent variable 'attitude' at 5% significance level. Again, the independent variables: 'type of thinking', 'sibling relationship', 'curiosity to learn spiritual life skill' and 'family spiritual belief' were found to be associated with 'practice' of spiritual life skills among the respondents at 5% level of significance. The study gives a thorough overview on knowledge, attitude and practice of the respondents towards spiritual life skills. Future research can be conducted to study the impact of spirituality on college students.

# **Effect of Bandhan Microfinance on Empowerment of Rural Women in Tinsukia district of Assam**

*Inameeka Baruah*

The study on Effect of Bandhan Microfinance on empowerment of rural women in Tinsukia district of Assam was conducted with the objective (i) To develop a complete understanding of members of Bandhan groups, (ii) To study the functioning of Bandhan microfinance, (iii) To identify the problems faced by the respondents after availing the microfinance services (iv) To assess the effect of Bandhan microfinance on empowerment of rural women. The present study was conducted in Tinsukia district of Assam. Margherita Sub-division, was purposively selected from where two Bandhan banking units i.e., Banking Unit, Digboi and Banking Unit, Margherita was included. 108 respondents were selected using purposive cum simple random sampling method. The study revealed that 60.00 per cent of the respondents were in middle age group 35 – 47 years. It was found that 41.68 per cent had farming as their family occupation, 30.55 per cent did business and majority of the respondent (73.05%) were housewives. About 49.70 per cent respondents were members of the Bandhan group for 1-5 years which depicts their trust towards Bandhan Microfinance. Majority of respondents (70.37%) joined Bandhan group to maintain their household expenditure. High percentage of respondents (78.70%) have taken loan from Bandhan microfinance for starting new business of livestock at household level as they possessed 89.91 per cent of poultry birds and the respondents utilized their loan in business purpose as well. It was revealed from the findings that large percentage (71.00%) respondents belonged to medium socio-economic category. As only 31.48 per cent and 20.30 per cent had knowledge about the terms of repayment and the interest rate respectively so, the most common problem faced by the respondent after availing the loan from Bandhan microfinance services is short period for repayment and not clear about the interest rate. The findings also revealed that there was significant improvement in economic, psychological, personal and socio-cultural empowerment whereas there was less improvement in terms of political empowerment after availing loan from Bandhan Microfinance services. There was also an overall increase in the level of empowerment of rural women after availing

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**Major Adviser: Dr. Mayuri Bora**

the Bandhan Microfinance services. In the study a positive significant relationship can also be seen between the socio-economic status and the empowerment of rural women. Thus, Bandhan microfinance has significantly contributed towards the empowerment of the rural women in the study area. Therefore, Proper training should be given to the rural people regarding the terms, conditions, the bank loan formalities and the interest charged on the loans should be reduced to encourage and attract new customers. Further research should be done considering other microfinance related issues and how these issues affect the empowerment of rural women.

## **Problems faced by undergraduate students of Assam Agricultural University in obtaining scholarships**

*Santosh*

Various academic scholarship schemes were introduced by the Government of India with the aim to empowering and inspiring students to do excel in academic and to provide financial support to low income group students. But students are not much aware about scholarship schemes and encounter many problems in getting scholarship. With this background the present study entitled “Problems faced by undergraduate students of Assam Agriculture University in obtaining scholarships” was conducted with the specific objective: 1.To study the background characteristics of the respondents. 2. To assess the level of awareness of the respondents regarding different scholarship. 3. To explore the types of scholarships availed by the respondents. 4. To find out the problems faced by respondents in obtaining scholarships. Two colleges were selected purposively for the present study. Equal number of respondents selected from each of the selected colleges through stratified random sampling. Thus the total number of respondents was 240. Data were collected through the self-prepared questionnaire and analysed using appropriate statistical test and techniques i.e. frequency, percentage, mean, standard deviation and chi- square. The data revealed that highest percentage of respondents (59.20%) were in the age group of above 20 years, majority of the respondents (70.40 per cent) were female, 42.50 per cent of respondents belonged to general caste, 90.00 per cent of respondents were Hindu, 49.60 of the respondents belonged to urban area, 75.80 per cent of the respondents’ mother tongue was Assamese, 28.40 per cent of respondent had family income above rupees five lakhs, 52.90 per cent of the respondent got admission in 1stcounseling, 75.40 per cent of the respondents got orientation after getting admission. Finding further showed that majority (88.75%) of respondent was aware about State Merit Scholarship followed by 83.75 per cent of respondents about IshanUdya scholarship, 53.33 per cent respondents were aware about National Talent Scholarship whereas 2.91 per cent about Financial Support to the Economically Backward Students of AAU. Majority of the respondents

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**Abstarct of M.Sc. Community Science**

**Department : Extension & Communication Management**

**Major Adviser: Dr. Mayuri Bora**

i.e. 90.00 per cent had senior as source of awareness. Around 50.00 per cent respondents were availing IshanUday scholarship from College of Agriculture whereas the corresponding percentage for College of Community Science was 42.59. The data on problems faced by students in availing scholarship indicated that 52.92 per cent had faced moderate level of problem. Among the problems related to submission 'Detail information of the scholarship was not known' ranked I with mean score 0.42 whereas 5 out of the problems related to amount and regularity of receiving the scholarship 'Delay in receiving the scholarship' ranked I with mean score 0.51. Association between college and awareness regarding State Merit Scholarship of the respondents was significant ( $p < 0.05$ ) and IshanUday scholarship with class of respondents was highly significant ( $p < 0.01$ ).

# **Prevalence of work related musculoskeletal disorder of women involved in Papad Making industry of Ganjam, District, Odisha**

*Smruti Rekha Panigrahi*

Cottage industry is one of the most employment generating sector which is predominantly performed in rural household by rural women. The present study entitled “Prevalence of work related musculoskeletal discomfort of women involved in papad making industry of Ganjam district, Odisha.” Was proposed with following objectives: (1) To study the activity profile of women involved in home based papad making industry. (2) To evaluate the posture assumed by workers in selected activities of papad making process. (3) To assess perceived discomfort of workers in papad making process. (4) To analyze the work related musculoskeletal disorders prevalent among the workers. (5) To suggest ergonomic recommendations for enhancing comfort of workers.

For this study a total of 120 samples were selected from 3 villages of blocks of Ganjam district, Berhampur city by multistage random sampling. Both interview and observational method was used and collection of data was done through a questionnaire and still photography method (Rapid Upper Limb Assessment) RULA and (Ovako Working posture Analysis System) OWAS methods were also used for postural deviation. Information on general characteristics, activity profile and severity of musculoskeletal discomfort were collected. Further chi square analysis was done to determine the association between variables. Respondents were found to perform this activity on a daily basis and found that majority of 70% respondents work from 10am to 2pm. Workers perceived rolling to a very heavy sub activity among all other activities with highest mean score of 4.46. Musculoskeletal disorder was the major health problems of the workers. Analysis of MSDs revealed that hand pain (98.3%) was more predominant followed by wrist (95.8%) buttock (95%) and others. It was observed that there is a significant association between body part discomfort with age ( $p=0.000$ ) and years of involvement ( $p=0.000$ ). Association was also found between perceived discomfort of rolling sub activity with age ( $p=0.001$ ). RULA score in ball making and

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**Abstract of M.Sc. Thesis**

**Department : Family Resource Management**

**Major Advisor : Dr. Ruplekha Borah**

rolling were found to be in the level (5-6) and (7) respectively which mean further investigation and changes are required soon and investigation and changes are required now. While OWAS score for sun drying activity indicated that light stress and no immediate action is necessary but changes should be considered in future.



# **Development and quality evaluation of hydrothermally treated rice from Kaoi Jamfri – a red kernel rice of Assam**

*Mandeep Digra*

The present study was undertaken with an aim of developing of hydrothermally treated rice from Kaoi Jamfri - red kernel rice of Assam having potential nutritional benefits. The objectives of the study were to optimize the process variables for developing hydrothermally treated red rice and to evaluate the quality of the developed hydrothermally treated red rice. In the present study, eighteen hydrothermally treated Kaoi Jamfri samples namely T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T11, T12, T13, T14, T15, T16, T17, and T18 coded as T1:2 (1h), T1:3 (1h), T1:4(1h), T1:2(3h), T1:3(3h), T1:4(3h), T1:2(6h), T1:3(6h), T1:4(6h), T1:2(9h), T1:3(9h), T1:4(9h), T1:2(12h), T1:3(12h), T1:4(12h), T1:2(24h), T1:3(24h) and T1:4(24h), respectively were developed with processing variables such as paddywater ratio (w/v) i.e., 1:2, 1:3 and 1:4 and different soaking times i.e. 1 h, 3 h, 6 h, 9 h, 12 h, and 24 h. For soaking of the paddy, boiled distilled water (100 °C) was used for all the samples followed by draining water and steaming at 15 psi (121°C) in vertical autoclave for 20 min and drying in tray drier till 11-13% moisture content. The untreated paddy sample was considered as control T0 coded as T0. All the samples were dehusked and polished (6%) and analysed for moisture content; milling qualities such as dehusked rice yield, polished rice yield, head rice yield, broken rice yield; physical characteristics such as length/ breadth ratio, 1000 grain weight, bulk density, color intensity, and texture; cooking qualities, such as water uptake ratio, cooking time, and grain elongation ratio; biochemical parameters such as DPPH radical scavenging activity, total anthocyanin content, amylose content and resistant starch. The hydrothermally treated cooked rice samples were evaluated for parameters by sensory evaluation conducted by ten trained and semi-trained panelists from the Department of Food Science and Nutrition, Assam Agricultural University using nine-point hedonic scale. Data obtained from moisture, milling, physical, cooking and biochemical analysis were subjected to completely randomized design to determine differences between developed hydrothermally treated

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**Department : Food Science and Nutrition**

**Major Adviser: Dr. Pranati Das**

Kaoli Jamfri rice samples means by using ICAR WASP software. The moisture content of samples before soaking were found to be similar ( $p \geq 0.05$ ), after soaking and drying ranged from  $20.21 \pm 0.09\%$  in T2 to  $41.71 \pm 0.09\%$  in T18 and  $11.95 \pm 0.47\%$  in T8 to  $13.98 \pm 0.15\%$  in T5 respectively. The dehusked and polished rice yield of hydrothermally treated rice samples ranged from  $72.70 \pm 0.16\%$  in T0 to  $77.55 \pm 0.30\%$  in T18 and  $66.73 \pm 0.18\%$  in T0 to  $71.39 \pm 0.37\%$  in T17 respectively. The head and broken rice yield of hydrothermally treated rice samples ranged from  $54.31 \pm 0.41\%$  in T0 to  $96.79 \pm 0.85\%$  in T15 and  $2.12 \pm 0.10\%$  in T18 to  $814.92 \pm 0.14\%$  in T0 respectively. The length/ breadth ratio of the hydrothermally treated rice samples were statistically similar ( $p \geq 0.05$ ), 1000 grains weight samples ranged from  $13.23 \pm 0.06\text{g}$  in T0 to  $18.77 \pm 0.03\text{g}$  in T18, bulk density ranged from  $0.77 \pm 0.05\text{ g/ml}$  in T0 to  $0.88 \pm 0.05\text{g/ml}$  in T8, colour intensity ranged from  $30.05 \pm 0.02$  in T6 to  $39.11 \pm 0.04$  in T0. The hardness of the hydrothermally treated cooked rice samples were found to be similar ( $p \geq 0.05$ ). The water uptake ratio of the hydrothermally treated rice samples ranged from  $2.72 \pm 0.07$  in T0 to  $3.04 \pm 0.02$  in T18, cooking time ranged from  $20.45 \pm 0.60$  min in T18 to  $33.23 \pm 0.62$  min in T0, and elongation ratio among the samples were found to be non-significant ( $p > 0.05$ ). The DPPH radical scavenging activity (%) of hydrothermally treated uncooked and cooked rice samples ranged from  $14.42 \pm 0.07$  in T18 to  $24.23 \pm 0.51$  in T0 and  $6.48 \pm 0.12$  in T0 to  $7.37 \pm 0.16$  in T17 respectively. The total anthocyanin content of hydrothermally treated uncooked and cooked rice samples ranged from  $0.68 \pm 0.03\text{ mg/100g}$  in T18 to  $5.96 \pm 0.11\text{mg/100g}$  in T0 and  $0.45 \pm 0.06\text{ mg/100g}$  in T18 to  $1.74 \pm 0.06\text{ mg/100g}$  in T0 respectively. The amylose content of hydrothermally treated uncooked and cooked rice samples ranged from  $21.17 \pm 0.34\text{ g/100g}$  in T0 to  $27.39 \pm 0.24\text{ g/100g}$  in T18 and  $18.97 \pm 0.48\text{ g/100g}$  in T0 to  $26.99 \pm 0.06\text{ g/100g}$  in T18 respectively. The resistant starch of hydrothermally treated uncooked and cooked rice samples ranged from  $12.04 \pm 0.07\text{ g/100g}$  in T0 to  $27.46 \pm 0.36\text{ g/100g}$  in T17 and  $6.20 \pm 0.09\text{ g/100g}$  in T0 to  $23.34 \pm 0.08\text{ g/100g}$  in T18 respectively. From the findings it can be concluded that hydrothermally treated Kaoli Jamfri have better milling qualities with increased head rice yield, reduced cooking time and improved resistant starch content. Resistant starch plays an essential role in decreasing postprandial hyperglycemia and thus hydrothermally treated Kaoli Jamfri can provide a better food option for people suffering from diabetes mellitus.

## **Effect of processing on antioxidant potential and antidiabetic activity of *Cajanus cajan* (L.) tender leaves**

*Meghna Borgohain*

The present study was undertaken with an aim to assess the effect of processing on antioxidant potential and antidiabetic activity of *Cajanus cajan* (L.) tender leaves. A series of laboratory experiments were carried out to study the physico-chemical properties of the raw and the processed leaves. The optimization of the processing technique for *Cajanus cajan* (L.) tender leaves were done in two techniques viz. drying and cooking techniques. Under drying treatments, shade drying and oven drying whereas in cooking, techniques like boiling, steaming, microwaving and stir frying were selected. In each technique, two treatments (T1 and T2) with varied time and temperature were taken. The shade dried sample showed the highest moisture (8.66%), fat (2.54g/100g), carbohydrate (49.35g/100g) crude fiber (8.12 g/100g) as compared to the oven dried sample. Fat content was observed the highest in the shade dried samples (2.54 g/100g), the raw leaves had lower fat content (1.71 g/100g). The carbohydrate content of the raw and the dried leaves ranged from 24.11 to 36.99 g/100g, the oven dried showed higher carbohydrate content and the lowest carbohydrate content was observed in the raw leaves. The energy content of the raw and the dried samples ranged from 175 to 342 kcal. The shade dried showed higher energy content (342 kcal) and the raw leaves showed the lowest energy content (175 kcal). The significant changes in dietary fibre content was found and the oven dried showed highest dietary fiber content (20.28 g/100g). The ash content was higher in the shade dried samples (11.21 g/100g), than the raw leaves (6.31 g/100g). The boiled sample showed higher moisture content (52.73%) compared to the other cooking techniques. The steamed sample showed the lowest protein content (12.77 g/100g), T The stir-fried sample showed the highest fat content (5.02 g/100g) as compared to the raw and other cooking techniques adopted. The fat content ranged from 5.02 g/100g (stir-fried) and 0.84 g/100g (boiled samples). The microwaved samples contained the highest carbohydrate content (71.05 g/100g) and the boiled sample showed the lowest carbohydrate content (26.04g/100g). The highest

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**Major Adviser: Dr. Premila L. Bordoloi**

energy content of 391.08 kcal was observed in stir-fried leaves while lowest was found in boiled (156 .00 kcal). The crude fiber content among the dried samples ranged from 4.71 to 8.12 g/100g. The boiled leaves showed highest dietary fibre content (24.53 g/100g) while the stir-fried sample showed the lowest dietary fibre content (21.05g/100g). The preliminary phytochemicals screening reveals that both raw and processed samples contain, phenol, tannins, flavonoids, saponins and alkaloids, however, 8 steroids and glycosides were not present in any of the samples. The Total Phenolic Content and The Total Flavonoid content were found highest in the oven dried sample 246.14 mg GAE/100g and 53.89mg QE/100g while compared to raw. The Total Phenolic Content and Total Flavonoid Content was found highest in the steamed sample (235.15mg GAE/100g and 41.42mg QE/100g) while compared to raw while lowest was found in boiled (220.07 mg GAE/100g and 31.09±0.21 mg QE/100g). Two solvents were used to extract samples and analysis of antioxidant and antidiabetic activities. The total antioxidant activity of the raw sample by methanolic and ethyl acetate extract were 85.74 per cent and 87.21per cent respectively, while the shade dried showed the highest antioxidant activity both in methanolic (45.12%) and ethyl acetate extracts (47.34%). The total antioxidant activity was observed highest in the steamed sample (85.25 %). The inhibitory activity of  $\alpha$ -amylase by methanolic extract showed the highest as compared to the ethyl acetate. The highest inhibition was shown by the raw leaves in both the extracts for  $\alpha$ -amylase (96.79% in methanolic and 92.15% in ethyl acetate) which reduced to inhibition percentage after drying. Oven dried samples showed higher  $\alpha$ -amylase inhibition (86.54 % in methanolic and 83.51% in ethyl acetate) and  $\alpha$ -glucosidase (75.23% in methanol and 72.11%in ethyl acetate) compared to the shade dried. Among the drying techniques adopted i.e shade drying and oven drying, the per cent inhibition of  $\alpha$ -amylase was found high in oven dried methanolic extract of *Cajanus cajan* (L) tender leaves with a IC<sub>50</sub> values 31.07  $\mu$ g/ml. For the  $\alpha$ -glucosidase inhibition, from different drying treatments adopted, the oven dried sample lower (20.06  $\mu$ g/ml) IC<sub>50</sub> compared to shade dried (23.06  $\mu$ g/ml) by methanolic extracts. Among the cooking techniques, steamed sample showed highest  $\alpha$ -amylase inhibition (80.14% in methanolic and 71.24 % in ethyl acetate) and the  $\alpha$ - glucosidase (70.08% in methanolic and 64.27% in ethyl acetate) with the IC<sub>50</sub> values ranged from 34.02 to 41.35  $\mu$ g/ml by methanolic and 40.27 to 55.19  $\mu$ g/ml by ethyl acetate extract. A strong positive correlation between TPC and TFC (0.96), antioxidant activity (0.98), and  $\alpha$ amylase activities inhibited by methanolic extract (0.98) were observed. However, there was weaker correlation exhibited in the  $\alpha$ -glucosidase and TPC and also with  $\alpha$ -amylase. It is evident from the present study that the optimized drying and cooking techniques which exhibited better nutritional potential in terms of antioxidant and antidiabetic can be used to ensure better option for prevention and management of diabetes mellitus.

## **Development of gluten- free functional rice bread**

*Pallabi Sarkar*

The present study was undertaken with an aim of developing gluten- free functional rice bread having nutritional benefits and potential option for gluten-intolerant population. Therefore, the objectives of the study were decided to formulate bread using gluten- free base ingredients, to study the overall acceptability of the developed products and to evaluate the physical and nutritional composition of the developed products. Rice flour was selected as major base ingredient along with oats flour and barley flour and were analysed for nutrient composition in terms moisture, crude protein, crude fat, total mineral, crude fibre, dietary fibre, total carbohydrates, physiological energy value, total starch and amylose. Nine formulations namely T1, T2, T3, T4, T5, T6, T7, T8 and T9 were developed using rice flour, oats flour and barley flour as base ingredients. Other ingredients used were sugar, yeast, salt, xanthan gum, refined oil and water. Two controls namely positive control (wheat based) and negative control (rice based) were also developed. All the formulations were analysed for physical properties in terms of colour, texture, specific volume and bread shape ratio and sensory evaluation. Acceptability trials were conducted by 15 trained and semitrained panelists from the Department of Food Science and Nutrition, Assam Agricultural University using nine- point hedonic scale. Three formulations namely, T7, T8 and T9 were selected based on their highest acceptability trial values and nonsignificant difference from the positive control and were analysed for nutrient composition in terms moisture, crude protein, crude fat, total mineral, crude fibre, dietary fibre, total carbohydrates and physiological energy value. Data obtained from sensory, physical and nutritional composition analysis were subjected to completely randomized design to determine difference between formulation means by using ICAR WASP software. Results revealed that there was significant difference between base ingredients and formulations in most of the parameters. The ranges of nutrients of base ingredients were, moisture  $6.66\pm 0.18\text{g}/100\text{g}$  to  $11.28\pm 0.39\text{g}/100\text{g}$ , crude protein  $10.27\pm 0.39\text{g}/100\text{g}$  to  $14.34\pm 0.18\text{g}/100\text{g}$ , crude fat  $1.74\pm 0.22\text{g}/100\text{g}$  to  $6.94\pm 0.10\text{g}/100\text{g}$ , total mineral  $0.62\pm 0.20\text{g}/100\text{g}$  to  $1.37\pm 0.13\text{g}/100\text{g}$ , crude fibre  $1.57\pm 1.13\text{g}/100\text{g}$  to  $2.42\pm 0.47\text{g}/100\text{g}$ , dietary fibre  $2.92\pm 0.26\text{g}/100\text{g}$  to  $16.03\pm 0.39\text{g}/100\text{g}$ , total carbohydrates  $68.70\pm 0.28\text{g}/100\text{g}$  to  $80.52\pm 2.73\text{g}/100\text{g}$ , physiological energy value

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354.24±2.08kcal/100g to 394.65±1.05kcal/100g, total starch 60.75±0.47g/100g to 68.97±0.21g/100g and amylose 14.52±0.70g/100g to 26.13±2.24g/100g. Colour parameter of crust of developed products, L\* value ranged from 54.55±0.36 to 72.38±0.16, a\* value ranged from 3.03±0.16 to 16.23±0.41, b\* value ranged from 22.32±0.55 to 36.02±0.43 and browning index (BI) ranged from 40.30±1.21 to 112.79±1.00. L\* value of crumb of developed products ranged from 67.55±0.07 to 79.37±0.11, a\* value ranged from 1.16±0.16 to 2.79±0.12, b\* value ranged from 16.40±0.25 to 18.40±0.15 and browning index (BI) ranged from 23.45±0.67 to 31.77±0.67. For texture, firmness value of the developed products ranged from 5.50±1.38 N to 35.27±4.87 N, specific volume ranged from 2.49±0.18 cm<sup>3</sup>/g to 4.69±0.13 cm<sup>3</sup>/g and bread shape ratio ranged from 0.51±0.02 to 0.85±0.02. The ranges of nutrients of selected developed products were, moisture 32.86±0.66g/100g to 47.36±0.51g/100g, crude protein 10.76±0.48g/100g to 11.94±0.51g/100g, crude fat 3.36±0.15g/100g to 4.02±0.37g/100g, total mineral 0.25±0.02g/100g to 0.88±0.06g/100g, crude fibre 1.39±0.32g/100g to 1.90±0.25g/100g, total dietary fibre 4.70±0.15g/100g to 7.98±0.46g/100g, total carbohydrates 35.21±0.08g/100g to 53.56±0.49g/100g and physiological energy value 228.21±0.67kcal/100g to 284.42±0.89kcal/100g. From the findings it can be concluded that the products developed using rice flour, oats flour and barley flour has a good nutritional profile and could be a healthy option for the gluten- intolerant population as well as a source of nutritious gluten- free product.

## **Assessment of nutritional status of Karbi adolescent girls from Diphu, Assam**

*Puspa Khakhlary*

The present investigation was an attempt to assess the nutritional status of Karbi adolescent girls from Diphu, Assam. The specific objective of the study was to assess the nutritional status of target group through anthropometric indices, food and nutrient intake pattern and to evaluate with clinical parameters. A purposive random sampling was carried out to select 200 adolescent girls corresponding to the age group 13-15 years from 4 high schools of Diphu namely Mount Calvary English High School, Chandra Singh Teron High School, Don Bosco High School, Badan Memorial English High School. Anthropometric measurements revealed that majority of the adolescent girls were significantly lower than ICMR standard and NCHS standard with respect to height. According to Waterlow's classification of height-for-age majority of the Karbi adolescent girls (13 and 14 years) falls under normal nutritional status and in age 15 years, 52% were under marginal malnutrition. According to WHO (2007) Z scores of height for age observed majority of stunting in the age 13 years. The weight measurement revealed that the mean weight of 13-15 years were significantly lower than ICMR and NCHS standards. According to Gomez classification (weight for age), majority of the adolescent girls (13 and 15 years) falls under normal category and in the age 14 years, 41.77% were under mild malnutrition. According to World Health Organization (WHO, 2007) Z-score of BMI-for-age, majority of the study population between the age group of 13-15 years were normal (61.47% to 74.52%), the prevalence of thinness ranged from 3.92 to 21.42 and the prevalence of overweight and obesity ranged from 5.71-11.76% and 1.4-6.33% respectively. Garrow's BMI classification concluded that 35.71% in the age group of 13 years had severe chronic deficiency, whereas in the age group of 14 years, 29.11% had normal BMI for age, which was the highest percentage in the target group. In 15 years, 25.49% had low weight normal. The waist-hip ratio of Karbi adolescent girls was slightly higher than normal range ( $\leq 0.80$ ). There was a significant positive correlation observed between fat intake and weight of the target adolescent girls. Food habits revealed that cent percent of the target adolescent girls were non-vegetarian. The meal pattern of the respondents reflected that the

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majority of the girls had three main meals a day namely breakfast, lunch, and dinner with two mid snacks namely breaktime (tiffin time) and evening snacks. The frequency of consumption of food groups revealed that cereals, pulses, fats and oils and sugar and jaggery were consumed by all 13-15 years of age group. The consumption of other vegetables, roots and tubers, meat, fish and poultry were quite frequent in comparison to green leafy vegetables, fruits and milk and milk products. The average daily intake of cereal, pulses, roots and tuber, fats and oils, sugar and jaggery, meat, fish, poultry was fulfilled upto 70-90% of balanced diet recommended (BDR). The intake of other vegetables was fulfilled upto 60% of the BDR. On the other hand the mean daily of green leafy vegetables, milk and milk products and fruits were found to be 40-50% of BDR. The inadequate consumption of green leafy vegetables, milk and milk products and fruits leads to the deficiency of important vitamin sand minerals which in turn may affect growth and development of the adolescent girls. The Frequency of consumption of fast foods was once to thrice per week. Clinical signs and symptoms of adolescent girls revealed the deficiency in nutrient intake of iron, vitamin C and beta-carotene.



## **Development and quality evaluation of nutri-dense pancake mix**

*Taposhi Thakuria*

The present study was undertaken to formulate a nutri-dense pancake mix with an aim of enhancing the nutritive value of the traditionally prepared rice based pancake in Assam. Therefore, the objectives of the study were formulation of nutridense pancake mixes, physico-chemical analysis of the developed nutri-dense pancake mixes and storage study of the developed nutri-dense pancake mixes. Twelve formulations of nutri-dense pancake mixes were developed where the principle ingredient, i.e., rice flour was partially substituted with soybean flour (*Glycine max*), amaranth seed flour (*Amaranthus cruentus*), mushroom flour (*Pleurotus ostreatus*) and garden cress seed flour (*Lepidium sativum*) into three different sets. Each set contained four variations viz. PM with mushroom flour [PM1 (50:10:35:5), PM2 (50:10:30:10), PM3 (50:10:25:15) and PM4 (50:10:20:20)], PG with garden cress seed flour (*Lepidium sativum*) [PG1 (50:10:35:5), PG2 (50:10:30:10), PG3 (50:10:25:15) and PG4 (50:10:20:20)] and PMG with combination of mushroom flour and garden cress seed flour [PMG1 (50:10:30:5:5), PMG2 (50:10:20:10:10), PMG3 (50:10:20:15:5) and PMG4 (50:10:20:5:15)]. The developed formulations were subjected to sensory evaluation conducted by 10 trained and semi-trained panelists from the Department of Food Science and Nutrition, College of Community Science, Assam Agricultural University using nine-point hedonic scale. From the three group, the most acceptable variation was selected for further analysis of physico-chemical analysis, mineral contents in terms of calcium and iron and storage stability. Data obtained were subjected to completely randomized design to determine difference between treatment means by using ICAR WASP software. Colour parameter in terms of L\* values ranged from  $39.12 \pm 0.64$  to  $80.92 \pm 0.28$ , a\* values ranged from  $0.70 \pm 0.04$  to  $5.55 \pm 0.04$ , b\* values ranged from  $2.51 \pm 0.17$  to  $17.1 \pm 0.48$ , hue values ranged from  $24.33 \pm 0.45$  to  $85.76 \pm 7.61$  and chroma values ranged from  $11.85 \pm 0.19$  to  $293.96 \pm 3.46$  in control, PM1, PG1 and PMG2. Physical parameters such as weight ranged from  $53.00 \pm 2.29\text{g}$  to  $53.83 \pm 1.61\text{g}$ , diameter ranged from  $12.17 \pm 0.58\text{cm}$  to  $12.33 \pm 0.47\text{cm}$ , thickness ranged from  $34.00 \pm 1.00\text{mm}$  to  $40.00 \pm 1.00\text{mm}$  and spread ratio ranged from  $3.05 \pm 0.23$  to  $3.61 \pm 0.28$  among control, PM1, PG1 and PMG2. The

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moisture content of the developed pancake mixes ranged from  $9.38 \pm 0.02\%$  to  $11.06 \pm 0.20\%$ , energy content ranged from  $255.39 \pm 7.65$  Kcal/100g to  $359.79 \pm 1.31$  Kcal/100g, crude protein content ranged from  $12.80 \pm 0.03$  g/100g to  $16.93 \pm 0.03$  g/100g, crude fat content ranged from  $1.24 \pm 0.12$  g/100g to  $6.69 \pm 0.01$  g/100g, crude fibre content ranged from  $1.59 \pm 0.03$  g/100g to  $3.48 \pm 0.02$  g/100g, carbohydrate content ranged from  $62.47 \pm 0.08$  g/100g to  $80.02 \pm 0.39$  g/100g and ash content ranged from  $1.01 \pm 0.01$  g/100g to  $2.56 \pm 0.03$  g/100g. Functional properties such as bulk density ranged from  $1.54 \pm 0.002$  g/ml to  $1.70 \pm 0.002$  g/ml, water absorption capacity ranged from  $67.57 \pm 0.40\%$  to  $160.07 \pm 0.55\%$  and oil absorption capacity ranged from  $87.23 \pm 0.25\%$  to  $112.27 \pm 0.25\%$ . Calcium content ranged from  $15.64 \pm 0.56$  mg/100g to  $111.50 \pm 1.32$  mg/100g and iron content ranged from  $1.38 \pm 0.20$  mg/100g to  $16.4 \pm 0.33$  mg/100g. The moisture content, free fatty acid and peroxide value increased significantly from day 15 to day 30. The mean scores of microbial study of the nutrified pancake mixes stored in laminated aluminium foil zip lock pouches at refrigerated temperature of  $4^{\circ}\text{C}$  changed significantly ( $p \leq 0.05$ ) from 0th day to 30th day. It was observed that at day 30, the total bacterial counts exceeded the acceptable limit of  $\leq 100000$  cfu/g as per WHO guideline 1998 signaling the end of shelf-life of the product by day 15. The mean scores of the sensory attributes of the developed mixes did not change significantly but there was a slight decrease in sensory scores across storage of 15 days. As bacterial load exceeded on day 30, sensory evaluation was not done on day 30. From the findings of the study it can be concluded that the developed pancake mixes had good nutritional profile and can be popularized among the population as a source of nutritious food in the form of snack.

## **Prevalence of bullying among adolescents**

*Irin Das*

The present study has been undertaken to see the prevalence of bullying among adolescents in school. The primary objectives of the present study were to, (i) Assess the prevalence of bullying among adolescent in schools (ii) Assess the causes of bullying among adolescent in schools (iii) Find out the gender difference in attitude towards bullying among adolescent in schools. 118 number of school students from class 7 to 10 were selected from the co-educational schools of the Jorhat block from the Jorhat district of Assam. A questionnaire was prepared for collecting the background information and a standardized tool 'Bully Survey' was used for data collection. The questionnaire consisted of four parts. The first part elicits information on when the respondent was bullied, the second part assess information about when the respondent saw other students been bullied, the third part asks information about when the respondent bullied others and the fourth part contains information about the attitude of bullying among the adolescent. Their responses were coded and analyzed. The findings of the study revealed that majority 81.4 percent student were bullied by others, 92.4 percent students saw others who have been bullied and 72 percent student bullied others. One place where bullying mostly happened was in the academic class for all the cases when the respondent was bullied by others, saw others been bullied and bullied others. In all the situations when the respondent was bullied by others, saw others been bullied and bullied others, it was found that the average range was the highest which means the students were bullied quiet often in the schools. The way in which one got bullied by others was highest by calling names, when one saw others been bullied the highest was by making fun of them and when one bullied others the highest was by playing jokes on them. The respondents who were bullied by others and saw others been bullied were mostly bullied by boys in the same grade and who bullied others was mostly younger boys. When asked about whether bullying was a problem, it was found that when the respondent was bullied by others, saw others been bullied and bullied others, the adolescent revealed that they were facing problem from bullying at school. The respondents mostly felt sick when they were bullied by others and when the respondent saw others been bullied and when the respondent bullied others it made them feel bad or

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sad. The reasons for bullying in all the cases were due to one reason that is being fat. The attitude towards bullying ranged in average which reveals that adolescents have pro-bullying attitude. It was also found that there is no significant gender difference in attitude towards bullying among the adolescents in the school. Higher percent of the adolescents revealed that bullying was a problem in the schools and they also expressed that schools should worry and think about how to resolve this issue of bullying.

# **Enhancing Number Concepts of Preschool Children Through Musical Intervention**

*Jyotika Boruah*

Child psychologists often regard pre-school age as crucial period of life. They pay considerable amount of attention to this phase of life because the child undergoes greatest development during this period. It is the time when skills are attained which acts as a foundation for all the subsequent years in the life-span. Therefore, children must be provided with stimulating and enriching learning environment to facilitate the learning process.

Research findings suggest that children tend to develop apprehension towards mathematics (Heibert, 1999), so increased attention should be provided to establish an exemplary foundation in the preschool years. Music could act as a stimulating tool in providing positive results in early childhood development and learning of mathematics. With this background the present study entitled, “Enhancing number concepts of preschool children through musical intervention” was undertaken in Jorhat district during 2018-2020. The study aimed at investigating the effectiveness of using musical activities for enhancement of number concepts in pre-school children. The objectives of the study were to assess the number concept attained by preschool children, to prepare and administer the music integrated activities on number concepts to children and finally to assess the number concepts formed after musical intervention.

The sample of the study constituted of twenty four children belonging to the age group of 3-4 years, who were selected through convenience and purposive sampling methods. The investigator developed activities which were self prepared to assess the number concepts developed by preschool children. The assessment was conducted on the five conceptual principles of number concepts given by Gelman and Galistell (1978). The prepared music integrated activities on number concepts were administered on the children. The activities were prepared following Orff Approach. The Orff Approach is an artistic concept, which integrates music, movements, action and speech as key elements of teaching mathematics for children.

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Pre and post-intervention assessment design was used to judge the effectiveness of the musical activities on the development of number concepts in children. From the pre-intervention assessment, it was revealed that most children could name numbers but the concept of cardinality was not attained by many of the children. Findings revealed that children improved in all the areas of number concepts after the musical intervention. However, it was also observed that all the concepts are not mastered at the same time by all the children.

**Key words:** Preschool children; number concept; musical intervention

# **Parent-adolescent disagreement in the use of social media**

*Kshiptimayee Patra*

Social media is very popular among adolescents, as it allows them to connect with their families and friends. Adolescents spend most of their time on social media for making new friends, sharing their emotions and feelings. They feel more connected in the virtual world than in the real world and they start ignoring other activities and interact less with their real surroundings. As parents are the primary caregiver of their children therefore, they feel that using social media is a waste of time and they think that their children are wasting their precious time which would hamper in their carrier and future. Parents also think that due to more dependency on social media their adolescents are not able to focus on their important life activities. Whereas adolescents think that social media has given them the opportunity and the platform for developing their social skills, updating important events, sharing their creativity and ideas with their friends, and they believed that, they are benefited a lot from the different social media sites. As the perceptions of parents and adolescents are different from each other regarding the use of social media, there starts the disagreement between parents and adolescent regarding the use of social media. With this background the present study entitled, "Parent-adolescent disagreement in the use of social media" was undertaken during the calendar year 2018-2020 with the objectives as - to identify different social media sites used by adolescents, identify the reasons of disagreement between parents and adolescents for use of social media and to find out the gender differences in disagreement between parent and adolescent for use of social media.

By using multi-stage sampling procedure, sample of 118 numbers of adolescents and their respective parents, (236 samples) were selected from five schools of the Jorhat block from the Jorhat district of Assam. A self-constructed questionnaire was prepared to collect the required information from all the respondents. The findings revealed that the majority of the adolescents used WhatsApp among all social media sites and they spend 3-4 hours per day on social media. It was also found that in the areas of academic performance and socialization there was disagreement between parents and adolescents for use of social media, while in the area of health there was no

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disagreement between parents and adolescents for use of social media. It was also revealed from the findings that there was no significant gender difference in disagreement between parents and adolescents for use of social media. To overcome the disagreement between parents and adolescents regarding the use of social media, parents should be a good role model and help their adolescents to understand the value of face to face communication and also engage their adolescents with different kinds of extra-curricular activities as per their interest so that they can divert themselves from the urge of using social media.



## Selfie taking behaviour of college students

*Pallavi*

Technology is an essential part of our everyday life and it is difficult to ignore its impact on human's social and personal life. Technological advancements have brought forward significant change in many spheres of our life. Globally, the interests of people in gadgets like computers, mobile phones and internet have increased. The use of smart phones for self-photography which is popularly known as „Selfie“ has become a routine for college students after computer and internet. Selfies is described in the current study as a photograph taken by self with the use of smart phones. The present study was conducted to study the Selfie taking behavior of college students in Assam Agricultural University, Jorhat. The gender difference in Selfie taking behaviour and the reasons behind Selfie taking behaviour were also studied. The study was conducted in two colleges of Assam Agricultural University, Jorhat. A total of 203 numbers of respondents were selected for the purpose. Sample size was calculated by using Yamane's Formula and Probability Proportional to size (PPS). A self constructed questionnaire and interview method was used to elicit information. Collected data were analyzed using Frequency, percentage and Chi-square test. The findings of the study revealed that majority of the respondents spent less than 15 minutes per Selfie, took 1-3 numbers of Selfies on an average day and took Selfies occasionally. It was also found that majority of the respondents preferred evening time to take Selfies, preferred to have friends in Selfies, took head/face type of Selfies, attracted to take Selfies in famous places and preferred the emotional expression, „joy“ while taking Selfies. More number of respondents preferred WhatsApp to upload /share their Selfies; half of the respondents edit Selfies before posting and sometimes reload their Selfie after uploading to see new like and comments. More number of respondents felt upset when they see negative comments on their Selfie and majority of respondents never untagged themselves in group Selfies if not looking good. A significant difference was found between male and female respondents in „Persons or objects preferred in Selfies“ and „Edit Selfies before posting“. The environmental conditions were found to be the major reason for clicking Selfies by the respondents. **Key words:** College students, Selfie, Selfie taking behavior.

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# **Academic procrastination among students of Assam Agricultural University of Jorhat- An Explorative Study**

*Rashmi Rekha Gohain*

Academic procrastination is a behavior that is very common among students. It involves knowing that individual's needs to finished the academic task before the assigned time but for one or another reason respondents fail to accomplished the task within the expected time frame. It is the practice of doing more pleasurable or less urgent tasks instead of more urgent ones. Individuals often promise themselves not to delay things until the last minute but it happens again. Such procrastination behaviors affect the student's actual performances in the learning process and lead to feelings of guilt, inadequacy, depression, and self-doubt. So understanding the delaying habit of the individual will facilitate them to overcome and cope up with academic procrastination behavior.

With this background, the present study entitled, —Academic procrastination among students of the Assam Agricultural University of Jorhat- An Explorative Studyl was undertaken during the calendar year 2018-2020. The study was conducted to assess the areas of academic procrastination among university students, to assess the reason that is contributing to academic procrastination among university students and to find out the gender difference in academic procrastination among university students.

A sample of 199 undergraduate students was selected from Assam Agricultural University using Solvin's formula ( $N/1+Ne^2$ ), where  $N$  is the total population and  $e$  is the margin of error. A standard tool named —Procrastination Assessment Scale for Students (PASS) developed by Solomon & Rothblum (1984) was used to assess the academic procrastination of the students. In addition to that an interview schedule was prepared for collecting the background information of the respondents and various information related to academic procrastination.

The findings revealed that in areas of procrastination majority 61.3 percent of the respondents had an average level of academic procrastination, as most of the respondents (63.81%) sometimes procrastinate in school activities in general also 65.32 percent of respondents sometimes face problem when they procrastinate in school

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activities in general. Findings also depicts that 49.74 percent definitely want to decrease the tendency to procrastinate in keeping up with weekly reading assignments. According to the results, it was found that respondents were high and low procrastinators due to various reasons such as 68.9 percent were high procrastinators as they waited until a classmate did his or hers so that he or she could give some advice (dependency). On the other hand, 72.8 percent were found to be low procrastinators in the task look forward to the excitement of doing the task at the last minute (risk-taking). It was also revealed from the findings that there was no gender difference in academic procrastination among university students.

## **Extraction of fiber from *Gossypium arborium* and evaluation of fiber for various end uses**

*Rikamchi Ch. Marak*

Cotton stalks are a by-product of cotton farming and about two to three tones of cotton stalk are generated per hectare of land farmed. Therefore it is necessary to preserve the environment for sustainable development and economic upliftment of the country.

In the present study, the investigation was carried out on the possibilities of cotton stem fiber for future prospective of developing textile products. In this research, the fiber was successfully extracted from stems of the cotton plant (*Gossypium arborium*). Cotton stem is one of the agricultural wastes, commonly stems are disposed by burning after harvesting, which contributes to release harmful greenhouse gases that pollute the environment. The cotton plants used in the current study were collected from Tura, West Garo Hills Meghalaya. The collected plants from the farmer's field were evaluated for their morphological studies. The stalks were subjected to water retting followed by fiber extraction through manual decortications. Based on the highest yield percentage (31.2%) and quality of fiber by visual observation, 5% concentration for 45minute was considered as optimum duration for extraction of cotton stalk fiber. The fiber was dyed with natural dyes (marigold), after that the dyed fiber were assess for color fastness properties. Color measurement revealed that after wet processing treatments increased the WI and BI of the cotton fiber, while decreased the YI and color strength of the cotton fiber. Cotton stalk fibers have high cellulose (67.09%) and lignin (27.66%), but less ash content (3.06%) in case of retted fiber. The cotton stalk fibers have tensile strength of (3.48 g/tex) and the length of (3.41mm). The solubility percentage in different solvents such as cold water, hot water and dilute alkali were also tested. Among all the solvents dilute alkali showed the maximum solubility percentage in cotton fiber. SEM was done for the extracted fiber which depicted the complete removal of non-cellulosic material from fibers after wet processing treatment and cylindrical shape was clearly observed. The IR spectra were examined, highest peak was found 3367cm<sup>-1</sup> corresponds to O-H stretching of hydrogen bond. The IR spectra show that the cellulose and hemicelluloses and waxy substances have been removed from the

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chemically treated cotton fibers. From the dyed cotton fibers, the different diversified items have been prepared. Subjective evaluations of the products were assessed through visual inspection. Using cotton stalks as a source for natural cellulose fibers has great potential for high value addition leading to higher income from cotton crops. This could help to make cotton cultivation competitive and suitable compared to the higher income generating bio-fuels crops.

## **Extraction of sugarcane bagasse fibre for different end uses**

*Dilowar Hussain*

The present study was carried out to investigate the possibility of utilizing sugarcane fibre for developing diversified products. Sugarcane bagasse, which remains after extraction of juice from sugarcane, is considered as an agricultural waste but, never-the-less is a good source of natural fibres. This investigation mainly focused on extraction of Sugarcane fibres and the effect of wet processing on the extracted fibres. Sugarcane fibres were extracted by chemical extraction method and the extracted fibres were subjected to two wet processing treatments, i.e. scouring and bleaching. Various chemical and physical properties as well as solubility percentage of raw, scoured and bleached sugarcane fibres in different solvents were evaluated. Chemical constituents were found maximum in raw sugarcane fibres, followed by scoured and bleached sugarcane fibres. Solubility of bleached fibres was more in all the solvents as compared to raw and scoured fibres.

Morphological properties of sugarcane fibre were also found highest in raw fibres followed by scoured and bleached sugarcane fibres. Maximum mechanical properties of fibres were also observed in raw fibre and minimum were found in bleached fibre. The Infra-Red spectrum and Scanning Electron Microscope (SEM) test depicted the removal of non cellulosic material from fibres after wet processing treatment.

From the extracted fibre four different products were developed namely disposable plate, disposable bowl, paper bag and fibre reinforced composite board. Subjective evaluation of products regarding appearance, texture and suitability was assessed through visual inspection. All the developed items were found to be suitable based on their quality and their intended use.

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**Major Adviser: Dr. Satvinder Kaur**

# **A study on extraction of underutilized plant fibre from pendulous sleeping hibiscus and evaluation of its physico-chemical properties**

*Mintu Hazarika*

Plant fibers have great potential for their use in various innovative applications as an ecological, biodegradable and renewable resource with unique properties. It is one of the emerging and indispensable products of nature in the field of ecofriendly product. Due to the alarming rise of global warming issues and also industrialization and technological advancements has raised the need for development of innovative fibers especially from natural origin. The goal of the present study was to utilize the barks of pendulous sleeping hibiscus- an underutilized plant source for fiber extraction. This investigation mainly focused on optimization of fibre extraction process and to evaluate the physico-chemical properties of extracted fibers as well as study the effect of wet processing treatments on extracted fibres. In this investigation, fibres from pendulous sleeping hibiscus plant was extracted by using two retting method i.e. water and urea retting where maximum yield (8.4%) was found in water retted fibres. Various physical and chemical properties as well as solubility percentage of pendulous sleeping hibiscus fibres in different solvents were evaluated. The bleached fiber revealed with maximum solubility in cold water, hot water and dilute alkali solutions than retted fibers. Solubility (%) of urea retted fibres was more in all the solvents as compared to water retted fibres. All the physical properties showed satisfactory results in both water and urea retted fiber. On the other hand, chemical constituents like lignin, hemi-cellulose, ash, fat and wax of water retted fibers were found more (%) than the urea retted fiber except cellulose and moisture content. Later, fibers were subjected to different wet processing treatments such as scouring, bleaching and dyeing. Treated water retted and urea retted fibers were evaluated for their different physical properties such as length, diameter, wall thickness, bundle strength, elongation, fineness and density. In all the properties, fiber showed a decreasing trend except elongation, which was higher in water retted bleached fibers (3.65%). Colour measurements of water retted fibre in regards to whiteness index (15.37), brightness index (22.26) and yellowness index (33.45) showed

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**Major Adviser: Dr. Nabaneeta Gogoi**

higher than urea retted fibre. Wet processing treatments affects the dyability of extracted fibres also. It was observed that water retted bleached fiber showed maximum dye absorption percentage (47.74%) as compared to raw fiber. The Infra-Red spectrum and Scanning Electron Microscope (SEM) test were assessed for both untreated (Raw) and treated fibres. The IR spectrum depicted a significant reduction in the peak of treated fibres which might be due to the removal of non cellulosic material from fibres after wet processing treatment. Scanning electron microscopic view depicted that pendulous sleeping hibiscus fibre was tubular in shape with serrated outer lining. It was also observed that more extraneous substance were present in raw fibre as compared to treated fibre. The findings of the study revealed that, the pendulous sleeping hibiscus fiber has requisite properties as textile fibre which could be enhanced through subsequent wet processing treatments. As a new fibre, it has tremendous potentiality to be used as a new bast fiber, that will add a new arena in the future textile world.



## **Development of Lac Dye from Lac Insect *Kerria chinensis*, (Hemiptera:Kerriidae)**

*Saswati Rajkhowa*

The present investigation entitled “Development of Lac Dye from Lac Insect *Kerria chinensis*, (Hemiptera:Kerriidae)” was conducted during the year 2018-20, to study about Lac dye extracted from species *K. Chinensis* with following objectives. 1. Standardization of dyeing conditions of scrapped Lac, *K. chinensis*. 2. Evaluation of dyed yarn. Natural dyes are emerging globally as eco-friendly colourant. The greater part of natural dyes are vegetable dye obtained from plant source but there are dyes also obtained from insects e.g. Lac Dye. Lac is an animal originated insect dye which is found in India. They can also produce variety shades of color. In this study, aqueous and acidic extraction method using water and HCl was employed for extraction of Lac dye from *K. chinensis*. Result showed that the optimum extraction was 2% and 10% at 60°C for 90 minutes. The natural colourant extracted from Lac insect (*Kerria chinensis*), was utilized for colouration of silk, wool and cotton yarns and their dyeing properties were investigated. The optimal conditions for silk, wool and cotton dyeing with Lac dye were carried out at 100°C for 45-60 minutes. Two different mordants such as alum and myrobalan were tried on silk, wool and cotton yarns at different concentrations with pre and post-mordanting method to assess the colour fastness properties of the dyed samples. Result showed that, mordant has a significant effect on the color of yarns and fastness properties were influenced by the type of mordants used. Lac dye showed burgundy to purple colour with mordant alum and orange to red orange colour with mordant myrobalan on silk and wool yarn. On cotton yarn Lac dye showed purple colour with mordant alum and peach colour with mordant myrobalan. Alum mordant showed more excellence with both colour fastness and physical properties of dyed yarn. Dyed silk and wool yarn exhibited the best colour fastness range from very fair to good with alum mordant followed by cotton yarn which showed fair to very fair with alum mordant. Myrobalan mordanted cotton yarn showed good crocking fastness results in both dry and wet condition. The silk and wool yarn samples dyed with alum was found to be better than myrobalan in respect of tenacity (g/tex), wicking height (cm) and

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moisture regain (%). Cotton yarn samples mordanted with myrobalan showed highest density, wicking height and moisture regain. The myrobalan mordanted dyed silk yarn showed highest elongation and alum mordanted cotton yarn showed highest tenacity and elongation.

## **Master of Science (Veterinary)**

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- **Animal Genetics and Breeding**
- **Animal Nutrition**
- **Animal Reproduction, Gynaecology and Obstetrics**
  - **Anatomy and Histology**
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- **Clinical Medicine, Ethics and Jurisprudence**
  - **Epidemiology and Preventive Medicine**
    - **Extension Education**
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    - **Parasitology**
    - **Pathology**
- **Pharmacology & Toxicology & Jurisprudence**
  - **Physiology**
  - **Public Health**
  - **Surgery and Radiology**
- **Livestock Production and Management**
  - **Livestock Products Technology**
  - **Poultry Science**

# **Dna Polymorphism In Mitochondrial Genes Encoding Nd1, Co1 and Cytb In Canine Malignant Tumours**

*Shakeel-Ul-Rehman*

Malignant tumours in dogs are frequently reported. The types of malignancies commonly reported in canines include female breast cancers, lymphomas, adenomas and carcinomas of mast cells. Specific mutations and polymorphism in mitochondrial genes have been shown to be associated with different types of human malignancies. However, similar studies in respect to malignant tumours in dogs are very limited. Hence in the present study, an attempt was made to identify frequency of occurrence of mutation and polymorphism in gene sequences encoding NADH dehydrogenase subunit 1 (ND1), cytochrome b (CYTB) fragments of mtDNA and cytochrome c oxidase subunit 1 (CO1) in dogs, and to define the association of DNA polymorphic mutations with different tumour types.

Based on histopathology, out of 10 tumours examined 5 (50%) were found to be of epithelial and the rest 5 (50%) of mesenchymal origin. Two of the five epithelial tumors were recognized as adenocarcinoma and three as squamous cell carcinoma. Of the five mesenchymal tumors, four were identified as fibrosarcoma and one as liposarcoma. Of the 10 cases, 8 (80%) were recorded in local and 2 (20%) in crossbred dogs. While 7 (70%) cases were recorded in male, 3 (30%) were observed in females. Location-wise, two each of the tumours were observed in skin and mammary gland, while one each was observed in mouth, left flank, abdominal region, testicle, right elbow and left forelimb. The dogs suffering from the neoplastic growth in different parts of the body were within the range of 5 - 13 years of age.

Analysis of three mtDNA gene fragments established a relatively low level of molecular genetic variation between the tissues (tumour tissue, normal tissue and blood) of the individuals examined. Majority of the mutational changes in the *ND1*, *COI* and *CYTB* gene fragments in the analyzed tissues in most of the dogs with tumours were insertions and deletions. Only a few polymorphisms were noted in the partial gene fragments of the analyzed tissues when compared to reference successions.

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**Abstract of M.Sc. Thesis**

**Department : Animal Biotechnology**

**Major Advisor : Dr. Probodh Borah**

Multiple substitutions and insertions have been noted in *NDI* gene fragment; these included four substitutions (C218T, T455C, G498A and C666T) and three insertions (341InsC, 355InsC and 718InsT). However, no mutations were recorded in *NDI* gene fragment from any of the three types of tissues examined in case of a dog affected with squamous cell carcinoma. Changes in *CYTB* gene fragment included two substitutions (C322T and T799C) and one insertion (303InsG) mutation. Polymorphism C322T in the *CYTB* fragment was noted in 40% of the samples analysed. No mutation was, however, detected in this gene fragment in one case of fibrosarcoma. In the *COI* gene fragment, A735G polymorphic mutation was recorded in all (100%) the 10 cases of malignant tumours investigated in the present study. In this gene fragment, instances of mutations recorded were comparatively lesser.

Except for C218T mutation observed in *NDI* gene fragment seven cases of canine malignant tumour that induced S (Serine) to Y (Tyrosine) variation in the amino acid sequence of the coded protein at position 72, no other substitution mutation recorded in this gene fragment could cause a variation at the level of amino acid sequence. On the other hand, none of the mutations detected in *CYTB* gene fragment could induce any change in the level of amino acid sequence of the coded protein. Similarly, the only substitution mutation in the *COI* gene fragment that induced a change at the amino acid level was A813T mutation observed in a case of fibrosarcoma, which caused a G (Glycine) to A (Alanine) variation at 71 position.

Results of the present study showed the effect of two alleles (*NDI*: 218, *COI*: 813) on the amino acid sequence of the coded proteins which suggested consequently their potential role in carcinogenesis. However, the sample size in the present study was too small to infer conclusively about the association of the mutations and polymorphisms identified in the present study with specific malignant tumours in dog.

# **Evaluation of PagN-Based Peptide(S) IN Combination With Vi-Capsular Antigen as Vaccine Candidate for *Salmonella* Typhi**

*Puranpurna Goswami*

The present study was undertaken with a view to select the peptides representing the most potent B-cell and T-cell epitopes in the extracellular loops of PagN protein, synthesize them and evaluate their immunogenicity and protective efficacy either alone or in combination with Vi-polysaccharide in a mouse model against *Salmonella* Typhi. For this, the most potent B-cell and T-cell epitopes were selected using Ellipro and DiscoTope tools of IEDB resources and were chemically synthesized.

For immunogenicity study, the synthetic peptides of PagN protein in combination with Vi-polysaccharide were injected intraperitoneally in three different combinations, viz., 10µg of Vi-polysaccharide, 10µg of Vi-polysaccharide +100µg of each peptides, and 100µg each of all the peptides, into each of the six mice of Groups 2, 3 and 4, respectively, while the mice in Group 1 were kept as the control. Indirect ELISA was carried out to monitor the immune response against the peptides and Vi-polysaccharide.

The antibody titre against the synthetic peptides and Vi-polysaccharides showed a significant rise in all the three immunized groups (Groups 2, 3 and 4) as compared to the control group from day 7 till day 42. A significant rise in antibody titre was observed in both the Groups 3 and 4 in respect of the synthetic peptides, which sustained till the end of the study (till 42<sup>nd</sup> day of the experiment). In respect of Vi-polysaccharide, it was observed that there was a significant rise of antibody titre in both the Groups 2 and 3 with higher antibody response in group 3 (peptides +Vi-polysaccharide).

All the mice in different experimental groups were challenged with a lethal dose of *Salmonella* Typhi on the 42<sup>nd</sup> day post-primary immunization and observed for 10 days. All the animals in the control group started showing the symptoms suggestive of salmonellosis and died within 3 days of infection while the group of mice immunized

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**Abstract of M.Sc. Thesis**

**Department : Animal Biotechnology**

**Major Advisor : Dr. Deep Prakash Saikia**

with Peptides + Vi-polysaccharide (Group 3), showed complete protection (100%) against *the challenge infection*. The groups vaccinated with the combination of all the peptides (Group 4) and Vi-polysaccharide(Group 2) showed 83.33 percent protection against *S. Typhi*.

The present study showed that the Peptides+Vi-polysaccharide combination may be a very potential vaccine candidate against *S. Typhi*. However, this needs further exploration particularly in respect of its protective efficacy against heterologous challenges, determination of the appropriate time of booster vaccination, and the effect of individual peptides on humoral and cell-mediated immune responses.

# **Molecular Characterization of *Lactobacilli* Isolated From Indigenous Ducks of Assam and In Vitro Assessment of Their Probiotic Activity**

*Samiso Kramsapi*

Probiotic being an important bacteria to keep gut healthy are considered as good and helpful bacteria. The present study was mainly undertaken with a view to see if there is presence of good probiotics in Duck gut and if good probiotic candidate could be obtained from different isolates, isolated from faecal samples of cloaca of Duck. Samples were collected from different regions of Assam viz Hamren, Barpeta, Beltola, Hojai, Diphu, Karimganj, Kohora, Nagoan, Nalbari, Phuloni, Sivasagar, Sonapur etc from the cloaca of indigenous Ducks of Assam and brought in transport medium i.e Cary Blaire Media. Samples were process and inoculated in MRS broth for isolation of Lactobacillus with overnight incubation, which were further streaked in MRS Media Plate subsequently to obtain pure colonies.

The suspected pure colonies were preliminary identified by studying their Morphology through Gram staining, followed by Biochemical Test like sugar fermentation, Catalase Test which were followed again by PCR. PCR +ve samples were further tested for *In vitro* probiotic activity test for selection of good probiotic candidate. Different *In vitro* probiotic activity test include tolerance to low pH, tolerance to bile, lysozyme tolerance test, Autoaggregation, Cell surface Hydrophobicity, Antimicrobial activity test and Antibiotic sensitivity test.

Out of 320, 122 samples which were PCR +ve were tested for In-Vitro probiotic activity, where 15 samples could surpass low pH tolerance test at pH 2 & pH 2.5, being the main selection test for obtaining good probiotic candidate. The 15 isolates which tolerated low pH test were further tested for other test like Bile, Lysozymes tolerance test and adhesion test like Autoaggregation and Cell surface Hydrophobicity and then followed by Antimicrobial activity test, followed by Antibiotic sensitivity or susceptibility test.

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**Abstract of M.Sc. Thesis**

**Department : Animal Biotechnology**

**Major Advisor : Dr. Rupam Dutta**



Altogether 8 samples could surpass all the test, which were further sent for Molecular characterization by outsourcing where 7 were identified as *Lactobacillus Reuteri* & other 1 isolates as *Lactobacillus fermentation*. *L. Reuteri*, being the common or predominant probiotic Isolates obtained in other Poultry also found to be predominant probiotic isolate in Ducks too while *L. fermentation*, which are mainly found in fermented products could also be recovered from Duck faecal sample collected from cloaca. The 8 probiotic candidate which surpass all the *In vitro* probiotic activity test could be used as a future probiotic candidate only if further study undertaken with inclusion of *In vitro* Test.

## **Expression of Cap Protein of Porcine Circovirus Type 2 (PCV2) and Evaluation of Its Immunogenicity in Mice**

*Debarun Borah*

The present study was conducted with an aim to express the Cap protein of Porcine Circovirus Type 2 (PCV2) in a prokaryotic host and to assess its immunogenicity in mice. The recombinant pET32a/CT-His plasmid containing a codon-optimised PCV2 *cap* gene was transformed into *E. coli* BL21(DE3) cells for expression of the Cap protein after 8 hours of IPTG induction at 37°C. Subsequent SDS-PAGE analysis revealed an intense band of 46 kDa. Following successful purification by affinity chromatography using Ni-NTA column under denaturing conditions, the recombinant protein was refolded by dialysis. In western blot analysis of the purified protein, a 46.0 kDa-sized intense band was detected in the PVDF membrane. In four groups of Swiss albino mice consisting of six mice in each group, the immunological response to the purified recombinant Cap protein was assessed and compared to that of a commercial vaccine. Group 1 served as the control group receiving PBS, while Group 2 received a commercial vaccine, Group 3 received the recombinant Cap protein, and Group 4 received the Cap protein combined with Freund's adjuvant. On the 14th day post-primary immunization, each group of mice received a booster dose of the corresponding inoculum. Serum was collected from all the experimental animals on 0, 7th, 14th, 21st, 28th, 35th, and 42nd days after immunization. As detected by indirect ELISA, the mean antibody level against PCV2 was significantly higher in Group 4 getting Cap protein with Freund's adjuvant, than in Group 2 receiving the commercial vaccine, and Group 3 receiving the Cap protein alone. The recombinant Cap protein was found to be immunogenic in mice and was capable of inducing a specific IgG response, as detected by indirect ELISA. Based on the results of the present study, it may be concluded that the recombinant Cap protein expressed in *E. coli* is a promising immunogen and may be further explored as a vaccine candidate against PCV2. Use of the recombinant protein as a potential diagnostic antigen may also be explored in future.

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**Department : Animal Biotechnology**

**Major Advisor : Dr. Girin Hazarika**

## **Production Performance of Daothigir Chicken Under Field Condition**

*Banani Talukdar*

A study was conducted in Chirang and Kokrajhar district of Assam to evaluate the morphological characters, production, reproductive performance, growth and mortality of Daothigir chicken. Data pertaining to records of 497 Daothigir chicken were collected from both the districts during the period from August, 2018 to June, 2019 through field survey for the purpose of present study. Predominant plumage colour of head and neck in cock was blackish white followed by whitish brown and brownish black whereas body plumage colour was mostly white with black feathers followed by black with brown feathers. In hens, the most common plumage colour observed in head and neck was blackish brown followed by white with black feathers while body colour was mostly brown with black feathers followed by black with white feathers. Tail feathers were predominantly black in colour in both the sexes, however, black with brown feathers was also seen in some birds. Skin colour was found to be mostly white followed by pinkish in both cocks and hens. Shank colour was found to be whitish and yellow. Comb was red coloured, single and erect in both cocks and hens. The average age at first egg was  $198.80 \pm 3.05$  days and annual egg production was  $68.93 \pm 1.06$  numbers. The hens were reported to have an indefinite pattern of clutch size and clutch interval and undergoes three to four laying cycle in a year. The overall mean of egg weight (g), albumen index, yolk index, haugh unit, shell thickness (mm), shape index and specific gravity were recorded as  $42.19 \pm 0.19$  g,  $0.08 \pm 0.001$ ,  $0.39 \pm 0.005$ ,  $69.31 \pm 0.36$ ,  $0.33 \pm 0.001$  mm,  $75.33 \pm 0.98$  and  $1.10 \pm 0.016$  respectively. The colour of the egg shell of Daothigir hens was mostly light brown. Fertility and hatchability was recorded as 91.54% and 83.89 % with a range of 87.50 to 94.11% and 80 to 86.66% in the present investigation. The hens are quite broody and about 54.31 % showed broodiness.

Average mortality rate were 13.33 %, 3.21 % and 8.12 % with a range of 9.65 to 17.01 %, 1.06 to 4.76 % and 5.43 to 11.61 % during 0 to 8th week, 9th to 20th week and 21 weeks and above ages respectively. The overall mean of body weight at day old stage, 20 weeks and 40 weeks of ages were found to be  $33.56 \pm 0.65$  g,  $975.03 \pm 9.36$  g

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and  $1539.37 \pm 8.41$  g respectively. The mean body weight at day old stage, 20 weeks and 40 weeks in Chirang and Kokrajhar was found to be  $32.46 \pm 0.21$  g,  $32.80 \pm 0.15$  g;  $934.15 \pm 15.33$  g,  $989.34 \pm 14.23$  g and  $1545.64 \pm 10.23$  g,  $1512.21 \pm 9.54$  g respectively. The body weight of cocks at 20 weeks and 40 weeks of age were found to be  $992.05 \pm 14.44$  g and  $1590.74 \pm 9.80$  g and the corresponding values of hens were found to be  $820.98 \pm 7.93$  g and  $1416.83 \pm 8.99$  g respectively. Effect of district was found to be non-significant ( $p \geq 0.05$ ) on age at first egg, annual egg production and body weight at 0 day, 20 weeks and 40 weeks of ages. However, significant effect ( $p < 0.01$ ) of sex was found in body weight at 20 weeks and 40 weeks of age.

## **Growth and Reproductive Performance of Hampshire X Desi Half- Bred Pigs**

*Toshimongla Aier*

The study was carried out in the Department of Animal Genetics and Breeding, College of Veterinary Science, AAU, Khanapara by utilizing the animal records maintained at ICAR-Mega Seed Project (MSP) on Pig located at College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati, Assam. Records pertaining to 51 sows and 464 progeny of Hampshire x Desi half-bred pigs were utilized in the present study. The data obtained were classified according to the sex, season and parity of the animals. The overall least-squares means in Hampshire x Desi half-bred pigs for body weight at birth, weaning, 3 months, average daily gain during 0-42 days, 42-90 days and 0-90 days were found to be  $1.149 \pm 0.010$  kg,  $7.060 \pm 0.024$  kg,  $13.539 \pm 0.166$  kg,  $140.721 \pm 0.443$  g,  $131.753 \pm 3.450$  g and  $137.154 \pm 1.823$  g, respectively. Statistical analysis revealed that males were significantly ( $P < 0.05$ ) heavier than females at birth. Significant ( $P < 0.01$ ) effect of season on birth and weaning weight was observed indicating that piglets born during season  $S_2$  (June to September) had significantly higher body weight. Parity had significant ( $P < 0.05$ ) effect on body weight at 3 months of age and mean body weight during second parity was the highest followed by third and the fourth and which however, was the lowest in the first parity. The results revealed that parity had significant ( $P < 0.05$ ) effect on average daily gain during 42-90 days and 0-90 days which was highest in the pigs born to sows during second parity. The overall least-squares mean for age at first conception, age at first farrowing, gestation period and farrowing interval were found to be  $257.663 \pm 4.362$ ,  $371.006 \pm 4.470$ ,  $113.549 \pm 0.115$  and  $182.978 \pm 1.759$  days, respectively in Hampshire x Desi half-bred pigs under study. Statistical analysis revealed that season had significant ( $P < 0.05$ ) effect on farrowing interval and that sows that farrowed during season  $S_3$  had significantly shorter farrowing interval. Parity had significant ( $P < 0.05$ ) effect on gestation period and compared to other parities of the sow, third and fifth parity of the sow had significantly shorter gestation period. The overall average litter size at birth and weaning and litter weight at birth and weaning were  $7.918 \pm 0.128$  numbers,  $7.862 \pm$

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**Major Advisor : Dr. Galib Uz Zaman**

0.133 numbers,  $9.231 \pm 0.209$  and  $56.205 \pm 1.386$  kg respectively in Hampshire x Desi half-bred pigs. Analysis of variance revealed that second parity had comparatively higher litter size at weaning.

## Characterization of Indigenous Ducks of Manipur

*Y. Sovarani devi*

Data pertaining to records of 924 indigenous ducks of Manipur were utilized in the present investigation to study their morphometric characteristics, productive and reproductive performance and important egg quality traits. Predominant plumage colour of head and neck in males of indigenous ducks of Manipur was glossy green, followed by greenish black and brown colour. Body colour of grey, tan and brown were most common. In females, the most common plumage colour observed was brown, followed by white, black; other colours were also observed in little frequency. Most of the birds had speckled plumage pattern and brown speckled plumage was more common in ducks. Both sexes had an area of white bordered iridescent blue, green or purple blue feathers on their wings. About 20% of the plumage pattern was solid. Bill colour was found to be mostly yellow, followed by orange, black and mixture of black and orange in both drakes and ducks. Skin colour was found to be pale pink and yellowish white. Shank and feet colour was predominantly orange, followed by brown, yellow, black and mixture of black and orange. The least squares means for body weight at 5, 6, 7, 8, 9, 10, 11 and 12 months of age were  $1.55 \pm 0.01\text{kg}$ ,  $1.61 \pm 0.01\text{kg}$ ,  $1.68 \pm 0.01\text{kg}$ ,  $1.83 \pm 0.01\text{kg}$ ,  $1.85 \pm 0.02\text{kg}$ ,  $2.08 \pm 0.01\text{kg}$ ,  $2.07 \pm 0.02\text{kg}$  and  $2.16 \pm 0.02\text{kg}$  respectively. The least squares means of body weight and body measurements *viz.*, body length, body circumference, bill length, bill width, head length, head width, neck length, breast length and shank length at adult were found to be  $1.72 \pm 0.01\text{kg}$ ,  $61.68 \pm 0.18\text{cm}$ ,  $38.54 \pm 0.17\text{cm}$ ,  $5.99 \pm 0.02\text{cm}$ ,  $3.36 \pm 0.02\text{cm}$ ,  $6.14 \pm 0.02\text{cm}$ ,  $3.87 \pm 0.02\text{cm}$ ,  $14.77 \pm 0.04\text{cm}$ ,  $17.27 \pm 0.06\text{cm}$  and  $5.42 \pm 0.02\text{cm}$  respectively. The age at first egg was  $170.80 \pm 0.91$  days and annual egg production was  $175.06 \pm 0.87$  numbers. These ducks were reported to have an erratic pattern of clutch size and interval and had a tendency to lay eggs throughout the year. The egg quality traits including egg weight, shape index, shell weight, shell thickness, specific gravity, albumen index, Haugh unit, yolk index and yolk colour score were  $61.13 \pm 1.31\text{g}$ ,  $72.17 \pm 0.47$ ,  $6.24 \pm 0.08\text{g}$ ,  $0.35 \pm 0.01\text{mm}$ ,  $1.08 \pm 0.01$ ,  $0.08 \pm 0.002$ ,  $74.01 \pm 0.91$ ,  $0.37 \pm 0.01$  and  $10.14 \pm 0.45$  respectively. Egg shell colour was found to be cloudy white. Broodiness was rarely observed in indigenous

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**Major Advisor : Dr. Arpana Das**

ducks of Manipur. Fertility was recorded as 85.06% within a range of 80.72 to 87.19% and hatchability on total egg set (TES) basis was 65.38% within a range of 61.01 to 73.35% in the present investigation. Average mortality rate were 15.31, 11.08, 7.67 and 3.96% with a range of 9.08 to 21.36, 6.35 to 16.25, 5.13 to 13.26 and 1.95 to 5.49% in between 0 to 1st week, 1st to 8th week, 8th to 20th week, 6th to 12th month respectively. Significant effect ( $P < 0.01$ ) of district as well as sex was observed on body weight and body measurements at different ages and males had higher values than females. Age at first egg also differed significantly ( $P < 0.01$ ) due to different district. However, no significant effect of district was found on annual egg production. Adult body weight had positive correlation with all body measurements under study; the highest being with body circumference ( $0.72 \pm 0.02$ ) and the lowest was with shank length ( $0.19 \pm 0.05$ ). Age at first egg was found to have negative correlation with annual egg production ( $-0.11 \pm 0.08$ ). Highest correlation coefficient was observed between albumen index and Haugh unit ( $0.73 \pm 0.08$ ). The linear and multiple regression equations were developed for prediction of adult body weight from body length, body circumference and breast length and multiple regression equations were comparatively reliable than the linear regression equations for the purpose.



# **Performance of Siri Cattle of Sikkim under Field Condition**

*Tenzing Lobsang Bhutia*

A total of 190 (64 male and 126 female) Siri cattle constituted the materials of the study and considered for morphometric measurements. Out of which, 114 (40 male +74 female) from West Sikkim and 76 (24 male +52 female) from East Sikkim districts of Sikkim respectively. The reproduction and production traits were collected from 104 cows and out of which 64 from West Sikkim and 40 from East Sikkim districts. In order to study the milk constituents, 87 milk samples were collected from 45 and 42 Siri cows of West Sikkim and East Sikkim districts respectively from the 8 different villages from West Sikkim (5) and East Sikkim (3) district. The data obtained were classified according to location, sex and lactation order. The overall least-squares means for the body length, height at withers, heart girth, pouch girth, head length, eye to eye space, horn tip circumference, horn mid circumference, horn base circumference, space between horns, horn length, udder length, udder breadth, teat length front left, teat length front right, teat length rear left, teat length rear right, teat diameter front left, teat diameter front right, teat diameter rear left and teat diameter rear right were  $115.24 \pm 0.24$  cm,  $126.56 \pm 0.31$  cm,  $160.96 \pm 0.31$ cm,  $168.33 \pm 0.26$  cm,  $41.32 \pm 0.14$  cm,  $18.99 \pm 0.11$  cm,  $8.40 \pm 0.07$  cm,  $11.01 \pm 0.08$  cm,  $14.79 \pm 0.08$  cm,  $16.89 \pm 0.10$  cm,  $17.64 \pm 0.12$  cm,  $27.73 \pm 0.16$  cm,  $30.57 \pm 0.13$  cm,  $5.31 \pm 0.11$  cm,  $5.36 \pm 0.12$  cm,  $4.46 \pm 0.10$  cm,  $4.48 \pm 0.10$  cm,  $6.20 \pm 6.40$  cm,  $5.91 \pm 0.08$  cm,  $4.98 \pm 0.07$  cm and  $5.03 \pm 0.08$  cm respectively. Sex and location had significant effect on various morphometric measurements under body measurements, head and horn measurements and teat measurements. The most predominant coat colour was found to be black and white (46.84 per cent), black (22.42 per cent) brown (18.42 per cent) and brown and white (12.63 per cent). Animals were found to have black switch (62.11 per cent) and white switch (37.89 per cent), black muzzle (77.89 per cent) and albino muzzle (22.11 per cent) and hooves colour were black (81.05 per cent) and white (18.95 per cent). Various udder shapes recorded were found to be bowl (42.06 per cent), round (15.87 per cent), bath (15.08 per cent), flat (14.29 per cent) and goat (12.70 per cent). For teat the various shapes recorded were as follows: cylindrical (50.79 percent), funnel (30.16 per cent) and

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pear (19.05 per cent). The least-squares means for reproductive traits age, at first fertile service, age at first calving, gestation period, service period and inter-calving period of Siri cattle of Sikkim was found to be  $1209.35 \pm 5.96$  days,  $1492.25 \pm 6.37$  days,  $286.43 \pm 0.34$  days,  $196.97 \pm 0.63$  days and  $483.80 \pm 0.64$  days respectively. The least-squares means for various productive traits, lactation length, lactation milk yield, dry period, peak yield and days to attain peak yield of Siri cattle of Sikkim was found to be  $225.30 \pm 0.36$  days,  $671.86 \pm 2.64$  kg,  $258.01 \pm 0.43$  days,  $3.30 \pm 0.02$  kg and  $60.72 \pm 0.33$  days. Location had non-significant effect on all the reproductive and productive traits except lactation milk yield and dry period. Lactation order had significant effect on all the reproductive and productive traits except age at first fertile service, age at first calving, gestation period and days to attain peak yield. The milk constituents of Siri cattle of Sikkim in the present study fat, solid not fat, protein and total solids was found to be  $5.36 \pm 0.14$  per cent,  $8.44 \pm 0.08$  percent,  $2.99 \pm 0.05$  per cent and  $13.80 \pm 0.82$  per cent. No significant effect of location on the milk constituents was observed in the present study.

# **Performance of HD-K75 in The Original Nucleus Herd *Vis a Vis* Public and Private Sectors of Organised Pig Farm**

*Eyangshuman Das*

The investigation was carried out on HD-K75. The data pertaining to 889 animals from third crop of 14<sup>th</sup>, 15<sup>th</sup>, 16<sup>th</sup> and 17<sup>th</sup> generation born to 103 dams and 35 sires maintained at ICAR- All India Co-ordinate Research Project (AICRP) on pig, Assam Agricultural University (AAU) Khanapara, Guwahati. The data was also collected for 1657 progenies of same genetic group maintained from various government, private and medium pig farms of different districts of the state of Assam, constitute the materials for the study.

The least-squares means (LSM) for body weights of HD-K75 were  $0.994 \pm 0.002$ ,  $9.845 \pm 0.009$ ,  $12.140 \pm 0.019$ ,  $27.821 \pm 0.033$ ,  $48.038 \pm 0.037$  and  $74.972 \pm 0.027$  kg at birth, at weaning (42 days), 2 month, 4 month, 6 month and 8 months of age respectively. The least-squares means for daily body weight gain in HD-K75 were  $210.765 \pm 0.194$ ,  $328.937 \pm 0.141$  and  $308.248 \pm 0.113$  g during the period from birth to weaning, weaning to 8 months and birth to 8 months of age respectively. The least-squares means for age at first fertile service, age at first farrowing, litter size at birth, litter weight at birth, litter size at weaning and litter weight at weaning in HD-K75 were  $241.153 \pm 1.770$  days,  $354.678 \pm 1.777$  days,  $8.733 \pm 0.111$ ,  $8.684 \pm 0.083$  kg,  $8.483 \pm 0.131$  and  $83.417 \pm 1.166$  kg respectively.

The average body weight at birth and at weaning of HD-K75 pigs in organized public farms, organized private farms and medium farms were  $0.998 \pm 0.003$ ,  $1.022 \pm 0.003$  and  $1.024 \pm 0.003$  kg and  $9.868 \pm 0.027$ ,  $9.986 \pm 0.011$  and  $10.015 \pm 0.143$  kg respectively. In the corresponding farms the average daily body weight gain during the period from birth to weaning were  $211.052 \pm 0.025$ ,  $213.299 \pm 0.009$  and  $214.010 \pm 0.011$  g respectively.

The age at first fertile service (days) were found to be  $249.074 \pm 0.782$ ,  $243.635 \pm 0.848$  and  $246.355 \pm 0.688$  in organized public farms, organized private farms and medium farms respectively and corresponding values for age at first farrowing

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(days) were  $362.864 \pm 0.771$ ,  $354.141 \pm 3.582$  and  $360.177 \pm 0.688$ . The average litter size at birth, litter weight at birth (kg), litter size at weaning and litter weight at weaning (kg) were obtained as  $7.851 \pm 0.229$ ,  $7.835 \pm 0.192$ ,  $7.160 \pm 0.184$  and  $70.655 \pm 1.733$  respectively in organized public farms;  $7.858 \pm 0.224$ ,  $8.037 \pm 0.183$ ,  $8.037 \pm 0.183$  and  $70.214 \pm 1.769$  respectively in organized private farms and  $7.844 \pm 0.226$ ,  $8.031 \pm 0.178$ ,  $7.244 \pm 0.198$  and  $72.328 \pm 1.879$  respectively in medium farms.

It was found that the generation of the animals had highly significant ( $P < 0.01$ ) effect on body weight at different ages except at 6 month of age where the effect was non significant and it was also observed that effect of generation was highly significant on average daily body weight gain during different period of growth.

In this study the effect of sex was found to be highly significant ( $P < 0.01$ ) for body weight at different ages of growth and average daily body weight gain during different periods of growth.

It was found that the generation of the animals had highly significant ( $P < 0.01$ ) effect on first fertile service, age at first farrowing, litter size at birth and litter weight at birth, whereas effect of generation was significant ( $P < 0.05$ ) for litter weight at weaning and non significant for litter size at birth.

The heritability ( $h^2$ ) estimate for body weight at different ages and daily body weight gain were lower and the standard errors were higher in most of the cases.

The heritability ( $h^2$ ) estimate for the reproductive traits were also found to be low to moderate with high standard errors.

The phenotypic and genetic correlation coefficient among the body weight at different ages found to be positive except the correlation related to 8 months of age and the genetic correlation between birth with 8 month The phenotypic and genetic correlation for daily body weight gain was found to be positive and ranged from low to high.

The phenotypic and genetic correlations among reproductive traits were estimated and were found to be moderate to high with high standard errors in most of the cases and in the other cases the correlation was found to be negative.

The  $R^2$  value was found to be high for all linear regression equations that were developed on the basis of body length, height at withers and chest girth for male and females, whereas, the  $R^2$  value was found to be low for linear regression equations that were developed on the basis of height at withers and chest girth for the males and females together.

The multiple regression equations were developed on the basis of two linear body measurements at a time such as body length and height at withers, body length and chest girth and height at withers and chest girth. Another set of multiple regression equation was developed on the basis of body length, height at withers and chest girth for males, females and male and female together. The  $R^2$  values for all the multiple regression equations were high.

# **Performance Evaluation and Polymorphism Profiling of Fecundity Genes in Indigenous Sheep of Meghalaya**

*Dimpi Khanikar*

The present investigation was carried out on Indigenous sheep of Meghalaya covering Nongrum, Thynroit and Mawjrong villages of East Khasi Hills district and Mawthungkper, Marang and Jaidoh villages of West Khasi Hills district of Meghalaya. The different objectives of the present investigation were to study body weights and body measurements at different ages, to study important traits of reproduction, to study different wool characteristics and to identify polymorphism of fecundity genes. A total of 567 animals were utilised to study body weight and morphometric traits; 77 animals were utilised to study reproductive traits and 38 animals were utilized to study wool traits. 50 randomly chosen ewes were utilized to study polymorphism of fecundity genes. The overall least-squares means (LSM) for body weight of Indigenous sheep of Meghalaya at birth, 3 months, 6 months and 12 months were found to be  $2.917 \pm 0.017$ ,  $12.149 \pm 0.056$ ,  $15.074 \pm 0.055$  and  $20.217 \pm 0.050$  kg respectively. The males and the sheep belonging to East Khasi Hills revealed significantly higher body weight in all ages compared to females and the sheep belonging to West Khasi Hills. The LSM for body lengths, height at withers, chest girth, neck girth, head length, head breadth, ear length and tail length were recorded as  $38.79 \pm 0.081$ ,  $37.956 \pm 0.088$ ,  $46.130 \pm 0.086$ ,  $23.802 \pm 0.087$ ,  $10.640 \pm 0.068$ ,  $7.104 \pm 0.063$ ,  $7.865 \pm 0.059$  and  $11.891 \pm 0.060$  cm at birth;  $46.19 \pm 0.055$ ,  $47.115 \pm 0.056$ ,  $56.49 \pm 0.047$ ,  $29.330 \pm 0.056$ ,  $12.337 \pm 0.045$ ,  $8.899 \pm 0.039$ ,  $8.814 \pm 0.042$  and  $14.065 \pm 0.035$  cm at 3 months;  $52.25 \pm 0.097$ ,  $54.663 \pm 0.051$ ,  $61.52 \pm 0.072$ ,  $31.364 \pm 0.057$ ,  $13.723 \pm 0.046$ ,  $8.706 \pm 0.045$ ,  $8.837 \pm 0.041$  and  $15.070 \pm 0.032$  cm at 6 months and  $56.19 \pm 0.031$ ,  $57.053 \pm 0.061$ ,  $72.48 \pm 0.104$ ,  $36.189 \pm 0.044$ ,  $14.989 \pm 0.033$ ,  $10.809 \pm 0.033$ ,  $10.281 \pm 0.031$  and  $14.937 \pm 0.029$  cm at 12 months of age. The overall least-squares means for horn length at 12 months of age in the present study was recorded as  $7.305 \pm 0.079$  cm. Significant effect of sex was observed on body length, chest girth, height at withers, neck girth, head breadth and ear length where males showed higher averages compared to females at different ages. The

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**Major Advisor : Dr. Arundhati Phookan**

sheep belonging to East Khasi Hills showed significantly higher body length, chest girth, height at withers, neck girth, head length, head breadth, ear length and tail length than sheep of West Khasi Hills at different ages with the exception of higher value of neck girth at birth for sheep belonging to West Khasi Hills. The LSM for age at first fertile service (AFFS), age at first oestrus (AFO), oestrus cycle duration (OC), age at first lambing (AFL), lambing interval (LI), service period (SP), litter size (LS) and lifetime lamb production (LLP) were  $389.37 \pm 0.134$  days,  $370.052 \pm 0.802$  days,  $16.494 \pm 0.058$  days,  $540.123 \pm 0.128$  days,  $408.005 \pm 9.527$  days,  $256.432 \pm 8.961$  days,  $1.259 \pm 0.051$  nos. and  $3.584 \pm 0.091$  nos. respectively. The LSM for staple length, fibre length, fibre diameter and medullation percentage were  $6.016 \pm 0.029$  cm,  $57.899 \pm 0.134$  mm,  $57.899 \pm 0.134$   $\mu$  and  $50.974 \pm 1.042$  % respectively. Female sheep revealed significantly higher fibre length, fibre diameter and medullation percentage than males. The sheep belonging to East Khasi Hills showed significantly higher values for all wool characteristics except medullation percentage than the sheep of West Khasi Hills. PCR-RFLP analysis of fecundity genes *viz.* *FecB*, *FecG* and *FecX*; revealed polymorphism in *FecB* and *FecX* genes. However, *FecG* gene was found to be monomorphic. In case of *FecB*, the genotypic frequency and allelic frequency were 0.28, 0.78 and 0.64, 0.36 for AA, AB, A and B respectively. In case of *FecX*, the genotypic and allelic frequency were 0.10, 0.90 and 0.55, 0.45 for AA, AB and A, B respectively. The population under study was not in Hardy-Weinberg Equilibrium for *FecB* and *FecX* gene.

## Performance of Indigenous Sheep of Assam

*Pinky Saikia*

The present investigation was undertaken on the indigenous sheep of Assam to evaluate their performance potential available in their breeding habitat. Informations were collected from 8 districts of Assam to study their growth traits, reproductive traits, the effect of some non-genetic factors on performance traits, carcass traits and genetic polymorphism of candidate gene for growth and fecundity traits *viz.*, *IGF1* and *GDF9*, *BMP15* and *BMP4* respectively. Data on 1287 animals for growth traits, 387 animals for reproductive traits, 50 animals for carcass traits and 193 animals for molecular genetic analysis belonging to Dhubri, Barpeta, Darrang, Kamrup, Bongaigaon, Goalpara, Kokrajhar and Nalbari districts were utilized for the present study. The data obtained were classified according to sex, season of birth, season of lambing and parity.

The overall least-squares means for body weight at birth, 3 months, 6 months, 9 months, 12 months and adult body weight (>12 months) were found to be  $0.936 \pm 0.12$  kg,  $5.196 \pm 0.11$  kg,  $7.949 \pm 0.15$  kg,  $10.636 \pm 0.12$  kg,  $13.399 \pm 0.25$  kg and  $17.695 \pm 0.27$  kg respectively. The corresponding values for male and female sheep were recorded as  $0.966 \pm 0.12$  kg and  $0.906 \pm 0.10$  kg;  $5.351 \pm 0.16$  kg and  $5.040 \pm 0.14$  kg;  $8.194 \pm 0.21$  kg and  $7.703 \pm 0.13$  kg;  $11.091 \pm 0.11$  kg and  $10.181 \pm 0.16$  kg;  $13.907 \pm 0.25$  kg and  $12.892 \pm 0.15$  kg;  $17.960 \pm 0.29$  kg and  $16.829 \pm 0.19$  kg at birth, 3, 6, 9, 12 months and as adult bodyweight respectively. Highly significant effect ( $P < 0.01$ ) of sex of the animal was found on body weight at all the ages. It was observed that the males were heavier than the females.

The least-squares means for body weight pertaining to S1, S2, S3 and S4 were found to be  $0.959 \pm 0.11$  kg,  $0.923 \pm 0.07$  kg,  $0.937 \pm 0.09$  kg and  $0.925 \pm 0.08$  kg at birth;  $5.261 \pm 0.12$  kg,  $5.185 \pm 0.15$  kg,  $5.163 \pm 0.18$  kg and  $5.175 \pm 0.11$  kg at 3 months;  $8.017 \pm 0.16$  kg,  $8.008 \pm 0.20$  kg,  $7.861 \pm 0.15$  kg and  $7.849 \pm 0.21$  kg at 6 months;  $10.657 \pm 0.12$  kg,  $10.401 \pm 0.08$  kg,  $10.940 \pm 0.12$  kg and  $10.546 \pm 0.08$  kg at 9 months;  $13.374 \pm 0.14$  kg,  $13.365 \pm 0.11$  kg,  $13.814 \pm 0.24$  kg and  $13.305 \pm 0.16$  kg at 12 months ;  $17.230 \pm 0.20$  kg,  $17.355 \pm 0.31$  kg,  $17.811 \pm 0.38$  kg and  $17.282 \pm 0.26$  kg as adult body weight respectively. Season of birth exerted highly significant effect

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( $P < 0.01$ ) on body weight at birth, 6 months, 9 months and 12 months. However, season of birth had non-significant effect on 3 months body weight and significant effect ( $P < 0.05$ ) on adult body weight.

The overall least-squares means for age at sexual maturity (ASM), age at first lambing (AFL) and lifetime lamb production (LLP) were noted as  $235.559 \pm 2.46$  days,  $384.142 \pm 2.46$  days and  $10.118 \pm 0.25$  respectively. The Least-squares means for ASM, AFL and LLP pertaining to S1, S2, S3, S4 and P1, P2, P3, P4 were found to be  $234.921 \pm 1.96$  days,  $232.256 \pm 2.53$  days,  $236.200 \pm 3.63$  days,  $233.208 \pm 2.45$  days and  $238.027 \pm 1.82$  days,  $231.192 \pm 3.54$  days,  $226.243 \pm 3.80$  days,  $249.178 \pm 3.34$  days;  $387.504 \pm 2.55$  days,  $380.839 \pm 2.53$  days,  $384.783 \pm 2.75$  days,  $381.791 \pm 2.45$  days and  $386.610 \pm 1.43$  days,  $379.775 \pm 2.65$  days,  $374.826 \pm 2.51$  days,  $397.761 \pm 4.10$  days; and  $10.177 \pm 0.19$ ,  $10.076 \pm 0.11$ ,  $10.186 \pm 0.13$ ,  $10.031 \pm 0.11$  and  $10.251 \pm 0.21$ ,  $9.819 \pm 0.18$ ,  $9.391 \pm 0.23$ ,  $11.011 \pm 0.38$  respectively. Season of lambing had non-significant effect on age at sexual maturity, age at first lambing and lifetime lamb production. However, parity exerted significant effect ( $P < 0.05$ ) on age at sexual maturity and age at first lambing but showed non-significant effect on lifetime lamb production.

The mean lamb size in indigenous sheep of Assam was found to be 2.1 with type of lambing as singlet (29.71 per cent), twin (52.19 per cent), triplet (17.06 per cent) and quadruplet (1.04 per cent).

The overall least-squares means for age at slaughter, weight at slaughter, hot carcass weight (HCW) and dressing percentage (DP%) were recorded as  $7.286 \pm 0.12$  months,  $9.852 \pm 0.25$  kg,  $4.634 \pm 0.13$  kg and  $47.024 \pm 0.14\%$  respectively. The corresponding values for male and female sheep were recorded as  $7.210 \pm 0.13$  months and  $7.400 \pm 0.15$  months;  $10.030 \pm 0.26$  kg and  $9.674 \pm 0.22$  kg;  $4.741 \pm 0.12$  kg and  $4.528 \pm 0.14$  kg;  $47.080 \pm 0.15\%$  and  $46.968 \pm 0.18\%$  for age at slaughter, weight at slaughter, hot carcass weight and dressing percentage respectively. The least-squares analysis of variance revealed that the influence of sex showed non-significant effect on age at slaughter, weight at slaughter, hot carcass weight and dressing percentage.

Amplification of *IGF1*, *GDF9*, *BMP15* and *BMP4* genes using selective primers resulted in generation of 505 bp, 462 bp, 356 bp and 517 bp DNA fragments respectively. PCR-RFLP analysis of *IGF1*, *GDF9* and *BMP15* gene using *HaeIII*, *HhaI* and *HinfI* restriction enzymes revealed monomorphic banding patterns. However, SNP was detected in case of *IGF1* and *BMP15* genes. PCR-RFLP analysis of *BMP4* gene with *HaeIII*, showed polymorphic banding pattern. Three genotypes *viz.*, AA, AB and BB were obtained. AA genotype yielded one fragment (517 bp), AB genotype yielded three fragments (175, 342 and 517 bp) and BB genotype yielded two fragments (175 and 342 bp). The frequencies of A and B alleles were found to be 0.32 and 0.68 respectively and the genotypic frequencies of *BMP4* gene were found to be 0.06, 0.52 and 0.42 for AA, AB and BB genotypes respectively. The calculated chi-square ( $\chi^2$ ) value was found



to be non-significant at 1 d.f. and hence indicated that the population under study was in Hardy-Weinberg Equilibrium for *BMP4* gene.

In *IGF1* gene the sequence variation in terms of nucleotide was observed in 403, 416, 427, 430, 433, 542, 550, 553, 638, 677, 680, 716, 719 and 762<sup>nd</sup> position. Upon restriction mapping of the partial sequence of *IGF1* gene, the restriction site for *HaeIII* was found to be in 451, 533, 545 and 685<sup>th</sup> position. No sequence variation in terms of nucleotide was observed in *GDF9* gene. Upon restriction mapping of the partial sequence of *GDF9* gene, the restriction site for *HhaI* was observed in 2067<sup>th</sup> position. In case of *BMP15* gene nucleotide sequence variation was observed in 1900, 1919, 1950, 1964, 2025, 2066, 2084, 2114 and 2115<sup>th</sup> position. The restriction site for *HinfI* restriction enzyme was found to be in 1825<sup>th</sup> position. In *BMP4* gene, sequence variation in terms of nucleotide was observed in 1888 and 1991<sup>st</sup> position. Upon restriction mapping of the partial sequence of *BMP4* gene, the restriction site for *HaeIII* was found to be in 1812<sup>nd</sup> position.

All the sequences of the *IGF1*, *GDF9*, *BMP15* and *BMP4* genes showed 99-100% similarity among all the sequenced samples irrespective of variation in kid size and growth.

The present study indicated that indigenous sheep of Assam is a small sized animal having high fecundity and reproductive efficiency with excellent meat producing ability. The information obtained on body weight, and reproductive performance of indigenous sheep of Assam under their native field condition can be utilized for their further improvement. Variation present in the traits under study suggested that there is scope to improve these sheep through selection. Presence of polymorphism in *BMP4* gene in indigenous sheep of Assam opens interesting prospects for future selective breeding programme, especially based on marker-assisted selection.

# Genetic Studies on Growth Performance of Crossbred Pigs

*Racy Rongpi*

The present study was carried out in 1025 piglets belonging to two genetic groups viz. Hampshire crossbred and crossbred of Tamworth and Desi (TND) pigs that were being bred and maintained at the Regional Pig Breeding Farm, Kyrdekulai, Meghalaya. Performance records of 379 and 646 piglets born to 136 gilts/dams and 25 sires belonging to the two genetic groups during the year 2016-2019 were studied with a view to assess the genetic and phenotypic parameters of growth traits viz. body weights at different ages and daily body weight gains during pre-weaning and post-weaning periods.

The overall least-squares means for body weight(kg) at birth, 4th week, 8th week, 12th week, 16th week, 20th week and 24th week of age were found to be  $1.247 \pm 0.007$ ,  $5.615 \pm 0.013$ ,  $11.302 \pm 0.032$ ,  $17.246 \pm 0.029$ ,  $23.349 \pm 0.053$ ,  $30.584 \pm 0.064$  and  $38.528 \pm 0.057$  respectively. The overall least-squares means (LSM) for daily body weight gain during the period from birth to 8thweek, 8thto 24thweek and birth to 24thweek of growth period were found to be  $179.532 \pm 0.528$ ,  $243.0.20 \pm 0.462$  and  $221.866 \pm 0.335$  respectively.

The least-squares analysis of variance showed highly significant effect of genetic group on body weight at all ages except at 12thand 16thweek of age. Significantly higher body weight was observed in Hampshire crossbred pigs. The least squares analysis of variance for effect of genetic group on daily body weight gain showed highly significant difference between 8thto 16thweek and birth to 24thweek of growth period. Significantly higher daily body weight gain was observed in Hampshire crossbred pigs.

The effect ofsex was found to be significant at all stages of growth in respect of body weight and daily body weight gains.

The least squares analysis of variance showed non-significant effect of season on body weight at all ages except at 20thweek (between Season 1 and Season 3) and 24thweek (between all the 3 seasons) of age. Piglets born during May to October month (Season 2) maintained significantly higher body weights than the animals born during

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February to March (Season 1) and December to January (Season 3). The least squares analysis of variance showed significant effect of season on daily body weight gain during various stages of growth except during birth to 8thweek growth period.

The heritability estimates of body weight at birth, 4thweek, 8thweek, 12thweek, 16thweek, 20thweek and 24thweek of age were found as  $0.392\pm 0.128$ ,  $0.104\pm 0.009$ ,  $0.268\pm 0.016$ ,  $0.408\pm 0.022$ ,  $0.338\pm 0.020$ ,  $0.130\pm 0.013$  and  $0.940\pm 0.042$  respectively. The heritability estimates of daily body weight gain during birth to 8thweek, 8th to 24thweek and birth to 24thweek growth period were found as  $0.288\pm 0.020$ ,  $0.980\pm 0.044$  and  $0.844\pm 0.040$  respectively.

The estimates of phenotypic correlation coefficients among body weight at birth with 4<sup>th</sup> week, 8<sup>th</sup> week, 12<sup>th</sup> week, 16<sup>th</sup> week, 20<sup>th</sup> week and 24<sup>th</sup> week of age were found as  $0.056\pm 0.034$ ,  $0.080\pm 0.033$ ,  $0.271\pm 0.032$ ,  $0.316\pm 0.031$ ,  $0.081\pm 0.036$  and  $0.061\pm 0.037$  respectively; between body weight at 4<sup>th</sup> week with 8<sup>th</sup> week, 12<sup>th</sup> week, 16<sup>th</sup> week, 20<sup>th</sup> week and 24<sup>th</sup> week as  $0.274\pm 0.032$ ,  $0.322\pm 0.030$ ,  $0.350\pm 0.029$ ,  $0.376\pm 0.031$  and  $0.169\pm 0.036$  respectively; between body weight at 8th week with 12thweek, 16thweek, 20<sup>th</sup> week and 24<sup>th</sup> week of age as  $0.288\pm 0.031$ ,  $0.550\pm 0.024$ ,  $0.542\pm 0.025$  and  $0.132\pm 0.036$  respectively; between body weight at 12<sup>th</sup> week with 16<sup>th</sup> week, 20<sup>th</sup> week and 24<sup>th</sup> week of age as  $0.488\pm 0.026$ ,  $0.481\pm 0.028$  and  $0.095\pm 0.035$  respectively; between body weight at 16<sup>th</sup> week with 20<sup>th</sup> week and 24<sup>th</sup> week of age as  $0.488\pm 0.027$  and  $0.179\pm 0.036$  respectively and between body weight at 20<sup>th</sup> week with 24<sup>th</sup> week of age as  $0.125\pm 0.028$ . The estimates of phenotypic correlation coefficients among daily body weight gain during birth to 8<sup>th</sup> week with 8<sup>th</sup> to 24<sup>th</sup> week, 8<sup>th</sup> to 24<sup>th</sup> week with birth to 24<sup>th</sup> week and birth to 8<sup>th</sup> week with birth to 24thweek were found as  $-0.182\pm 0.036$ ,  $0.425\pm 0.030$  and  $0.813\pm 0.012$  respectively.

The estimates of genetic correlation coefficients among body weights at birth with 4<sup>th</sup> week, 8<sup>th</sup> week, 12<sup>th</sup> week, 16<sup>th</sup> week, 20<sup>th</sup> week and 24<sup>th</sup> week of age were found as  $0.259\pm 0.019$ ,  $0.125\pm 0.014$ ,  $0.700\pm 0.006$ ,  $0.594\pm 0.009$ ,  $0.130\pm 0.002$  and  $0.170\pm 0.010$  respectively; among body weight at 4<sup>th</sup> week with 8<sup>th</sup> week, 12<sup>th</sup> week, 16<sup>th</sup> week, 20<sup>th</sup> week and 24<sup>th</sup> week of age as  $0.286\pm 0.003$ ,  $0.389\pm 0.003$ ,  $-0.107\pm 0.004$ ,  $0.502\pm 0.005$  and  $0.146\pm 0.003$  respectively; among body weight at 8<sup>th</sup> week with 12<sup>th</sup> week, 16<sup>th</sup> week, 20<sup>th</sup> week and 24<sup>th</sup> week of age as  $-0.078\pm 0.002$ ,  $0.137\pm 0.002$ ,  $-0.055\pm 0.004$  and  $0.192\pm 0.002$  respectively, among body weight at 12<sup>th</sup> week with 16<sup>th</sup> week, 20<sup>th</sup> week and 24<sup>th</sup> week of age as  $-0.214\pm 0.002$ ,  $0.589\pm 0.003$  and  $0.119\pm 0.005$  respectively; among body weight at 12<sup>th</sup> week with 20<sup>th</sup> week and 24<sup>th</sup> week of age as  $-0.101\pm 0.004$  and  $0.257\pm 0.004$  respectively and among body weight at 20<sup>th</sup> week with 24<sup>th</sup> week of age as  $0.294\pm 0.002$ . The estimates of genetic correlation coefficients among daily body weight gain during birth to 8thweek with 8<sup>th</sup> to 24<sup>th</sup> week, 8<sup>th</sup> to 24<sup>th</sup> week with birth to 24<sup>th</sup> week and birth to 8<sup>th</sup> week with birth to 24<sup>th</sup> week growth period were found as  $0.052\pm 0.003$ ,  $0.526\pm 0.002$  and  $0.077\pm 0.002$  respectively.

# **Certain Productive and Reproductive Performance of Sahiwal Cattle under Organized Farm Condition of Assam**

*Upasana Baruah*

Sahiwal breed of cattle is best known among the farmers and breeders for its outstanding capacity to produce a large quantity of milk. The original habitat of this milch breed falls in the Sahiwal area in the Montgomery district of Punjab in Pakistan. This study aims to examine the performance of the breed outside its breeding tract, mainly in the high humid conditions of North East India, in particular Assam.

The present study was carried out in Sahiwal cattle farm, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati by utilizing a total of 43 numbers of animals including 18 numbers of adult Sahiwal cows and 25 numbers of calves.

The major objectives of the present study were to study the production and reproduction traits of Sahiwal cow; to study the persistency of their first lactation milk yield; to study the percentages of different milk constituents in Sahiwal milk; to study the growth performance of Sahiwal calves from birth to six months of age at monthly interval.

The Least Squares Analysis of Variance Technique of Harvey (1975) as suitable for non-orthogonal data was used to study the effects of various genetic and non-genetic factors on different economic traits. To make a pair-wise comparison among the means, Duncan's Multiple Range Test (DMRT) as modified by Kramer (1957) was used wherever significant differences among different levels of factors were observed.

The least-squares means for average daily milk yield, average total lactation milk yield, peak mild yield, first lactation milk yield was found as  $3.30 \pm 0.13$  kg,  $697.94 \pm 43.58$  kg,  $10.09 \pm 0.58$  kg,  $1541.00 \pm 161.77$  kg, respectively.

The lactation order and period of milking had a highly significant effect ( $P < 0.01$ ) on the average daily milk yield. The lactation order did not show any significant effect but the period of milking had a significant effect on the average total milk yield ( $P < 0.05$ ). Lactation order had no significant influence on the peak mild yield and the first lactation milk yield.

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The first lactational length and first dry period were calculated out with simple average analysis and reported as  $274.83 \pm 14.48$  days and  $254.33 \pm 49.54$  days, respectively. The coefficients of variation for the above two mentioned traits were 18.25% and 67.47%, respectively.

The overall means for age at sexual maturity, age at first fertile service, age at first calving, first service period, first gestation length and first inter calving period were reported as  $892.89 \pm 43.20$  days,  $1044.79 \pm 37.16$  days,  $1236.79 \pm 92.83$  days,  $153.21 \pm 21.60$  days,  $283.00 \pm 1.44$  days,  $532.42 \pm 51.24$  days, respectively. The coefficient of variation for this mentioned traits were 20.53%, 13.31%, 28.08%, 52.76%, 1.90% and 33.34%, respectively.

Persistency of first lactation milk yield for Sahiwal cow along with the coefficient of variation was found as  $95.79 \pm 1.68$  kg and 6.09% respectively.

The least-squares means for presence of fat, solid not fat, protein, and density in the Sahiwal milk were  $4.42 \pm 0.02$  %,  $8.45 \pm 0.01$  %,  $3.23 \pm 0.01$  %, and  $29.34 \pm 0.04$ , respectively in our study.

Least squares analysis of variance technique revealed that season had a highly significant effect ( $P < 0.01$ ) on the fat, solid not fat and on the protein percentage but there was no significant effect of season on the density of milk. Least squares means and standard errors were calculated separately for the four seasons in such a way that for fat, the values were  $4.45 \pm 0.03$ %,  $4.28 \pm 0.02$ %,  $4.36 \pm 0.03$ %, and  $4.60 \pm 0.04$  in pre-monsoon season (S1), monsoon season (S2), post-monsoon season (S3) & winter season (S4), respectively. Means for SNF were  $8.48 \pm 0.02$ %,  $8.37 \pm 0.01$ %,  $8.39 \pm 0.02$ % and  $8.57 \pm 0.02$  in S1, S2, S3 & S4 seasons, respectively. Percent presence of protein were  $3.16 \pm 0.01$ %,  $3.21 \pm 0.01$ %,  $3.26 \pm 0.02$ % and  $3.27 \pm 0.02$  in S1, S2, S3 & S4 seasons, respectively. Again the values for density were  $29.43 \pm 0.07$ ,  $29.24 \pm 0.05$ ,  $29.28 \pm 0.08$  and  $29.42 \pm 0.09$  in S1, S2, S3 & S4 seasons, respectively. The period of milking had a highly significant effect ( $P < 0.01$ ) on the fat, solid not fat, protein percentage, and on the density of milk. The least-squares means of fat were  $4.11 \pm 0.02$ % in the morning period and  $4.73 \pm 0.02$  % in the evening period. The values were  $8.16 \pm 0.01$ % &  $8.75 \pm 0.01$ % for SNF;  $3.09 \pm 0.01$ % &  $3.36 \pm 0.01$ % for protein and  $28.66 \pm 0.05$  &  $30.02 \pm 0.05$  for density in the morning period and in the evening period, respectively.

The least-squares means for body growth in Sahiwal calves on the day of birth, 1st month, 2nd month, 3rd month, 4th month, 5th month, and 6th months were  $26.96 \pm 0.27$  kg,  $32.03 \pm 0.47$  kg,  $37.03 \pm 0.62$  kg,  $42.91 \pm 0.76$  kg,  $48.45 \pm 0.77$  kg,  $55.22 \pm 0.77$  kg and  $62.08 \pm 0.88$  kg, respectively.

Least squares analysis of variance technique revealed that sex had a significant effect ( $P < 0.05$ ) on the bodyweight of calves during the day of birth and at the 4<sup>th</sup> month of age, but there was no any effect of sex in the 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 5<sup>th</sup> and the 6<sup>th</sup> months of age. The body weights of male calves were found significantly higher than that of female calves. The least-squares means for male calves were  $27.54 \pm 0.39$  kg,  $32.71 \pm 0.68$  kg,  $38.30 \pm 0.89$  kg,  $44.43 \pm 1.10$  kg,  $50.27 \pm 1.10$  kg,  $56.53 \pm 1.11$  kg and  $63.16 \pm 1.27$  kg

from birth to six months of age, respectively. On the other hand, least-squares means for female calves were  $26.38 \pm 0.37$  kg,  $31.35 \pm 0.66$  kg,  $35.77 \pm 0.85$  kg,  $41.39 \pm 1.06$  kg,  $46.62 \pm 1.06$  kg,  $53.91 \pm 1.07$  kg,  $60.99 \pm 1.22$  kg from birth to six months of age, respectively. The male calves were found significantly higher than the female calves.

The information generated under the study will be helpful to understand the performance of Sahiwal cattle in the region and subsequently develop some policies for this unique germplasm.

# **Performance of Binjharपुरi Cattle in Its Breeding Tract**

*Shrabanee Nayak*

The present study was conducted on 507 lactation records of Binjharपुरi cows from different clusters namely Chandramu, Chatishdebil, Ratlanga, Rudrapur, Sujapur in the Jajpur district of Odisha. The data were first analysed by least-squares variance technique of fitting constants to estimate the mean performance and the effect of genetic and non-genetic factors on production, reproduction, production efficiency and milk quality traits. The least-squares mean for production traits were estimated as lactation milk yield  $974.490 \pm 6.788$  kg, average daily milk yield  $3.557 \pm 0.023$  kg, Peak milk yield  $4.633 \pm 0.0213$  kg, days to attain peak milk yield  $59.225 \pm 0.298$  days, monthly milk yield  $84.280 \pm 0.372$  kg, lactation length  $274.444 \pm 1.249$  days and dry period  $121.913 \pm 0.611$  days for overall lactations. Non-significant influence of location was found on peak yield, significant effect on days to attain peak yield and rest of the production traits had highly significant relationship with location. The lactation order had highly significant effect on all production traits. Season of calving had highly significant influence on lactation milk yield and average daily milk yield, while it had significant effect on lactation length and non-significant influence on rest of the production traits. The sex of calf showed nonsignificant influence on all the production traits. The average age of Binjharपुरi heifers at first calving was observed to be  $1452.332 \pm 10.160$  days. The least-squares mean and standard error for different reproduction traits from overall lactations are  $115.061 \pm 1.106$  days for service period,  $281.296 \pm 0.193$  days for gestation period,  $396.357 \pm 1.088$  days for calving interval. The location had highly significant influence on service period, calving interval, age at first calving with exception of gestation period having nonsignificant effect. The lactation order had highly significant effect on service period and calving interval while significant effect on gestation period. The season of calving had highly significant effect on service period, calving interval and non-significant influence on rest of the reproduction traits. The sex of calf had non-significant influence on all the reproduction traits. The present investigation was also carried out on different compositional parameters of milk expressed in different traits like fat per cent, solid-notfat per cent,

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total solids per cent, protein per cent and finally the density which were estimated to be  $5.503 \pm 0.087$  per cent,  $8.004 \pm 0.124$  per cent,  $13.507 \pm 0.121$  per cent,  $3.379 \pm 0.066$  per cent and  $26.981 \pm 0.411$  respectively. The least-squares analysis of variance revealed highly significant influence of lactation order on fat per cent, solid-notfat per cent, total solids per cent where as significant effect on protein per cent and nonsignificant effect on density of the milk of Binjharपुरi cows. The reports on production efficiency traits *viz.*, milk yield per day of first lactation length (MY/FLL), milk yield per day of first calving interval (MY/FCI) and milk yield per day of age at second calving (MY/ASC) were found to be  $3.352 \pm 0.051$  kg/day,  $2.188 \pm 0.031$  kg/day and  $0.475 \pm 0.007$  kg/day respectively. The MY/ASC and MY/FLL were significantly affected by the location while no significant effect of location was observed in case of MY/FCI. The season of calving showed highly significant effect on all the production efficiency traits. The variation of the traits showed no significant difference due to sex of calf.



## Characterization of Indigenous Geese of Assam

*Hanidul Hoque*

The present study carried out in indigenous geese of Assam belonging to, Udalguri, Nalbari, Darrang and Barpeta district. Data pertaining to a total of 251, 686, 184, 845 nos. of geese and 32 nos. of eggs were utilized to study physical characteristics; body weight and body measurements; productive and reproductive traits; mortality percentage and egg quality traits. Indigenous geese were found to be Cinnamon coloured with border plumage pattern and White coloured with solid plumage pattern. Bill colour was observed to be black, orange, yellow and admixture of black and orange. Shank and feet colour were observed to be orange and yellow. Least-squares means (LSM) for body weight at hatching, 1 month, 2 months, 3 months, 4 months, 6-8 months and 12 months and above age were found to be  $0.087 \pm 0.001$ ,  $0.514 \pm 0.005$ ,  $1.699 \pm 0.043$ ,  $2.740 \pm 0.031$ ,  $3.030 \pm 0.022$ ,  $3.480 \pm 0.055$  and  $3.970 \pm 0.025$  kg respectively. LSM for body length, body circumference, bill length, bill width, head length, head width, neck length, breast length, shank length and feet length were  $8.606 \pm 0.020$ ,  $12.437 \pm 0.119$ ,  $1.813 \pm 0.022$ ,  $1.125 \pm 0.015$ ,  $2.610 \pm 0.03$ ,  $1.496 \pm 0.018$ ,  $2.820 \pm 0.024$ ,  $6.259 \pm 0.025$ ,  $2.802 \pm 0.021$  and  $2.686 \pm 0.022$  cm at hatching;  $17.151 \pm 0.158$ ,  $18.59 \pm 0.163$ ,  $3.228 \pm 0.031$ ,  $1.626 \pm 0.020$ ,  $5.671 \pm 0.040$ ,  $2.267 \pm 0.030$ ,  $6.398 \pm 0.040$ ,  $14.426 \pm 0.181$ ,  $5.461 \pm 0.047$  and  $5.151 \pm 0.050$  cm at 1 month;  $28.220 \pm 0.535$ ,  $30.080 \pm 0.496$ ,  $5.044 \pm 0.090$ ,  $2.060 \pm 0.028$ ,  $6.805 \pm 0.067$ ,  $2.655 \pm 0.036$ ,  $11.036 \pm 0.247$ ,  $16.686 \pm 0.128$ ,  $6.688 \pm 0.069$  and  $6.191 \pm 0.066$  cm at 2 months;  $36.700 \pm 0.329$ ,  $38.040 \pm 0.332$ ,  $6.784 \pm 0.067$ ,  $2.123 \pm 0.025$ ,  $6.793 \pm 0.066$ ,  $2.702 \pm 0.047$ ,  $14.036 \pm 0.104$ ,  $21.944 \pm 0.206$ ,  $7.206 \pm 0.037$  and  $6.764 \pm 0.037$  cm at 3 months;  $37.956 \pm 0.326$ ,  $39.220 \pm 0.286$ ,  $7.012 \pm 0.041$ ,  $2.359 \pm 0.028$ ,  $7.674 \pm 0.036$ ,  $3.144 \pm 0.034$ ,  $16.168 \pm 0.129$ ,  $24.169 \pm 0.109$ ,  $7.916 \pm 0.040$  and  $7.458 \pm 0.043$  cm at 4 months;  $40.282 \pm 0.349$ ,  $42.580 \pm 0.405$ ,  $7.697 \pm 0.055$ ,  $2.496 \pm 0.028$ ,  $7.997 \pm 0.046$ ,  $3.414 \pm 0.030$ ,  $17.186 \pm 0.100$ ,  $25.623 \pm 0.237$ ,  $8.052 \pm 0.038$  and  $7.586 \pm 0.037$  cm at 6-8 months and  $44.954 \pm 0.159$ ,  $48.876 \pm 0.192$ ,  $8.491 \pm 0.017$ ,  $3.304 \pm 0.017$ ,  $9.723 \pm 0.037$ ,  $4.207 \pm 0.019$ ,  $19.097 \pm 0.051$ ,  $27.998 \pm 0.099$ ,  $8.376 \pm 0.016$  and  $7.954 \pm 0.016$  cm at 12 months and above age. Body weights and body measurements were found to be significantly higher in males. Geese from Darrang district were found to have significantly higher body measurements. LSM for

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age at first egg, annual egg production, clutch size and clutch interval was found to be  $320.196 \pm 2.882$  days,  $19.886 \pm 0.306$  nos.,  $9.897 \pm 0.143$  nos. and  $59.206 \pm 0.531$  days. Two laying cycles in a year observed i.e. September to November and December to February and each laying cycle ranged from 12 days to 1 month. Average egg weight, shape index, shell weight, shell thickness, specific gravity, albumen index, Haugh unit and yolk index were found to be  $115.445 \pm 2.320$  g,  $70.476 \pm 1.120$ ,  $16.756 \pm 0.282$  g,  $0.560 \pm 0.009$  mm,  $1.285 \pm 0.017$ ,  $0.075 \pm 0.001$ ,  $64.662 \pm 1.201$  and  $0.362 \pm 0.006$ . Yolk colour observed to be yellow and sometimes orange. Egg shell colour was observed white and sometime cloudy white. Geese found to be quite broody. Average fertility and hatchability % (TES) were found to be 87.11% and 80.53%. Average mortality % were recorded as 12.93, 9.52, 6.74 and 3.07 % for 0 to 1 week, 2 to 4 weeks, 4 to 20 weeks and 24 weeks and above age groups.

# **Performance of Indigenous Chicken in Certain Districts of Assam under Backyard Farming System**

*Jehirul Islam*

The study was conducted on indigenous chickens of Darrang and Udalguri district of Assam to evaluate growth, performance and reproductive traits. Data on body weights relating to 747 birds were used in the study. The data of 115, 137 and 95 number of birds were utilized for age at first egg, annual egg production and reproductive traits respectively. Fifty eggs were randomly collected for the study of egg quality traits. Data were collected during the period from August, 2020 to June, 2021 through field survey and interviewed the farmers with pre-tested questionnaire. The overall least-squares means of body weight at day old stage, 20 weeks and 40 weeks were found to be  $28.332 \pm 0.218$ ,  $745.719 \pm 4.479$  and  $1296.984 \pm 6.971$  g respectively. The body weight of males at 20 weeks and 40 weeks were found to be  $779.924 \pm 7.995$  g and  $1389.121 \pm 11.670$  g and the corresponding values of females were found to be  $711.513 \pm 5.407$  g and  $1204.846 \pm 8.691$  g respectively. Chicken of Darrang district had higher body weight of  $29.002 \pm 0.304$ ,  $750.310 \pm 6.215$  and  $1302.030 \pm 9.596$  g at day old stage, 20 and 40 weeks of age than Udalguri district with  $27.662 \pm 0.314$ ,  $741.128 \pm 6.461$  and  $1291.938 \pm 10.142$  g respectively. Significant effect of district on body weight at day old stage ( $P < 0.01$ ), 20 weeks ( $P < 0.05$ ) and 40 weeks ( $P < 0.01$ ) were observed. The overall least-squares means for age at first egg was found to be  $199.286 \pm 4.236$  days. The least-squares means for age at first egg in Darrang and Udalguri district were  $196.741 \pm 7.986$  and  $201.831 \pm 9.022$  days respectively which were found to be non-significant. The overall least-squares means for annual egg production was found to be  $65.236 \pm 0.813$  numbers. The least-squares means for annual egg production in Darrang and Udalguri district were  $67.901 \pm 1.137$  and  $65.570 \pm 1.162$  numbers respectively which

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were found to be significant ( $P < 0.01$ ). The overall mean for egg weight (g), Albumen index, Yolk index, Haugh unit, Shell thickness (mm) and Shape index were recorded as  $40.54 \pm 0.63$ ,  $0.077 \pm 0.003$ ,  $0.502 \pm 0.006$ ,  $70.213 \pm 0.700$ ,  $0.323 \pm 0.003$  and  $75.725 \pm 0.407$  respectively. The egg shell colours were mostly light brown followed by creamy white. The average fertility and hatchability were recorded as 90.75 % and 87.42 % respectively.

# **Effect of Supplementation of Certain Anti-oxidants (Vitamin E, Vitamin C and Selenium) on The Growth Performance of Broiler Chicken During Heat Stress**

*Chanra Deep Singh*

An experiment was conducted to determine the effects of level of inclusion of the different anti-oxidant combinations on broiler chicken during heat stress. One hundred eighty (n=180) day old broilers chicks of vencobb 400 strain were distributed randomly into 5 groups (T0, T1, T2, T3 and T4) having 36 chicks in each on the basis of their body weight. Each group divided into three replicates of 12 chicks in each. The control group was fed with standard starter and finisher rations, computed by using common feed ingredients to meet the nutrient requirement as per ICAR (2013) for broiler chicken and other four groups (T1, T2, T3 and T4) were offered the the same standard ration of the control group but supplemented with the combination of vitamin E , vitamin C and Se in the drinking water as follows : T1 (vitamin E@100mg/ltr and Se@0.2mg/ltr), T2 (vitamin E@100mg/ltr and Se@0.3mg/ltr), T3(vitaminE@100mg/ltr and vitamin C@100mg/kg )and T4 (vitamin E@200 mg/ltr and vitamin C@200 mg/ltr). The result of the experiment showed significantly ( $P<0.05$ ) higher in body weight, total weight gain, total feed intake and overall FCR in the groups T1 and T4 than the control, T2 and T3 groups. Broiler performance efficiency index was found better in T1 and T4 groups. Significant difference ( $P<0.05$ ) was observe in the level of Hb and WBC whereas, PCV did not differ significantly ( $P>0.05$ ) among the groups. Supplemented groups showed significant better glucose and protein content in the serum. Serum Electrolyte and liver enzymes were significantly better ( $P<0.05$ ) in the T1 and T4 groups than other groups. Erythrocytic antioxidants viz, Catalase, SOD and Reduced glutathione, are significantly higher in the T1 and T4 groups. Heat shock protein was found highly significant ( $P<0.01$ ) between control and supplemented groups. Whereas, no significant difference ( $P>0.05$ ) was recorded in the carcass characteristics viz. dressing percentage, prime cuts percentage, giblet weight and lymphoid organs weight. WHC, drip loss, pH and TBARS values were noted significantly better in the T1 and T4

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groups than T0, T2 and T3 groups. The study revealed that the supplementation of vitamin E and Se @ 100mg and 0.03mg/ltr. and vitamin E and C @200mg/ltr. increased the profit for broiler production.

On the basis of above experimental findings, combination of vitamin E and Se @ 100mg and 0.03mg/ltr. & vitamin E and C @200mg/ltr was found to be better on the growth performance during heat stress.

# **Evaluation of Banana Stem and Urea Treated Paddy Straw Based Complete Rations for Growing Crossbred Calves**

*Keruulenuo Yhome*

An experiment was conducted to evaluate banana stem and urea treated and untreated paddy straw based complete rations on the growth performance, feed intake, nutrient utilization, blood biochemicals and cost of feeding on growing crossbred (HF×J) male calves. A standard concentrate mixture (C) having CP-20% and TDN 75% was prepared using conventional ingredients. Two isonitrogenous and isocaloric complete rations *viz.* T1 using 20% banana stem and 30% paddy straw with concentrate ingredients in the ratio of 50:50 roughage and concentrate and T2 using 20% banana stem, 30% urea (3%) treated paddy straw with concentrate ingredients at the ratio of 50:50 roughage and concentrate were prepared. Banana stem and paddy straw were chopped into 2-3 cm long before mixing. Chopped banana stems were cooked for 15 minutes before mixing. Fifteen weaned crossbred (HF×J) male calves with average body weight of 87.7 kg were divided randomly into three groups *viz.* C, T1 and T2 consisting of five (5) animals each in randomized block design. A feeding trial for a period of 90 days duration followed by a metabolic trial of 5 days duration were conducted in the last week of the feeding trial. Calves belongs to control (C) group were fed with standard concentrate mixture (C), mixed green fodder and paddy straw. Calves of group T1 and T2 were fed with complete ration T1 and T2, respectively. Each calf became one replicate for their respective group since they were fed individually during entire feeding trial. Amount of feed were adjusted every fortnightly along with the body weight change to meet the nutrient requirements as per ICAR (2013) standard for growing calves. Daily feed consumption and fortnightly body weight of calves were recorded. Blood samples were collected from each calves at initial (0th day), mid (45th day) and end (90th day) of the experiment to estimate the blood biochemicals. Feed and biological samples were analyzed as per standard procedures (AOAC, 2007), Van Soest *et al.* (1991), Talapatra *et al.*(1940) and blood samples using method described in the kits. Data obtained were analyzed statistically as per procedure suggested by Snedecor

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and Cochran, (1994) and significance of difference by Duncan's Multiple Range Test (Duncan, 1995) using SPSS 20.0 version.

The DMI per animal per day, per 100 kg body weight and per kg W0.75 were comparable among the groups and no significant difference ( $P>0.05$ ) were observed between the groups. Non significant difference were observed among the groups in respect of digestibility coefficient of DM, OM and NFE but there was significant difference ( $P<0.05$ ) in CP, EE, CF, NDF and ADF among the groups and the values were higher in T1 and T2 group as compared to control group C. Calves of different groups were in positive balance of N, Ca and P, however significant different were observed among the group in respect of balance and retention of N, Ca and P. The ADG were  $242.09\pm 32.84$ ,  $256.13\pm 17.55$  and  $280.89\pm 20.63$  g in C, T1 and T2 group, respectively. Non significant difference was observed among the groups in respect of ADG, however values were in increase trend from group C to group T2. The FCE were  $10.48\pm 0.36$ ,  $9.63\pm 0.15$  and  $8.97\pm 0.16$  in C, T1 and T2 group, respectively. The FCE was significantly lower in T1 and T2 groups as compared to the control group C. The complete rations (T1 and T2) were able to meet the DM, CP and TDN requirement as per ICAR (2013) standard for growing male calves. The blood biochemicals viz. serum cholesterol, total protein, serum albumin, serum globulin and albumin/globulin ratio were within the normal range and no significant difference was observed among the groups. The feed cost per kg gain in body weight were Rs. 155.86, Rs. 173.99 and Rs. 153.44, respectively for C, T1 and T2 group, respectively. The nutritive value of the complete ration T1 were CP-14.63%, DCP-11.65% and TDN- 57.53 %, DE- 2.54 MCal/kg and ME- 2.08 MCal/kg and for T2 were CP-14.63%, DCP-11.73%, TDN- 57.98%, DE-2.56 MCal/kg and ME- 2.10 MCal/kg, respectively. Based on the result of the present study, it is concluded that banana stem (*Musa balbisiana colla*) can be used upto 20% in the paddy straw based complete rations for growing calf without any adverse effect.



# **Effect of Supplementation of Garlic and Multi-Strain Probiotics on The Performance of Broiler Chicken**

*Reema Shrestha*

An experiment was conducted to investigate the effect of supplementation of garlic (*Allium sativum*) and multi-strain probiotics (MSP) on the performance of broiler chicken. One hundred eighty (N=180) day old commercial Ven Cobb 50 strain broiler chicks were used having average body weight and was equally divided into four groups having three replicate (15 chicks in each replicate). The dietary treatments were control (T0- basal diet) and group supplemented with 0.25%, 0.50% and 0.75% garlic powder (GP) and multi-strain probiotics (MSP) in T1, T2 and T3, group, respectively. The basal diet was prepared according to ICAR (2013) recommendation for starter and finisher phase by using commonly available feed ingredients. Result of the study showed that average weekly body weight change, gain in body weight and total gain (g/bird) were significantly highest ( $P < 0.05$ ) in T2 (0.50% garlic powder + MSP) group compared to other treatment groups where the total gain in weight (g/bird) were  $1569.90 \pm 4.16$ ,  $1606.89 \pm 0.21$ ,  $1652.85 \pm 0.16$  and  $1402.93 \pm 0.59$ g in T0, T1, T2 and T3 groups, respectively. The feed intake was not differed significantly among the groups. However better ( $P < 0.05$ ) FCR was observed in T0, T1, T2 groups than T3 group. The Broiler Performance Efficiency Index was  $68.26 \pm 4.52$ ,  $82.63 \pm 5.90$ ,  $76.75 \pm 7.91$  and  $62.01 \pm 1.48$  was better ( $P < 0.05$ ) for T0, T1, T2 and T3 groups, where T1 group had highest BPEI among the treatment groups. The digestibility of nutrients and N retention were not showing any significant affect except NFE digestibility was significantly highest in T2 group. The serum glucose, total protein, albumin and globulin did not show any significant effect ( $P > 0.05$ ) among the treatment groups; whereas serum cholesterol and triglycerides were lowest ( $P < 0.05$ ) in 0.50% garlic powder + MSP fed group. Erythrocytic reduced glutathione which was significantly better in T0, T2 and T3 groups as compared to T1 group. The carcass characteristics like dressing percentage, prime cuts, giblet weight and lymphoid organ weight did not differ among the groups. Caecal microbial profile in Lactic acid bacteria was increased ( $P > 0.05$ ) and *E. coli* count

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decreased ( $P>0.05$ ) in T2 group. Whereas, the villi height of jejunum was significantly ( $P<0.05$ ) increased in supplementation of 0.50% garlic powder + MSP in broilers. On the basis of above findings, it can be concluded that 0.50% garlic powder + MSP can be used as synbiotic for better production and health status in commercial broilers.

## **Effect of Feeding Total Mixed Ration and Complete Feed Block on Productive Performance of Crossbred Cows**

*Sikhamoni Haloi*

An experiment was planned and conducted to assess the effect of feeding of total mixed ration and complete feed block on productive performance of crossbred cows compared to conventional feeding system. Eighteen lactating crossbred cows of 1st, 2<sup>nd</sup> and 3rd lactation were randomly divided into three groups of six animals in each group following Completely Randomized Design (CRD) and were allotted to three dietary treatments (T0, T1 and T2). Feeding of animals under T0 group was done in conventional method (separate feeding of concentrate and roughage), whereas T1 and T2 groups were fed complete feed block (CFB) and total mixed ration (TMR), respectively. The feeding trial was conducted for a period of 90 days followed by digestibility trial of 5 days. The average dry matter intake was  $11.09 \pm 0.07$ ,  $11.22 \pm 0.07$  and  $11.17 \pm 0.06$  for T0, T1 and T2 group, respectively and did not differ significantly. The dry matter intake per 100 kg body weight was  $3.65 \pm 0.07$ ,  $3.77 \pm 0.10$  and  $3.70 \pm 0.12$  for the corresponding group. The dry matter intakes per kg W<sup>0.75</sup> body weight were  $152.01 \pm 3.28$ ,  $156.73 \pm 3.78$  and  $153.99 \pm 4.69$ . The percent digestibility of DM, OM, CP, CF, NFE and NDF were significantly higher in T1 and T2 group over T0 group, however digestibility of EE and ADF did not differ significantly. The average daily milk yield was  $7.79 \pm 0.04$ ,  $9.04 \pm 0.03$  and  $8.92 \pm 0.04$  for the T0, T1 and T2 group, respectively which was significantly higher ( $P < 0.01$ ) in T1 and T2 group. The feed conversion ratio per kg of milk yield was  $1.52 \pm 0.01$ ,  $1.31 \pm 0.01$  and  $1.32 \pm 0.01$  for the T0, T1 and T2 group, respectively. The milk constituent like total solid, solid not fat, protein and specific gravity, titratable acidity and pH of milk were not affected by system of feeding. Milk fat content was significantly higher ( $P < 0.05$ ) in T1 and T2 group compare to T0 group. The blood glucose, total serum protein and blood urea nitrogen were comparable among the groups. The cost of milk production was lowest in TMR (Rs.20.11) followed by CFB (Rs.22.93) and conventional system (Rs. 23.40). It could be

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concluded that feeding of complete feed in the form of block (T1) and TMR (T2) gave better results in terms of milk yield, FCM yield, milk fat and digestibility of nutrients over conventional system and system of feeding had no influence on blood biochemical parameters like blood glucose, total serum protein and blood urea nitrogen.

# **Effect of Mannan-Oligosaccharide and Pomegranate (*Punica granatum*) Peel Powder on The Performance of Broiler Chicken**

*Sudhanya Nath*

An experiment was conducted to study the effect of mannan-oligosaccharide (MOS) and pomegranate (*Punica granatum*) peel powder (PPP) on the performance of broiler, nutrient digestibility, blood biochemical and antioxidant profile, gut health, carcass characteristics and intestinal morphology. Two hundred forty (N=240) day old commercial Ven Cobb strain 400 broiler chicks were randomly distributed into 4 groups of 3 replicates of 20 chicks in each. The dietary treatment groups were as follows, T0 (Control; basal diet), T1 (basal diet +0.1% MOS), T2 (basal diet + 0.6% PPP) and T3 (basal diet+0.9% PPP). Chicks were fed ready-made pre-starter diet up to 6 days which was followed by starter and finisher basal (ICAR, 2013) prepared by using common feed ingredients. Results of the study showed significantly (P<0.05) higher body weight, total gain in weight and FCR in T1 and T3 groups compared to control (T0) and T2 group. Whereas, feed intake (g/bird) was not different among the groups. Supplemented groups also showed significant (P<0.05) results in respect of CP metabolizability, EE digestibility and N retention. Broiler performance efficiency index was better (P<0.05) in T1 and T3 groups. Significantly higher (P<0.05) serum glucose, A:G ratio and total cholesterol were observed in treatment groups compared to control. Erythrocytic antioxidant like catalase activity was significantly (P<0.05) higher in T1 and T3 groups. Supplementation of MOS and PPP showed significant improvement in faecal LAB and NH<sub>3</sub>-N concentration. However, the carcass characteristics *viz.* dressing percentage, prime cuts, giblet weight and lymphoid organ weight were not showing any significant results except CP percentage in breast meat. CP percentage was significantly (P<0.05) higher in T1 and T3 groups compared to T0 and T2 groups. The intestinal villi height and crypt depth were greater (P<0.05) in 0.9% PPP supplemented group. The study indicated that supplementation of MOS @ 0.1% and PPP @ 0.9% in broiler rations increased the profit for broiler production and is inevitable for production of cost effective high quality broiler ration. On the basis of the experimental findings, the

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present study showed that 0.1% MOS and 0.9% PPP had better performance in respect of gain in weight, FCR, nutrient digestibility, blood biochemical profile and antioxidant status, gut health and intestinal morphology. Therefore, the PPP can be used as a prebiotic for broiler production.

## **Effect of Feeding Azolla (*Azolla pinnata*) Based Complete Feed Block on Growth, Nutrients Utilization and Blood Biochemical Parameters of Beetal X Assam Hill Goats**

*Mostafizur Ahmed*

Twenty four growing kids (Beetal x Assam Hill Goat) of 3-4 months of age having mean body weight  $8.12 \pm 0.01$  kg were randomly distributed into four groups of six animal in each group as T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> by using randomized block design (RBD). The feeding trial was conducted for 84 days. The control group (T<sub>0</sub>) fed with Complete Feed Block consisting Napier grass and concentrate mixture in the ratio 60:40 to meet the nutrients requirement as per feeding standards of ICAR (2013). In the treatment groups T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub>, the concentrate mixture was replaced with dried Azolla (*Azolla pinnata*) at levels of 10%, 20% and 30%, respectively. The concentrate mixture of experimental groups T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> had 13.01, 13.01, 13.02 and 13.01 percent DCP and 69.98, 69.47, 68.20 and 68.10 percent TDN respectively. At the end of the feeding trial, 5 kids from each group were randomly selected for digestion trial for a period of 3 days after 2 days of adaptation.

The total feed intake and average daily feed intake differed significantly ( $p < 0.01$ ) among the groups and T<sub>1</sub> had significantly ( $p < 0.01$ ) higher intake followed by T<sub>0</sub>, T<sub>2</sub> and T<sub>3</sub>. The total gain and average daily gain in body weight differed significantly ( $p < 0.01$ ) among the groups. Significantly ( $p < 0.01$ ) higher body weight gain was observed in T<sub>1</sub> followed by T<sub>0</sub>, T<sub>2</sub> and T<sub>3</sub>. The feed conversion efficiency (FCE) of T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> groups were  $8.83 \pm 0.16$ ,  $8.38 \pm 0.17$ ,  $9.23 \pm 0.14$  and  $9.57 \pm 0.15$  respectively and significantly ( $p < 0.01$ ) better FCE was observed in group T<sub>1</sub>. Digestibility coefficient of DM, OM, CP and NFE differed significantly ( $p < 0.01$ ) among the groups and significantly higher ( $p < 0.01$ ) digestibility coefficient of DM and CP were observed in group T<sub>1</sub> and lowest in T<sub>3</sub>. Plane of nutrition revealed that the protein and energy received by different treatment groups of kids fulfilled the nutrient requirement as per ICAR (2013).

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The blood biochemical parameters viz. total serum protein, total serum albumin and GGT were within normal range. The average OD value of ELISA showed Azolla has no effect on the immune response. No significant difference ( $p>0.05$ ) was observed among experimental groups in total serum protein, total serum albumin, GGT and humoral immune response.

The cost of feeding per kg live weight gain was lowest in T<sub>1</sub> ( $126.31\pm 2$ ) in comparison to T<sub>0</sub> ( $135.52\pm 2$ ), T<sub>2</sub> ( $136.47\pm 1.94$ ), and T<sub>3</sub> ( $138.67\pm 2.20$ ).

From the present study, it has been revealed that, dried Azolla can be incorporated at 10% level in concentrate mixture of Complete Feed Block of Beetal x Assam Hill Goat kids with a distinct economic advantage without any adverse effect.



# **Effect of Black Pepper (*Piper nigrum*) Supplementation to Diets Containing Different Levels of Energy on the Growth Performance, Nutrient Utilization and Blood Biochemical Profile of Growing Pigs**

*Akash Mahanta*

An experiment was conducted to study effect of black pepper (*Piper nigrum*) supplementation to diets containing different levels of energy on the growth performance, nutrient utilization and blood biochemical profile of growing pigs and to evaluate economics of feeding. Twenty four (24) weaned male castrated crossbred piglets were randomly divided on the basis of body weight into 4 groups i.e. BP0, BP1, BP2, and BP3, comprising 6 piglets in each group. Piglets of all the groups were fed individually. The control group BP0 was fed with a standard grower ration (basal diet) as per ICAR (2013) specification. The pigs in the group BP1 were fed the standard grower ration with supplementation of 0.5% black pepper powder. Pigs belong to group BP2 were fed ration having 3% lower energy with supplementation of 0.5% black pepper powder and the group BP3 fed with the ration having 3% higher energy with supplementation of 0.5% black pepper powder. Blood were collected at 0, 56th and 112th day of the feeding trial and analyzed for blood biochemical parameters. The economics of feeding was calculated.

Significant ( $P < 0.01$ ) differences were observed in fortnightly gain in body weight, average daily gain, overall FCR, digestibility coefficient of dry matter, organic matter and ether extract, blood cholesterol and serum LDL levels. Non significant ( $P > 0.05$ ) difference were observed in total feed intake, digestibility coefficient of crude protein, crude fibre and nitrogen free extract. Economics of production when calculated and revealed that supplementation of black pepper at 0.5% was profitable as compared to feeding ration without supplementation. The highest profit was observed in group BP2. Based on the results obtained in the present study, it could be concluded that growing pigs could be reared more profitably and with better blood biochemical profiles on a ration supplemented with @ 0.5% black pepper.

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## **Effect of Feeding Dry *Moringa oleifera* Leaves on Growth Performance and Nutrient Utilization in Crossbred Calves**

*Anisul Hamza*

An experiment was carried out to evaluate the effect of feeding dry *Moringa oleifera* leaf meal (MOLM) on growth performance, nutrient utilization, biochemical parameters and cost of feeding. Twenty four numbers of crossbred calves of same age group were selected irrespective of sex and distributed randomly into four groups (T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub>) of six animals in each group. 84 days feeding trial was carried out. The control group (T<sub>0</sub>) was fed with conventional feed comprising concentrate mixture, green grass (Napier) and paddy straw. The treatment groups were fed with roughage (green and dry roughage) same as control and iso-nitrogenous concentrate mixture with inclusion of 5% MOLM in T<sub>1</sub>, 10% MOLM in T<sub>2</sub> and 15% MOLM in T<sub>3</sub>. At the end of feeding trial 5 days metabolic trial was conducted with 5 animals from each group.

The feed intake was not affected due inclusion of MOLM in calves diet. However, total body weight gain, average fortnightly and daily gain differed significantly among the groups and highest observed in T<sub>3</sub> group followed by T<sub>2</sub>, T<sub>1</sub> and T<sub>0</sub>. Significantly (P<0.05) better FCE was observed with the increasing level of MOLM inclusion i.e. better in T<sub>3</sub> followed by T<sub>2</sub>, T<sub>1</sub> and T<sub>0</sub>. No significant difference (P>0.05) were observed in respect of digestibility coefficient of DM, OM, CF, EE, NFE, NDF and ADF among the groups, however CP digestibility was significantly (p<0.01) higher in T<sub>3</sub> and lowest in T<sub>0</sub>. All animals of different groups were observed positively balanced in case of nitrogen, calcium and phosphorus balance. Significantly higher retention of nitrogen and calcium were observed in T<sub>3</sub> group and lowest in T<sub>0</sub> group. Plan of nutrition revealed that protein and energy received by the treatment groups were adequate as per ICAR 2013 requirement.

Blood biochemical parameters viz. Blood glucose, serum total protein, serum albumin, serum globulin, blood urea nitrogen and gamma glutamyl transpeptidase were within the normal range and did not affected by MOLM feeding in calves. But, blood SOD

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were significantly ( $P < 0.01$ ) higher in groups fed with MOLM included concentrate feed. The relative feed cost per Kg weight gain was lowest in T<sub>3</sub> followed by T<sub>2</sub>, T<sub>1</sub> and T<sub>0</sub>.

The present study revealed that the dried *Moringa oleifera* can be included in the concentrate mixture of calves upto 15% without any adverse effect to improve their performance and to reduce the cost of feeding.

## **Performance of Broiler Chicken Fed on Diet Supplemented With Oregano Essential Oil**

*Biswajit Borah*

An experiment was conducted to study the performance of broiler chickens fed on a diet supplemented with Oregano Essential Oil. For the study, One Hundred eighty (n=180) Day old Broiler chicks of Ven Cobb 430Y strain were randomly divided into four groups (T0, T1, T2 and T3) having 45 chicks per group on the basis of their body weight, the groups were again subdivided into 3 replicates of 15 birds each. The control group was fed with basal diet or the standard pre-starter, starter and finisher diet which were formulated to meet the nutrient requirements as per ICAR, 2013 with the locally available ingredients. And the other three groups were fed with the same basal diet like the CONTROL group but with an additional supplementation of Oregano Essential Oil in the following concentrations: T1 (OEO@200mg/kg basal diet), T2 (OEO@400mg/kg basal diet) and T3 (OEO@600mg/kg basal diet).

The experimental results showed significantly ( $p < 0.05$ ) higher change in the body weight, total gain in the body weight, total feed intake and overall feed conversion efficiency in the groups T2 and T1 than the groups T3 and T0. The Broiler Performance Efficiency Index (BPEI) was also higher in the group T2 followed by T1, T3 and T0 respectively. Digestibility of Dry Matter (DM) and retention of nutrients like Nitrogen were found to be significantly ( $p < 0.05$ ) better in the treatment group than the control group. The Dressing percentage (%PSW) was also significantly improved in the treatment groups; T2 was having the highest dressing % followed by T1, T3 and T0. The weight of the Cut Parts (%PSW) was better in the treatment group; however, there was no significant difference. The giblet weight (%PSW) was also not significantly different among the groups. There was no significant ( $p > 0.05$ ) in terms of Total protein, HDL-C, and LDL-C. The blood lipid profile was also not significantly ( $p > 0.05$ ) different among the different treatment groups. And also there was no significant ( $p > 0.05$ ) difference was observed in terms of caecal microbial load. The study revealed that supplementation of Oregano Essential Oil at a concentration of 200mg/kg basal diet

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improved the net profit of the broiler production. On the basis of all these experimental findings supplementation of OEO @400mg/kg basal diet was found to be better on the growth performance of the broiler chicken.

## **Effect of Feeding Varying Levels of Subabul (*Leucaena leucocephala*) Leaf Meal on the Performance of Broiler Chicken**

*Tanmoy Medhi*

An experiment was conducted to study the effect of feeding varying levels of subabul (*Leucaena leucocephala*) leaf meal on on growth, nutrient utilization, blood biochemical profile, carcass characteristics and to evaluate economics of feeding in commercial broiler chicken. One hundred eighty (N=180) commercial broiler chicks (Vencobb 400) were randomly distributed into 4 groups (T0, T1, T2 and T3) on live weight basis comprising of 45 chicks in each group with three replicates of 15 chicks in each. The control group (T0) was fed with a standard pre starter, starter and finisher broiler ration as per ICAR (2013) specifications. The chicks belonging to group T1 was fed with standard ration along with 5% inclusion of subabul leaf meal. Birds belonging to group T2 and T3 were fed rations along with inclusion of 10% and 15% subabul leaf meal, respectively in all pre-starter, starter and finisher phases. At the end of pre-starter, starter and finisher phases blood samples were collected and analysed for blood biochemical parameters. Three birds from each group were slaughtered to study the carcass characteristics and chemical composition of meat. The economics of feeding and broiler production were evaluated.

Highly significant ( $p < 0.001$ ) differences were observed in weekly change in body weight, weekly and total gain in body weight, weekly and total feed intake, feed conversion ratio, digestibility of nutrients, retention of nitrogen. Dietary inclusion of subabul leaf meal at 5% level had no adverse effect on growth performance, digestibility of nutrients and carcass characteristics. Non-significant ( $p > 0.05$ ) differences were observed in retention of calcium and phosphorus, dressing percentage, yield of prime cuts, serum total protein, total cholesterol and total triglyceride level. Cost of production when calculated revealed that inclusion of subabul leaf meal at 5% level in broiler rations was more profitable than feeding diets without any inclusion or beyond 5% level

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of inclusion i.e. 10% and 15%. The highest gross profit was observed in treatment group T1, receiving 5% inclusion of subabul leaf meal. Hence, the study indicated that broilers could be reared more economically and profitably on broiler rations with 5% level of subabul leaf meal inclusion.

# **Certain Productive and Reproductive Performance of Sahiwal Cattle Under Organized Farm Condition of Assam**

*Gagan Bhuyan*

An experiment was conducted to investigate the effects of iron nano particles (Ferric phosphate NPs) at different doses on growth, feed conversion efficiency, nutrient utilization, haematological as well as biochemical parameters and immune system of growing pigs. A total of 36 weaned piglets of Large White Yorkshire of average  $16.82 \pm 1.78$  to  $17.30 \pm 2.05$  kg body weight of above two months of age irrespective of sex were selected from ICAR-NRC on Pig, Rani, Guwahati -781131 which were bred, born and raised at the NRCP, Rani pig farm complex. The piglets were randomly allotted to four treatments of nine piglets with three replicates of three piglets in each group on the basis of body weight. Assigned four experimental treatment groups were the T0 (100mg inorganic iron as  $\text{FeSO}_4$ ), T1 (100mg organic iron as iron methionine), T2 (100mg nano iron as ferric phosphate) and T3 (50mg nano iron as ferric phosphate). The basal diet was prepared as per the recommendation of NRC (2012). The feeding trial was conducted for a period of 90 days. At the end of the trial, the average body weight growth were  $51.54 \pm 2.16$ ,  $53.43 \pm 2.62$ ,  $54.69 \pm 2.01$  and  $51.87 \pm 1.42$  kg and the average total weight gains were  $34.65 \pm 0.85$ ,  $35.96 \pm 0.98$ ,  $37.58 \pm 1.02$  and  $34.78 \pm 0.90$  kg for T0, T1, T2 and T3 groups, respectively. Although there were no significant difference in body weight among the treatment groups, a linearly increasing body weight was observed in T2 as compared to other three groups. In body weight gain, it was observed that 60 days onwards, there existed significant difference between T1 and T2 with other two groups ( $P < 0.05$  for 60 and 75 days,  $P < 0.01$  for 90 days). The rate of average feed conversion efficiency of the experimental groups were found to be  $4.92 \pm 0.16$ ,  $4.74 \pm 0.12$ ,  $4.53 \pm 0.13$  and  $4.92 \pm 0.12$  for T0, T1, T2 and T3 groups, respectively where significant difference ( $P < 0.05$ ) existed between T2 and other three groups on 75th day. On 90th day, T2 and T3 differed significantly with T0 and T3 but no significant difference existed between T2 and T3 ( $P < 0.05$ ).

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The digestibility coefficient of DM, OM, EE and CF did not differ ( $P>0.05$ ) significantly among the treatment groups. Nano iron @ 100mg/kg of diet offered group (T2) showed the highest CP digestibility among all. The digestibility of soluble carbohydrate (NFE) was significantly higher in both T2 and T3 group where nano iron was offered in the diet @ 100, 50 mg per kg of diet respectively in comparison to inorganic Fe (T0) and organic Fe (T1) treated group. Significantly ( $P<0.05$ ) highest nitrogen retention was recorded in nano iron @ 100mg/kg of diet offered group as compared to T0 and T3 although no significant difference ( $P>0.05$ ) was observed in the said group (T2) with organic iron provided group (T1). Nitrogen voided was significantly lower in T1 and T2 then the other two groups. Further, it was observed that T2 showed the highest Fe retention and lowest excretion followed by T1, T0 and T3. In terms of haematological profile, higher Hb, RBC and PCV value was observed in group provided with nano iron @100 mg as compared to other three groups. Concentration of red blood cells (RBC) was the lowest ( $P<0.01$ ) in nano iron @ 50mg provided group. However, the other blood parameter like lymphocyte count, monocyte count, eosinophil count, basophil count, neutrophil count and platelet count were not affected by source of dietary iron fortification. The study revealed that nano Fe @ 100mg/kg of diet results in higher serum iron in comparison with organic iron and inorganic iron supplementation. The concentration of blood glucose was found within normal physiological range in all experimental groups and involvement of nano iron @ 100mg/kg of diet resulted higher level of blood glucose in T2 group. T2 showed the significantly higher ( $P<0.01$ ) serum protein, serum albumin value followed by T1, T0 and T3. Other value like globulin, A:G, AST, ALT, BUN showed no significant ( $P>0.05$ ) difference in overall mean value among the treatments. It was observed that T2 and T1 had a significantly ( $P<0.05$ ) higher antibody titers on 14th day than T0 and T3 reflecting better humoral immune response against SRBC (Sheep-Red blood Cells). The phytohemagglutination (skin challenge) test revealed better cell mediated immune response in T2 as compared to other three groups. So, the present study reflects that ferric phosphate nano particles @ 100mg/kg of diet improves growth, FCR, protein and carbohydrate metabolism in grower pig in comparison to inorganic iron ( $\text{FeSO}_4$ ) and organic iron (Methio-chelated) @ 100mg. Increasing the dietary nano iron level in feed have positive effect in haematological parameter like Hb, RBC, PCV, Albumin value without any detrimental changes in the biological marker like AST, ALT, BUN. Further, supplementation of ferric phosphate NPs @ 100mg/kg of diet may have positive effect on the immune system of the body. Thus, the present study reveals that supplementation of ferric phosphate NPs @ 100mg/kg of diet improves the overall growth performance and immunity without any adverse effect on animal's health.

## **Growth Performance of Beetal Kids Feeding on High Plan of Nutrition Under Stall Fed Condition**

*Pallab Borah*

An experiment was conducted to study the growth performance of Beetal goat feeding on different plan of nutrition under stall fed condition. Twelve weaned male Beetal kids with an average body weight of 12.20- 12.82 kg were divided randomly on the basis of live weight into three experimental groups (C, T<sub>1</sub> and T<sub>2</sub>) of four animal each. All group were offered a mixture of green fodder (Para and Napier in 1:1 ratio on DM basis) and respective concentrate mixture i.e., (C, T<sub>1</sub> and T<sub>2</sub>) to the kids of group C, T<sub>1</sub> and T<sub>2</sub> respectively to meet the DM, DCP and TDN requirement at 100, 110 and 120 percent of ICAR (2013) feeding standard for growing kids.

Weighed quantity of concentrate mixture and grasses in the ratio of 60:40 on DM basis were offered daily to meet the nutrient requirements (DM, DCP and TDN) for growing kids gaining @ 75g daily as per ICAR (2013) feeding standard. Rations were adjusted at fortnightly intervals along with change in live weight.

The feeding trial was conducted for a period of 84 days. A digestion trial was conducted for 5 days duration using four animals from each group during the last week of the experiment. Sample of feed offered, residues, faeces were collected and analyzed for proximate composition and fibre content. Blood samples were collected from each animal at initial (0) day and every fortnight interval for six fortnight. At the end efficiency of feed utilization and economics of feeding was calculated.

The fortnightly gain in body weight did not significantly differ among the groups in the 1<sup>st</sup>, 2<sup>nd</sup> and 6<sup>th</sup> fortnight. However, significant difference was observed among the groups at 3<sup>rd</sup>, 4<sup>th</sup> and 5<sup>th</sup> fortnight. Significantly higher ( $p < 0.05$ ) gain in body weight was observed in kids of T<sub>1</sub> and T<sub>2</sub> groups as compared to the group C in 3<sup>rd</sup>, 4<sup>th</sup> and 5<sup>th</sup> fortnights. No, significant difference was observed between group T<sub>1</sub> and T<sub>2</sub>.

The total gain in body weight in kids during entire feeding trial in group C, T<sub>1</sub> and T<sub>2</sub> were  $5.82 \pm 0.22$ ,  $6.28 \pm 0.43$  and  $7.03 \pm 0.36$  kg, respectively. Statistically no significant difference was observed among the groups in respect of total gain in body weight of the experimental kids during entire feeding trial.

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The average daily gain in body weight in group C, T<sub>1</sub> and T<sub>2</sub> were 69.28±2.96, 74.76±2.57 and 83.69±4.46 g/day, respectively. Significantly (<0.001) higher ADG were observed in T<sub>2</sub> group as compared to control group. However, no significant difference was observed between group C and T<sub>1</sub>, and group T<sub>1</sub> and T<sub>2</sub>.

The feed conversion efficiency (on DM basis) in the experimental kids of different groups during entire feeding trial were 6.28±0.63, 6.13±0.39 and 6.36±0.58 in group C, T<sub>1</sub> and T<sub>2</sub>, respectively. No Significant (p> 0.05) difference was observed among the groups in respect of FCE during entire feeding trial.

The dry matter intake per 100 kg body weight of experimental kids were 3.16±0.25, 3.44±0.17 and 3.60±0.10 kg in groups C, T<sub>1</sub> and T<sub>2</sub>, respectively. The dry matter intake per kg metabolic body size of the experimental kids were 65.14±2.53, 71.38±1.46 and 75.35±3.15 g in group C, T<sub>1</sub> and T<sub>2</sub>, respectively.

The digestibility coefficient of DM, OM, CP, EE, CF, NFE, NDF and ADF in group C were 57.54±1.91, 63.70±3.78, 73.00±3.62, 74.65±1.80, 53.42±2.35, 73.78±1.79, 58.65±4.38 and 46.41±1.92 percent, respectively, for group T<sub>1</sub> were 63.99±2.77, 76.55±3.48, 81.03±4.02, 77.31±1.55, 56.41±2.79, 79.52±3.01, 64.11±2.58 and 52.00±3.28 percent, respectively and for group T<sub>2</sub> were 67.00±1.50, 77.90±4.40, 84.94±2.57, 78.41±3.00, 55.46±1.74, 86.58±1.75, 64.65±1.89 and 50.94±1.70 percent, respectively. No significant difference was observed among the groups in respect of digestibility coefficient of Ether Extract, Crude Fibre, Nitrogen Free Extract, Neutral Detergent Fibre and Acid Detergent Fibre. However, significant difference (p<0.05) were observed among the groups in respect of digestibility coefficient of dry matter, Crude protein and organic matter. The digestibility coefficient of DM, CP and OM was significantly (p<0.05) higher in group T<sub>2</sub> as compared to group C and group T<sub>1</sub>.

All the experimental kids of different group received DM, CP, DCP and TDN in 100 percent of the requirement suggested by ICAR (2013) standard. The nutritive value of composite ration in term of CP, DCP and TDN were 16.18±1.02, 11.81±1.08 and 68.02±3.22 percent in group C, 17.79±0.54, 12.75±0.67 and 74.82±2.40 percent in group T<sub>1</sub> and 18.90±0.21, 14.05±0.32 and 81.33±2.96 percent in group T<sub>2</sub>, respectively.

No significant (p>0.05) variation was observed among the groups in respect of value of Blood Urea Nitrogen, Protein, Albumin, Blood Cholesterol, Creatinine, AST and ALT. But significant (p<0.05) difference was observed among the groups in respect of the values of glucose at all six fortnight where values were significantly higher in group T<sub>1</sub> and T<sub>2</sub> as compare to group C.

The cost of feed per kg live weight gain was found to be Rs.135.80±3.77, 139.00±3.79 and 146.37±2.50 in group C, T<sub>1</sub> and T<sub>2</sub>, respectively.

From the results of the present experiment it could be concluded that 100% of ICAR (2013) recommendation of DCP and TDN for growing kids were appropriate for satisfactory growth performance of Beetal kids under stall fed condition. However, for more growth performance, Beetal kids may be reared on higher protein and energy level upto 120% of ICAR (2013) recommendation under stall fed condition in the agro-

climatic condition of Assam and NE region. More elaborative feeding trial with large number of animal is required for ascertain accurate results.

## **Effect of Partial Replacement of Concentrate by Feeding Dried Azolla (*Azolla caroliniana*) on Growth Performance of Crossbred Calves**

*Sunita Kalita*

Eighteen crossbred calves of about 6 to 7 months old weighing average 71.12 kg were randomly distributed into 3 groups of six animals in each group as T<sub>0</sub>, T<sub>1</sub> and T<sub>2</sub> by using completely randomized block design (CRD). The control group T<sub>0</sub> fed with conventional feed comprising concentrate mixture, green grass (Napier) and paddy straw. The treatment groups were fed with dried Azolla (*Azolla caroliniana*) at 10% (T<sub>1</sub>) and 20% (T<sub>2</sub>) level by replacing concentrate mixture and with same green grass (Napier) and paddy straw. The concentrate mixture of the three treatment groups contains 20.20, 20.24 and 20.34 percent CP and 72.75, 72.07 and 71.70 percent TDN in T<sub>0</sub>, T<sub>1</sub> and T<sub>2</sub> group respectively. At the end of the experimental period of 90 days, a metabolism trial was conducted for 5 days.

The mean daily gain and total gain in body weight of T<sub>0</sub>, T<sub>1</sub> and T<sub>2</sub> group differed significantly (P<0.0001) among the groups of the experimental calves and highest in T<sub>2</sub> group followed by T<sub>1</sub> and T<sub>0</sub>. The feed conversion efficiency was 8.15±0.34, 7.90±0.27 and 7.78±0.21 in T<sub>0</sub>, T<sub>1</sub> and T<sub>2</sub> group respectively which had non significant difference (P>0.05) among the groups. DM intake was highest in the T<sub>2</sub> group followed by T<sub>1</sub> and T<sub>0</sub> (P<0.05). Digestibility coefficient of DM, OM, CF, EE, NFE, NDF and ADF had non significant difference among the groups (P>0.05), however digestibility of CP differed significantly (P<0.05) among the groups having highest digestibility in T<sub>2</sub> and lowest in T<sub>0</sub> group. All the animals in different treatment group were in positive balance of nitrogen, calcium and phosphorus. Plane of nutrition revealed that protein and energy received by the different treatment groups of animals were adequate as per ICAR requirement (2013).

The blood constituent viz. blood glucose, total serum protein was within the normal range and highest concentration was observed in T<sub>2</sub> (P<0.05) group and at 90<sup>th</sup> day of experimental period (P<0.0001). The lowest blood urea nitrogen level was in T<sub>2</sub> (P<0.0001) group and at 90<sup>th</sup> day of the experimental period (P<0.0001). The cost of

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feeding per kg live weight gain was lowest in T<sub>2</sub> (Rs.78.14) in comparison to T<sub>1</sub> (Rs. 85.12) and T<sub>0</sub> (Rs. 96.67).

The present study revealed that the dried Azolla (*Azolla caroliniana*) upto 20% level in replacement of concentrate mixture can be fed to crossbred calves without any adverse effect to economize the ration.

## **A Comparative Study on the Performance of Broiler Chickens on Feeding Diets Containing Essential Oil, Antibiotic and Probiotic**

*Baishali Shil*

An experiment was conducted to study the performance of broiler chicken fed diet supplemented with antibiotic, probiotic and clove oil. One hundred eighty (n=180) day old broilers chicks of Ven Cobb 400 strain were distributed randomly into 4 groups (T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub>) having 45 chicks in each group on the basis of their body weight. Each group divided into three replicates of 15 chicks in each. The control group was fed with standard pre-starter, starter and finisher rations, computed by using common feed ingredients to meet the nutrient requirement as per BIS (2007) for broiler chicken and other three groups (T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub>) were offered the same standard ration of the control group but supplemented with the zinc bacitracin antibiotic, multi-strain probiotic and clove essential oil in feed as follows: T<sub>1</sub> (ZincBacitracin@55mg/kg), T<sub>2</sub> (Probiotic@150mg/kg) and T<sub>3</sub> (Clove oil@400ppm).

The result of the experiment showed significantly (p<0.05) higher body weight, total weight gain, total feed intake and overall FCR in the groups T<sub>3</sub> and T<sub>2</sub> than the control and T<sub>1</sub> groups. Broiler performance efficiency index was found better in T<sub>3</sub> and T<sub>2</sub> groups. Digestibility of DM and EE, metabolizability of CP and nitrogen retention were significantly improved (p<0.05) in the treatment groups than control. Significant difference (p<0.05) was observed in the level of Glucose in T<sub>3</sub> group whereas, serum protein, albumin, globulin and A: G ratio did not differ significantly (p>0.05) among the groups. Supplemented groups T<sub>3</sub> and T<sub>2</sub> showed significant (p<0.05) better Cholesterol level in comparison to control and T<sub>1</sub>. Whereas, no significant difference (p>0.05) was recorded in the serum ALT and AST activity. Dressing percentage and prime cuts percentage were significantly better (p<0.05) in the treatment groups than control. Whereas, no significant difference (p>0.05) was recorded in the carcass characteristics viz., giblet weight and lymphoid organs weight. Abdominal fat was noted significantly

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lower ( $p < 0.05$ ) in the  $T_3$  and  $T_2$  groups than  $T_1$  and control groups. Protein percentage of meat is significantly higher in the treatment groups, whereas fat percentage is lower in  $T_3$  and  $T_2$  groups as compared to control and  $T_1$ . The study revealed that the supplementation of multi-strain probiotic @ 150mg and clove oil @400ppm increased the profit for broiler production. On the basis of above experimental findings, supplementation of clove oil @400ppm was found to be better on the growth performance of broiler chicken.



# **Effects of Feeding of Prebiotics, Probiotics and Synbiotics in Broiler Chicken on Corn-Soya Based Diet**

*Aibaniari Fancon*

An experiment was conducted at the Experimental Poultry Shed of the Department of Animal Nutrition, College of Veterinary Science, Assam Agricultural University, Khanapara, Assam to assess the effect of dietary supplementation of Prebiotic, Probiotic and Synbiotic on the performance, nutrient utilization, haemato-biochemical parameters and carcass traits of broiler birds. One hundred and eighty (N=180) day old commercial (Ven Cobb) broiler chicks were randomly distributed into four treatments groups. Each treatment had three replicates with 15 chicks in each replicate. Dietary groups consisted of Group-T0(control) birds which were fed basal diet without any supplementation; In Group-T1, birds were fed basal diet supplemented with Prebiotic (@ 0.2%); Group-T2: basal diet with 0.035% Probiotic; Group-T3(Synbiotic) contains basal diet with Prebiotic @0.2% + Probiotic @ 0.035 respectively. The basal diet was prepared as per ICAR (2013) recommended for Pre-starter, Starter and Finisher phase using commonly available feed ingredients. Results of the study showed that the average weekly body weight change (g/ bird), weekly gain in weight and total gain were significantly higher ( $P<0.05$ ) in synbiotic, i.e., T3 group as compared to the other groups. The total gain in weight during the entire experimental trial was  $1669.46\pm 33.46$ ,  $1724.219\pm 33.14$ ,  $1770.173\pm 38.50$  and  $1827.952\pm 40.36$  (g/bird) for T0, T1, T2 and T3 groups respectively. The feed intake did not differ significantly among the groups. However, significantly better ( $P<0.05$ ) FCR was observed in T3, followed by T2, T1 and T0. The Broiler Performance Efficiency Index (BPEI) among the experimental groups was  $91.06\pm 0.05$ ,  $98.67\pm 0.05$ ,  $104.66\pm 0.04$  and  $109.88\pm 0.05$  for T0, T1, T2 and T3 group, respectively; where T3 showed the best ( $P<0.05$ ) BPEI followed by T2, T1 and T0. The retention of Nitrogen differed significantly among the groups, with T3 showing better results as compared to the other groups. However, Retention of Phosphorus and Calcium did not differ significantly among the groups. The serum total protein, albumin,

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globulin, superoxide dismutase and GGT did not show any significant effect among the treatment groups, however serum cholesterol was lowest ( $P<0.05$ ) in T3 group as compared to the other groups. The dressing percentage, prime cuts, giblet weights, lymphoid organs weight did not differ significantly among the groups. Caecal microbial profile showed that Lactic acid bacteria was increased significantly in the prebiotic and probiotic supplemented groups, whereas *E. coli* count did not show any significant effect among the groups. The net profit per bird was found highest in the T3 group (Rs.20.51), followed by T2 (Rs.16.13), T1 (Rs.12.37) and T0 (Rs.6.54) groups.

**Key words:** Broiler, Prebiotic, Probiotic, Synbiotic, Carcass traits, Haemato-biochemical parameter, Feed conversion ratio.

# **Effect of Dietary Supplementation of Zinc Nano-Particles on Growth Performance of Crossbred Calves**

*Ajay Barman*

An experiment was conducted to evaluate the effect of dietary supplementation of zinc nano-particles (nano-ZnO) on growth performance, nutrient utilization, serum biochemical parameters and cost per kg weight gain in crossbred calves. A total twenty four crossbred calves of average body weight  $91.77 \pm 1.90$  and about 6-8 months of age were randomly selected and divided into 3 groups (T<sub>0</sub>, T<sub>1</sub> and T<sub>2</sub>) of 8 nos each. Experimental calves were provided with green roughage, paddy straw and standard concentrate ration supplemented with inorganic zinc @40 mg/kg DMI in T<sub>0</sub>, nano-zinc oxide @10 mg/kg DMI in T<sub>1</sub> and nano-zinc oxide @20 mg/kg DMI in T<sub>2</sub>. The concentrate ration was prepared as per BIS, 2013 by using conventional feed ingredients viz. maize, wheat bran, rice polish, GNC, MOC, mineral mixture and salt. The feeding trial was carried out for 84 days. Blood collection was done at 0, 42<sup>nd</sup> and 84<sup>th</sup> day for blood biochemical parameter estimation. Humoral immune and cellular immune responses were observed during the end days of the trails. At the end of the feeding trial metabolic trials was conducted for 5 days with 5 animals from each group.

The feed intake in crossbred calves was not affected due to the supplementation of nano-ZnO. However, the total body weight gain and average daily gain were significantly ( $P < 0.01$ ) higher in the nano-ZnO supplemented groups than the inorganic zinc supplemented group. Feed conversion ratio was significantly ( $P < 0.01$ ) better in the groups supplemented with nano-ZnO i.e. T<sub>1</sub> and T<sub>2</sub> compared to the T<sub>0</sub>. No significant difference was observed among the groups in respect of digestibility coefficient of the DM, OM, CP, EE, CF, NFE, ADF, NDF and retention percentages of nitrogen, calcium and phosphorus. The percent CP and TDN received (as per ICAR, 2013) were comparable among the groups.

The haematological parameters viz. serum cholesterol, serum triglycerides, serum creatinine, serum gamma glutamyl transferase, serum albumin: globulin were not significantly affected by supplementation of nano-ZnO. But, superoxide dismutase was

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significantly ( $P < 0.01$ ) higher in the groups supplemented with nano-ZnO compared to the inorganic zinc supplemented group. Significantly better humoral immunity and cell mediated immunity response was observed in T<sub>1</sub> and T<sub>2</sub> groups than the T<sub>0</sub> group. The relative feed cost per kg weight gain was low in the T<sub>2</sub> than other groups.

The present study revealed that the supplementation of nano-ZnO up to 20 mg/kg in calf ration is beneficial in terms of body weight gain, feed conversion ratio, immune response and economics of feeding.

# **Effect of Feeding Nano-Iron on Growth Performance and Nutrient Utilization In Grower Pigs**

*Dangshawa Morung*

An experiment was conducted to investigate the effect of feeding nano-Fe on growth performance and nutrient utilization in grower pigs. Twenty four (N=24) weaned pigs of HDK-75 having average body weight  $21.50 \pm 0.38$  kg of above two months of age irrespective of sex were selected from AICRP pig farm, College of Veterinary Science, Khanapara, Guwahati-22. Selected pigs were randomly allotted in four treatment groups, each group with 6 pigs on body weight basis. The treatment groups were T0 (Control), T1 (100 mg inorganic iron as FeSO<sub>4</sub>), T2 (75 mg organic iron as methiochelated) and T3 (50 mg nano iron as FePO<sub>4</sub>). The basal diet was prepared according to NRC (2012) recommendation for grower pigs. The feeding trial was conducted for 90 days. Result of the study showed that in average fortnightly body weight change, significant difference ( $P < 0.05$ ) was observed from 75th to 90th day. At the end of the feeding trial, the average body weight of different treatment groups was  $50.67 \pm 0.35$ ,  $51.22 \pm 0.44$ ,  $51.76 \pm 0.43$  and  $54.25 \pm 0.47$  kg for T0, T1, T2 and T3 groups, respectively. In body weight gain, significant difference ( $P < 0.05$ ) was observed from 60th to 90th day where the total gain in weight were  $29.17 \pm 0.004$ ,  $29.72 \pm 0.003$ ,  $30.26 \pm 0.001$  and  $32.75 \pm 0.004$  kg in T0, T1, T2 and T3 groups, respectively. The feed intake was not differed significantly ( $P > 0.05$ ) among the different treatment groups. However, FCR showed significant difference ( $P < 0.05$ ) from 60th to 90th day among the different treatment groups. The average FCR of different experimental groups was  $3.72 \pm 0.16$ ,  $3.67 \pm 0.10$ ,  $3.56 \pm 0.19$  and  $3.30 \pm 0.12$  T0, T1, T2 and T3 groups, respectively. The digestibility of nutrient was not showing any significant affect except NFE digestibility which was significantly ( $P < 0.05$ ) higher in T3 group. In hematological profiles, Hb, PCV and RBC values were significantly ( $P < 0.05$ ) higher in T3 group as compared to other treatment groups and there was no significant difference ( $P > 0.05$ ) observed for platelet, WBC, lymphocyte, monocyte and granulocyte count. In blood biochemical parameters, serum protein and serum iron was found significantly ( $P < 0.05$ )

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higher in T3 group and there was no significant difference ( $P>0.05$ ) observed for blood glucose, albumin, globulin, A: G, AST, ALT and BUN but all the values were found within normal physiological range in the present study, thus supplementation of nano-Fe @ 50mg per kg of diet improves overall growth performance of experimental pig (HDK- 75) without adverse effect.

# **Effect of Dietary Supplementation of Cysteine-Protease and 1,4-B-Xylanase and Their Combination In Low Plane of Nutrition on Growth Performance of Commercial Broiler Chicken**

*Mokadesh Ali*

An experiment was conducted to study the effect of dietary supplementation of cysteine- protease and 1,4- $\beta$ -xylanase and their combination in low plane of nutrition on growth, nutrient utilization, blood biochemical profile, carcass characteristics and to evaluate economics of feeding in commercial broiler chicken. One hundred sixty (N=160) commercial broiler chicks (Vencobb 400) were randomly distributed into 4 groups (T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub>) on live weight basis comprising of 40 chicks in each group with four replicates of 10 chicks in each. The control group (T<sub>0</sub>) was fed with a standard pre-starter, starter and finisher broiler ration as per ICAR (2013) specifications. The chicks belong to group (T<sub>1</sub>) was fed with standard ration but supplemented with cysteine-protease (32500 PU/kg of feed) and 1,4- $\beta$ -xylanase (16000 BXU/kg of feed) as per recommended dose of manufacturer. Birds belong to group T<sub>2</sub> and T<sub>3</sub> were fed rations with 4 and 6 percent lower crude protein (CP) and metabolizable energy (ME) content than ICAR (2013) specifications, respectively with supplementation of both cysteine-protease (32500 PU/kg of feed) and 1,4- $\beta$ -xylanase (16000 BXU/kg of feed) in all pre-starter, starter and finisher phases. At the end of pre-starter, starter and finisher phases blood samples were collected and analysed for blood biochemical parameters. Four birds from each group were slaughtered to study the carcass characteristics and chemical composition of meat. The economics of feeding and broiler production were evaluated.

Highly significant ( $p < 0.01$ ) differences were observed in gain in body weight, digestibility of organic nutrients, weight of intestine and abdominal fat pad (% of pre-slaughter live weight), serum albumin-globulin ratio and superoxide dismutase activity.

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Dietary supplementation of cysteine-protease and 1, 4- $\beta$ -xylanase improved feed conversion ratio, protein efficiency ratio and broiler performance efficiency index. Significant ( $p < 0.05$ ) differences were observed in metabolizability of crude protein, retention of nitrogen and yield of total giblet. Non-significant ( $p > 0.05$ ) differences were observed in total feed intake, retention of calcium and phosphorus, dressing percentage, yield of prime cuts, yield of lymphoid organs, chemical composition of meat, serum total protein, albumin, globulin and gamma glutamyl transferase level. Cost of production when calculated revealed that supplementation of cysteine-protease and 1, 4- $\beta$ -xylanase in broiler rations was more profitable than feeding diets without enzymes. The highest gross profit was observed in group T<sub>1</sub> receiving standard rations as per ICAR (2013) specifications supplemented with cysteine-protease and 1, 4- $\beta$ -xylanase. Hence, the study indicated that broilers could be reared more economically and profitably on broiler rations supplemented with cysteine-protease and 1, 4- $\beta$ -xylanase.



## **Effect of Supplementation of Acidifier on The Performance of Broiler Chicken**

*Rupjyoti Dutta*

One hundred twenty day old broiler chick of uniform body weight were divided into 4 different groups of 15 chick each viz. T0, T1, T2 and T3. Birds in all group were offered broiler starter (CP 21.5% and 3056 ME Kcal) and broiler finisher (CP 19.5% and 3100 ME/kg diet) from 0-21 days and from 22-42 days of age respectively. No acidifier was added in the diet of T1 group i.e. control group. The other three groups were fed acidifier in the diet @ 0.1%

At the end of 6<sup>th</sup> week, the average body weight was 2168.37, 2209.17, 2107.53 and 1883.57 and the average total body weight gain was 1906.20, 2154.90, 2029.20 and 1821.30 for T0, T1, T2 and T3 group respectively. The average daily gain was 49.86, 51.31, 48.31 and 43.36 for T0, T1, T2 and T3 groups respectively. The average total feed intake was 3447.82, 3544.42, 3627.23 and 3560.33 and the average feed conversion was 1.73, 1.65, 1.78 and 1.97 for T0, T1, T2 and T3 group. The average weekly protein efficiency rate was 2.99, 3.15, 2.94 and 2.62 for T0, T1, T2 and T3 group. The percentage of retention of nitrogen was 69.21, 70.46, 69.08 and 69.19 calcium was 62.72, 62.57, 61.46, 60.46 and phosphorous was 48.01, 49.19, 49.19 and 50.01 for T0, T1, T2 and T3 group. The average dressing percentage was 73.71, 74.19, 73.40 and 68.45 and total giblet weight percentage were 3.12, 3.06, 3.16 and 3.17 for T0, T1, T2 and T3 group respectively. Meat compositions showed that moisture percentage was 73.62, 73.35, 74.32 and 74.80 for T0, T1, T2 and T3 group respectively. The protein and fat percentage in meat was 18.84, 19.26, 18.82, 17.08 and 6.34, 6.62, 6.28 and 6.04 and 0.75, 0.80, 0.79, 0.74 for ash.

Overall mean concentrations of serum protein, blood glucose level, serum calcium and serum inorganic phosphorous was 3.84, 3.87, 3.78, 3.75, 188.62, 187.46, 184.14, 184.78, 5.22, 6.88, 6.62, 6.58 and 5.43, 5.55, 5.50, 5.63 respectively.

The cost of feeding per kg body weight gain was Rs. 62.16, 58.16, 60.92, 70.21. The cost of feed was cheaper in T1 and T2 as compared to T0 and T3 group. On the

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basis of the above results of the present study it can be concluded that supplementation of acidifier in broiler diet with normal protein and energy diet as per (ICAR 2013) is advantageous for broiler production.

# **Seroprevalence of Leptospirosis in Dairy Cows With Reproductive Disorders and Therapeutic Management of Endometritis**

*Alapa Baba Ikpe*

The present investigation was carried out to study the seroprevalence of leptospirosis in dairy cows with reproductive disorders and therapeutic management of endometritis. A total of 130 sera collected from dairy cows with reproductive disorders maintained by private farmers in different localities in Kamrup (Metro) district and the Instructional Livestock Farm, College of Veterinary Science, A.A.U., Khanapara were screened for leptospirosis by MAT.

The seroprevalence of leptospirosis in dairy cows with reproductive disorders was found to be 14.62 per cent. Twelve *Leptospira* antigen serovars: *L. Australis*, *L. Autumnalis*, *L. Ballum*, *L. Bataviae*, *L. Canicola*, *L. Grippytyphosa*, *L. Hebdomedis*, *L. Pomona*, *L. Pyrogenes*, *L. Sejroe*, *L. Icterohaemorrhagiae*, and *L. Javanica* were used, to screen for leptospirosis. *Leptospira* antibodies were detected in four serovars: *Australis*, *Autumnalis*, *Ballum* and *Bataviae*. *Australis* was found to be the most circulating serovar with 47.37 per cent.

The reproductive disorders reported in the present study were: repeat breeding 41 (31.54%), abortion 34 (26.15%), endometritis 25 (19.23%), post-partum anoestrus 14 (10.77%), dystocia 5 (3.85%), retention of foetal membrane 4 (3.07%), anovulation 2 (1.53%), uterine prolapse 2 (1.53%), silent oestrus 2 (1.53%) and cystic ovaries 1 (0.77%). Repeat breeding was found to be the most prevalent reproductive disorder (31.54%) followed by cases of abortion (26.15%) in Kamrup (Metro) district of Assam. Out of 18 samples, 10 (55.55%) were positive for Gram negative bacteria, 2 (11.11%) for Gram positive bacteria and 6 (33.33%) for both Gram positive and Gram negative bacteria. The bacteria isolated were *E. coli*, *Proteus* spp., *Bacillus* spp. and *Staphylococcus* spp. The Gram negative bacteria were found to be the major cause of endometritis in dairy cows. Levofloxacin was found to be the most effective antibiotic against uterine microflora.

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The overall conception rate after treatment of endometritis with *E. coli* LPS, antibiotics (levofloxacin) and uraksha were 83.33, 66.66 and 33.33 per cent respectively.

## **Addressing Postpartum Anoestrus in Crossbred Cows**

*Dr. Chandra Prakash Dixit*

A study was conducted on 554 crossbred cows to know the incidence of post partum anoestrus and to find out the fortification need of ovsynch and kisspeptin protocol in the treatment of postpartum anoestrous cows maintained in and around Guwahat city, Assam. Fifty postpartum anoestrous crossbred cows were selected based on history and clinico-gynaecological examination. The animals were divided into four treatment groups and treated with ovsynch, ovsynch fortified with minerals and bypass fat, kisspeptin and kisspeptin fortified with minerals and bypass fat. The study revealed that out of 554 crossbred cows surveyed, 32.13 per cent cows had one or the other reproductive disorders. The incidence of anoestrus and repeat breeding was the highest among the various reproductive disorder observed. Anoestrus and repeat breeding were common in cows  $\geq 8$  years of age and at 3rd parity.

Frequent urination and restlessness were observed to be typical behavioural signs of oestrus exhibited by anoestrous cows following different treatment protocols while congested and edematous vulva, good tone of uterus, open cervix and presence of large follicle with soft follicular wall were the most conspicuous physical signs of oestrus. Level of serum oestrogen increased to a significantly high ( $P < 0.01$ ) level upto day 10 of treatment in all treatment protocol groups and the increase was more prominent in cows treated with Ovsynch and fortified Ovsynch protocol as compared to that under Kisspeptin and fortified kisspeptin protocol. Level of progesterone increased significantly ( $P < 0.01$ ) on day 7 and declined thereafter in cows treated with Ovsynch and fortified Ovsynch protocol. Kisspeptin alone or with fortification did not show significantly changes in the level of serum progesterone upto day 10 of treatment. Higher oestrus response was observed in ovsynch + MM+ BPF, kisspeptin and kisspeptin + MM+ BPF than that of ovsynch protocol. Conception rate was recorded to be the highest in animal treated with ovsynch + MM+ BPF protocol.

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**Major Advisor : Dr. Dipak Bhuyan**

## **A Study on Centrifugation Regime and Commercial Extender on Quality of Frozen Beetal Buck Semen**

*Himsikha Chakravarty*

Fifty two pooled ejaculates comprising eighty ejaculates from five adult Beetal bucks maintained at Goat Research Station, AAU, Burnihat collected by artificial vagina method were used to study the effect of centrifugation regime and commercial extender on quality of frozen Beetal buck semen. Thirty six pooled ejaculates were used to find out a suitable centrifugation regime for removal of seminal plasma wherein the effect of three gforces viz., 700 x g, 1100 x g and 1400 x g at three time periods viz., 5, 8 and 11 minutes were studied in Tris extender. The remaining sixteen pooled ejaculates were used for studying the effect of three extenders viz., Tris (control), Optixcell and Bioxcell extenders on quality of frozen semen by using the best centrifugation regime. Freezing of semen was done in French mini straws by rapid horizontal vapour freezing technique.

The percentage of sperm motility, live sperm, intact acrosome and HOST-reacted sperm differed significantly ( $P < 0.0001$ ) between time periods at 700 x g, 1100 x g and 1400 x g centrifugation. On critical difference test mean post-thaw values after freezing semen centrifuged at 700 x g were significantly ( $P < 0.05$ ) higher for 8 minutes than for 11 and 5 minutes, and significantly ( $P < 0.05$ ) higher for 11 minutes than for 5 minutes whereas the post-thaw values at 1100 x g were significantly ( $P < 0.05$ ) higher for 8 minutes than for 5 and 11 minutes and significantly ( $P < 0.05$ ) higher for 5 minutes than for 11 minutes. The sperm motility, live sperm and HOST-reacted sperm at 1400 x g were significantly ( $P < 0.05$ ) higher for 5 and 8 minutes than for 11 minutes while the incidence of intact acrosome was significantly ( $P < 0.05$ ) higher for 5 minutes than for 8 and 11 minutes and significantly ( $P < 0.05$ ) higher for 8 minutes than for 11 minutes. On freezing of washed Beetal buck semen centrifuged at 700 x g for 8 minutes, 1100 x g for 8 minutes and 1400 x g for 5 minutes, the sperm motility, live sperm, intact acrosome and HOST-reacted sperm differed significantly ( $P = 0.0016; 0.0050; 0.0072$  and  $0.0019$  respectively) between centrifugation regimes. The post-thaw sperm parameters were significantly ( $P < 0.05$ ) higher at 1400 x g for 5 minutes and 1100 x g for 8 minutes than

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in 700 x g for 8 minutes. Beetal buck semen washed at 1400 x g for 5 minutes and frozen in Tris, Optixcell and Bioxcell extenders yielded significantly ( $P<0.05$ ) higher post-thaw values for sperm motility, live sperm, intact acrosome and HOST-reacted sperm in Optixcell extender than in Bioxcell and Tris extenders.

## **Pregnancy Diagnosis in Pig With Special Reference to Biomarker Analysis**

*Jyotimalita Roy*

Early pregnancy diagnosis is an important managerial practice for efficient swine operation. It can identify the non-pregnant or open female and reduce the non productive days by rebreeding or culling them as soon as possible. Therefore, the study was undertaken with the objective of finding the most suitable method for early pregnancy diagnosis in pig with special reference to the biomarker analysis. In the present study, real-time ultrasonography, hormone assays (estrone sulfate and progesterone in various body fluids) using ELISA, and biomarker (micro RNA) analysis using Real Time qPCR were conducted to identify early pregnancy in sows with the goal of selecting the most suitable method among them. A total of twenty healthy and fertile sows belonging to similar age group (2-3 years), maintained at ICAR-All India Coordinated Research Project (AICRP) on Pig, A.A.U., Khanapara and S.S. Agro (Pig Breeding Farm), Rani were selected for this study. The sows were categorized into two equal groups as nonbred (control) and bred animals and pregnancy diagnosis methods were applied. Considering the day of insemination as 0 day, pregnancy diagnostic techniques were carried out on the inseminated sows from 7th day onward at an interval of 3 days till 28th day of gestation. The results were compared with that of the non-bred sows of respective parameters. Pregnancy could be diagnosed in 80 per cent tested pigs on 25th day and rest 20 per cent on 28th day, thus 100 per cent sows were diagnosed to be pregnant by real time ultrasonography. Pregnancy diagnosis using hormone assay was carried out by estimating the level of estrone sulfate and progesterone hormone in various samples collected at different days of gestation. A highly significant difference ( $p < 0.01$ ) was observed between the concentration of hormones in non-pregnant and pregnant sows at different days of gestation. Estrone sulfate concentration in serum on day 19 and, saliva and urine on day 16 of gestation were significantly ( $p < 0.01$ ) higher in pregnant sows. Moreover, the Progesterone levels in serum and saliva were also increased significantly ( $p < 0.01$ ) in pregnant sows on days 16 and 19 of gestation as compared to the findings in non-pregnant sows, respectively. In regards to the biomarker

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analysis the expression of miRNA could be detected as early as 7th day of gestation considering miR-17 as target gene.

The results obtained from ultrasonography, hormone assay and biomarker expression were analyzed statistically and finally inference was drawn as the biomarker analysis (miRNA) to be the best and earliest method of pregnancy diagnosis in sows among all the tests applied under this present study.

## **Reproductive Performance in Prepubertal Assam Hill Goat Supplemented with Bypass Fat**

*Arjyarittik Kalita*

Early attainment of puberty and ultimately sexual maturity is very important in the reproductive life of an individual because it increases the productiveness of a herd. Nutrition plays a very important role in enhancing the reproductive performance in animals. The neuronal apparatus which is designed to detect the metabolic rate and energy balance which helps in transmission of circulating concentration of different hormone that in turn signals the nutritional status of the animal to the hypothalamo-pituitary-gonadal axis which affects sexual development. Bypass fat formulation prevents degradation by hydrolysis in the rumen and it can pass to the intestine and get absorbed resulting in more energy to the animals. Fat supplementation in ruminant diet is generally associated with increased cholesterol level, which is a precursor of steroid hormones and hence can improve the reproductive performance. A study was conducted with the primary objectives of evaluating the effect of bypass fat (Hilak, Ayurvet Limited, Delhi) supplementation on reproductive performance and to correlate it with the associated blood biochemical and hormonal profiles of pre-pubertal Assam Hill Goat. A total of 24 numbers of 3 months old pre-pubertal doelings maintained at Goat Research Station, Assam Agricultural University, Burnihat were randomly selected into one control and three treatment groups comprising of 6 animals in each group. Control group was fed with standard basal diet without bypass fat supplementation, treatment 1 group with 10g bypass fat per animal, treatment 2 group with 15g bypass fat per animal and treatment 3 group with 20g bypass fat per animal in addition to the standard basal diet for a period of two months. Blood was collected from each doeling before treatment i.e. day 0, day 30, day 60 and on the day of estrus. Findings of the present study indicated that supplementation of different doses of bypass fat significantly ( $P < 0.05$ ) varied with the period of appearance of first estrus and duration of estrus among the groups. The frequency of occurrence of intermediate estrus was found to be higher (41.66%) in all the groups followed by intense (37.50%) and weak estrus (20.80%). The

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most common behavioural signs of estrus observed in all the groups were bleating (100.00%), tail wagging (83.33 to 100.00%) and standing to be mounted by male (50.00 to 100.00%). The most common physical signs of estrus observed in all the groups were scanty and clear vaginal discharge (50.00 to 100.00%) and hyperemia of vulvar mucous membrane (50.00 to 100.00%). There was no significant difference in the mean percent of different cell types in between the groups observed during the cytological examination of the vaginal epithelial cells. Arborization pattern was found to be mostly typical in T-2 and T-3 groups whereas atypical and no fern pattern was observed mostly in the T-0 and T-1 groups. The conception rate was recorded to be higher in groups T-2 and T-3 (83.33%) than in groups T-0 and T-1 (66.66%). Among the blood biochemical parameters, serum calcium, zinc and copper level varied significantly ( $P < 0.05$ ) between and within the groups without affecting the serum phosphorous level. Superoxide dismutase activity was higher ( $P < 0.05$ ) in 15g and 20g bypass fat supplemented groups as compared to the group fed with 10g bypass fat and control. Serum cholesterol level did not vary significantly between the groups whereas it varied significantly ( $P < 0.05$ ) on different days of observation for all the groups. Serum estrogen level varied significantly ( $P < 0.05$ ) between and within groups with higher values in group T-2 and T-3 groups. Serum progesterone level did not differ significantly in between the groups but significant difference was observed in T-2 group on different days of observation. The Body Condition Score was recorded to be significantly higher in T-2 and T-3 groups. Hence, supplementation of bypass fat to the basal diet of pre-pubertal Assam Hill Goat significantly improved the reproductive performance by shortening age at puberty, increasing the duration and intensity of first estrus and thereby improving the conception rate and Body Condition Score. A significant correlation was observed between reproductive parameters like age at puberty and duration of first estrus with blood biochemical parameters like serum cholesterol, SOD, serum calcium, serum estrogen and progesterone.

# **Correlation of Insulin Like Growth Factor-1 Concentration with Semen Characteristics of Beetal Buck**

*Keshav*

A total of seventy two ejaculates, six from each of twelve adult Beetal bucks maintained at Goat Research Station, AAU, Burnihat, collected using standard artificial vagina and a total of thirty six blood samples, three from each of twelve Beetal bucks, collected on the day of semen collection, were used to study the correlation of serum and seminal plasma IGF-1 concentrations with semen characteristics. IGF-1 concentration was estimated in serum and seminal plasma using the ELISA kit following the standard procedure. Fresh semen attributes *viz.* ejaculate volume, mass motility, individual progressive motility, sperm concentration, sperm viability, intact acrosome, sperm abnormalities, sperm plasma membrane integrity and reactive oxygen species; and frozen semen attributes *viz.* post thaw sperm motility, sperm viability, intact acrosome, sperm abnormalities, sperm plasma membrane integrity and reactive oxygen species were evaluated following the standard procedures.

There was a highly significant positive correlation ( $r=0.4243$ ;  $p<0.01$ ) between IGF-1 concentration in serum and seminal plasma of the Beetal buck. Insulin like growth factor-1 concentration in serum had a highly significant positive correlation with sperm viability ( $r=0.554$ ;  $p<0.01$ ), acrosome integrity ( $r=0.527$ ;  $p<0.01$ ), post thaw sperm motility ( $r=0.407$ ;  $p<0.01$ ), post thaw sperm viability ( $r=0.426$ ;  $p<0.01$ ) and a significant positive correlation with post thaw acrosome integrity ( $r=0.333$ ;  $p<0.05$ ) of the Beetal buck semen. Insulin like growth factor-1 concentration in serum had a highly significant negative correlation ( $r=-0.458$ ;  $p<0.01$ ) with SOD activity in fresh semen.

There was no significant correlation between IGF-1 concentration in serum and ejaculate volume, mass motility, individual progressive motility, sperm concentration, sperm abnormality, plasma membrane integrity and post thaw sperm abnormality, post thaw sperm plasma membrane integrity and post thaw SOD activity. Insulin like growth factor-1 concentration in seminal plasma had a significant positive correlation with individual progressive motility ( $r=0.341$ ;  $p<0.05$ ) and highly significant positive

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correlation with sperm viability ( $r=0.527$ ;  $p<0.01$ ), acrosome integrity ( $r=0.539$ ;  $p<0.01$ ), sperm plasma membrane integrity ( $r=0.464$ ;  $p<0.01$ ), post thaw sperm motility ( $r=0.644$ ;  $p<0.01$ ), post thaw sperm viability ( $r=0.643$ ;  $p<0.01$ ), post thaw acrosome integrity ( $r=0.487$ ;  $p<0.01$ ) and post thaw sperm plasma membrane integrity ( $r=0.521$ ;  $p<0.01$ ). Insulin like growth factor-1 concentration in seminal plasma had a highly significant negative correlation with SOD activity in fresh semen ( $r=-0.714$ ;  $p<0.01$ ) and frozen semen ( $p<0.01$ ) of Beetal buck.

There was no significant correlation between IGF-1 concentration in seminal plasma and ejaculate volume, mass motility, sperm abnormality, sperm concentration and and post thaw sperm abnormality.

IGF-1 in seminal plasma can be considered as biomarker for selection of buck for breeding. However, further validation using a large sample size is required.

## **Nanoemulsions for Reducing Oxidative Stress in Cryopreserved Buck Semen**

*Soihem Diana Rongmei*

ROS production during cryopreservation is inevitable which induces detrimental changes to the plasma, acrosomal and mitochondrial membrane, DNA integrity and tail of the spermatozoa. In the same line of context, anti-oxidative supplements in the semen extender are highlighted to curtail the ROS production but their efficiency rate is variable. Therefore, we hypothesized that incorporating TEYCAE with nano zinc oxide might help to reduce the oxidative stress and maintain the sperm ultrastructure during cryopreservation. With this background, the present study conducted on 24 pooled ejaculates, collected by using standard collection method (artificial vagina) from 4 Beetal bucks (A1, A2, A3 and A4) maintained at Goat Research Station, A.A.U., Burnihat. Fresh and cryopreserved seminal traits of all the 4 bucks were evaluated for routine semen analysis and statistically ( $p < 0.05$ ) best 2 bucks were selected for further study. A total of 10 pooled ejaculates were harvested from the selected two bucks and centrifuged to form the pellet and separate the seminal plasma. The pellet was treated with different concentrations of nano zinc oxide (0, 0.05, 0.1 and 0.2 mg/ml) as additives in TEYCAE and cryopreserved by following standard freezing protocol. After cryopreservation, the nano zinc oxide treated semen samples were evaluated for sperm motility, HOST-reacted sperm, live sperm, live intact acrosome and sperm abnormalities and the mean percentage were recorded as  $59.5 \pm 0.89$ ,  $66.50 \pm 0.76$ ,  $66.5 \pm 0.76$  and  $64.5 \pm 1.16$ ;  $46 \pm 0.33$ ,  $49.3 \pm 0.21$ ,  $49.7 \pm 0.21$  and  $48.5 \pm 0.30$ ;  $73.7 \pm 0.59$ ,  $78.7 \pm 0.33$ ,  $79.3 \pm 0.26$  and  $77.9 \pm 0.45$ ;  $76.3 \pm 0.55$ ,  $82.8 \pm 0.35$ ,  $84 \pm 0.21$  and  $81.9 \pm 0.73$ ;  $11.1 \pm 0.56$ ,  $10.9 \pm 0.31$ ,  $10.3 \pm 0.21$  and  $10.5 \pm 0.42$  respectively, showing significant difference between the treated and non-treated groups in all the parameters except post thaw sperm abnormalities. Biochemical test such as Superoxide dismutase (SOD) and Malondialdehyde (MDA) for non-treated and treated groups were recorded as  $0.2195 \pm 0.03$ ,  $0.7271 \pm 0.48$ ,  $0.8286 \pm 0.04$  and  $0.6651 \pm 0.04$ ;  $1.851 \pm 0.03$ ,  $1.241 \pm 0.02$ ,  $1.176 \pm 0.02$  and  $1.275 \pm 0.02$  respectively, revealing significant difference ( $p < 0.05$ ) in treated groups as compared to the control group, highlighting a

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significant reduction in oxidative stress in nano zinc oxide incorporated samples. The advanced fluorescent dyes technique included membrane integrity using DNA integrity using acridine orange, acrosomal integrity using FITC-PSA, sperm viability using CFDA-PI and mitochondrial membrane potential using JC-1 and the recorded values were  $75 \pm 0.64$ ,  $78.5 \pm 0.61$ ,  $78.5 \pm 0.5$  and  $77.4 \pm 0.61$ ;  $62.9 \pm 0.48$ ,  $66.3 \pm 0.5$ ,  $66.5 \pm 0.57$  and  $66 \pm 1.38$ ;  $65.4 \pm 0.71$ ,  $68.4 \pm 0.58$ ,  $68.5 \pm 0.5$  and  $68 \pm 0.57$ ;  $51.2 \pm 0.38$ ,  $53.1 \pm 0.37$ ,  $54 \pm 0.21$  and  $53 \pm 0.42$  respectively for 0, 0.05, 0.1 and 0.2 mg/ml nano zinc oxide in the TEYCAE. Besides, significantly ( $p < 0.05$ ) lower DNA damage, higher live sperm, acrosome and mitochondrial health were observed in treated groups as compared to the non-treated group. On the other hand, electron microscopy (TEM) of the ultrastructure of the sperm cells detected intact nucleus, mitochondria, outer dense fiber and axoneme but ruptured and separating plasma membrane exposing the acrosome in non-treated group whereas the treated sperm showed distinct intact ultrastructure with intact plasma membrane. Although there was no significant difference among the treated groups but the concentration of 0.1 mg/ml nano zinc oxide revealed positive effect as compared to the other concentration of treatment groups. Hence, nano zinc oxide incorporated at a certain amount act as an effective antioxidant in reducing the cryo-stress and maintaining the quality of the sperm cells.

## **Effect of Bypass Fat and Bypass Protein Supplementation During Transition Period on Reproductive Performance of Assam Hill Goat**

*Akshay Krishnamurti Hegde*

The present study was undertaken to evaluate the response of Assam Hill Goat (AHG) in terms of their productive and reproductive performances upon bypass fat (10g/d/animal) and bypass protein (5g/d/animal) supplementation during the transition period. Twenty-four AHG in transition period (21day prepartum to 21day post-partum) were divided into two equal groups (n=12) viz. T-0 and T-1; where Group T-1 was supplemented with 10 g of bypass fat and 5 g of bypass protein along with their normal diet for a period of 42 days. Group T-0 acted as control and was provided with a normal diet without any supplementation. Blood samples were collected on day -21, -14, -7, 0 (day of kidding), +7, +14 and +21 of the transition period for haemato-biochemical studies. Birth weight (kg), milk yield (ml) and time taken for expulsion of foetus and foetal membrane and incidences of peri-partum diseases were recorded. The results indicated that the supplementation had no significant effect on haematological parameters (TLC, Neutrophil count and Hb), serum Ca, P, glucose, globulin and GGT activity. Serum NEFA levels were significantly ( $p<0.05$ ) lower in supplemented groups on the day of kidding ( $0.75\pm 0.09$  mmol/L) and day 21 of postpartum ( $0.38\pm 0.04$  mmol/L). Significantly ( $p<0.05$ ) higher mean values of total protein on day -14, -7, 0, 7, 14 and 21 ( $6.96\pm 0.21$ ,  $6.99\pm 0.25$ ,  $7.02\pm 0.26$ ,  $7.24\pm 0.28$ ,  $7.03\pm 0.12$  and  $6.95\pm 0.15$  g/dL) and serum albumin values on day -14, 7 and 21 ( $4.46\pm 0.23$ ,  $4.69\pm 0.23$  and  $4.44\pm 0.27$  g/dL) were recorded in T-1 group. Significantly ( $p<0.05$ ) lower mean values of BUN were recorded in T-1 group on day 0, 7 and 21 ( $30.25\pm 1.74$ ,  $35.62\pm 1.58$  and  $42.08\pm 1.45$  mg/dL). The supplemented (T-1) group recorded significantly higher milk yield ( $303.5\pm 21.16$ ,  $306.25\pm 19.67$  and  $310.75\pm 23.93$  ml) on day 14, 21 and 28 respectively after kidding and there was a significant ( $p<0.05$ ) reduction in time taken for the expulsion of foetus ( $89.75\pm 11.84$  mins) and foetal membranes ( $90.50\pm 5.86$  mins). In conclusion the supplementation of bypass fat (10g/day) and bypass protein (5 g/day)

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during the transition period reduced the effect of negative energy balance, facilitated quicker recovery from NEB along with improvement in milk yield and reduced time taken for the expulsion of foetus and foetal membrane.

## **Effect of Additives on Quality of Boar Semen During Preservation At 15°C**

*Mebanshan N. Lyngdoh*

From four experimental Hampshire crossbred boars, 48 ejaculates were collected once weekly by Gloved hand method, 12 ejaculates from each of the four boars maintained at the All India Coordinated Research Project (AICRP) on Pig, College of Veterinary Science, Khanapara, Guwahati were used in the present experiment to study the effect of three additives *i.e.* Butylated Hydroxy Toluene (BHT),  $\alpha$ -tocopherol (Vitamin E) and Curcumin on the quality of boar semen and also to evaluate the best concentration out of three *i.e.* 50  $\mu$ M, 100  $\mu$ M and 200  $\mu$ M during preservation in BOD incubator for 216 hours at 15°C.

There was no significant difference in initial motility between the boars but the volume of gel mass, the strained volume, total ejaculate volume, sperm concentration, and live sperm count, intact acrosome and HOST reacted spermatozoa differed significantly ( $P < 0.01$ ) between the boars. The highest overall mean percentage of motile spermatozoa, intact acrosome and HOST reacted spermatozoa was observed to be attained by semen extended in Modena extender containing BHT as the additive.

The mean sperm motility, intact acrosome and HOST reacted spermatozoa differed significantly ( $P < 0.01$ ) between additives and preservation period. Out of the three additives, BHT was found to be the best followed by Vitamin E based on sperm motility, intact acrosome and HOST.

The highest overall mean percentage of motile spermatozoa, intact acrosome and HOST reacted spermatozoa was observed to be attained by semen extended in Modena extender containing BHT of concentration 100  $\mu$ M.

The mean sperm motility, intact acrosome and HOST reacted spermatozoa differed significantly ( $P < 0.01$ ) between additives and preservation periods. It was observed that the percentage of sperm motility, intact acrosome and HOST reacted spermatozoa declined significantly ( $P < 0.05$ ) with the increase in hour of preservation irrespective of additives.

Out of the three concentrations, 100  $\mu$ M was found to be the best followed by 50  $\mu$ M based on Marginal average sperm motility, intact acrosome and HOST.

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A total of thirty eight pigs were inseminated with 80 ml of semen extended with Modena containing 100  $\mu$ M of BHT that was held for 4 hours at 22°C and subsequently preserved up to 216 hours at 15°C in a BOD incubator. The number of females inseminated using fresh diluted semen and semen preserved for 96, 120, 144, 168, 192 and 216 hours of preservation was 17, 4, 7, 4, 2, 2 and 2 respectively and the conception rate was worked out to be 82.35, 75, 71, 50, 0, 0, 0 respectively.

# **Fertility Status in Relation to the Physico-Biochemical Properties of Cervico-Vaginal Mucus, Serum Minerals Andhormonal Profile in Lakhimi Cattle**

*Bhaskarjyoti Kalita*

The present study was undertaken to find out the fertility status in relation to the physico-biochemical properties of cervico-vaginal mucus, serum minerals (Calcium, Phosphorus and Sodium) and hormone levels (estrogen and progesterone) at estrus. Eighteen apparently healthy Lakhimi cows (G1) and eighteen Lakhimi heifers (G2) were selected for the investigation. The concentration of minerals in cervico-vaginal mucus and serum were estimated by spectrophotometer using commercial kits. In cows having clear, thin, alkaline (pH=7.36±0.08) cervico-vaginal mucus with higher spinnbarkeit value (11.41±0.49 cm), and typical fern pattern were observed to be more fertile. In heifers having clear, thin, alkaline (pH= 7.27±0.07) cervico-vaginal mucus with higher spinbarkeit value (12.10±0.33 cm) and showing typical fern pattern appeared to favour conception.

The mean concentration of calcium, phosphorus and sodium in the cervicovaginal mucus of conceived and non conceived animals of G1 group were 11.31±0.26 and 11.75±0.41mg/dl, 2.14±0.03 and 1.55±0.09 mg/dl, 175.25±3.84 and 162.71±2.54 mEq/L, respectively. The mean±SE of respective parameters in heifers (G2) were 12.51±0.33 and 14.05 ±0.23 mg/dl, 2.01±0.06 and 1.43±0.13 mg/dl, 172.05±6.86 and 122.67±7.61 mEq/L. Significantly higher (P<0.01) phosphorus and sodium, and lower (P<0.01) calcium concentrations in cervico-vaginal mucus of conceived animals from both the groups were observed in sustaining favorable environment for conception. Mean ± SE concentration of serum calcium, phosphorus and sodium in G1 animals were 9.58±0.20 and 8.35±0.20 mg/dl, 4.09±0.05 and 3.51±0.10 mg/dl, 139.69±1.23 and 133.01±1.31 mEq/L in conceived and non-conceived animals, respectively; while they were 10.75±0.14 and 10.11±0.16 mg/dl, 4.11±0.04 and 3.92±0.08 mg/dl, 134.53±1.04 and 130.14±0.66 mEq/L for G2 group. The mean ± SE

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value of estrogen in the serum of conceived ( $10.34 \pm 0.30$  pg/ml) and non-conceived ( $8.97 \pm 0.25$  pg/ml) animals of G1 group differed significantly ( $p < 0.01$ ). Moreover, the estrogen values in G2 group also differed significantly ( $p < 0.01$ ) between the conceived ( $10.29 \pm 0.24$  pg/ml) and non-conceived ( $9.26 \pm 0.28$  pg/ml). However, the serum progesterone levels in both G1 and G2 groups differed non-significantly between the conceived and non-conceived animals.

Based on the results of present study, it could be concluded that the physicochemical properties of cervico-vaginal mucus could be considered as indicators of fertility in Lakhimi cows and heifers.

# **Induction of Postpartum Oestrus in *Lakhimi* Cow Through Hormonal and Nutritional Interventions**

*Chahidur Rahman*

The present investigation was conducted to study the incidence of postpartum anoestrus, changes in certain hormonal and biochemical profiles and to evolve a suitable therapeutic regime for addressing postpartum anoestrus in *Lakhimi* cattle. After screening of 500 *Lakhimi* cows from different villages of Hajo and Boko area of Kamrup (R) district, Assam a total of 42 *Lakhimi* cows having history of more than 90 days postpartum anoestrcity and after confirmation of anoestrus by per-rectal examination and ultrasonography were selected for the study to record the effect of hormonal and nutritional interventions and divided randomly into seven groups comprising six animals in each group *i.e.* Group A, B, C, D, E, F and G. Group A to F received different hormonal and nutritional treatment regimes where group G served as untreated control group. The different treatment regimes studied were Hydroxyprogesterone caproate + eCG, Clomiphene citrate alone, Clomiphene citrate + Mineral mixture, GnRH analogue alone, GnRH analogue + Mineral mixture and Mineral mixture alone. The response to different regimes was studied based on oestrus response, mean interval from the end of treatment to onset of oestrus and conception rate. The blood biochemical constituents, *viz.* serum oestrogen, progesterone, calcium and phosphorus were estimated on the day of treatment, day of induced oestrus and day 20 of breeding.

The study revealed that out of 500 *Lakhimi* cows the incidence of postpartum anoestrus was found to be 20.60 per cent.

Out of six treatment regimes for addressing postpartum anoestrcity, Clomiphene citrate + Mineral mixture administration regime brought about the highest oestrus induction response and conception rate based on treated animals. In the present study the shortest interval from end of treatment to onset of oestrus was found to be in Hydroxyprogesterone caproate + eCG treated group and the longest in GnRH analogue alone.

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In the cows treated with different treatment regimes the serum oestrogen level increased significantly on day of induced oestrus and then decreased on day 20 of breeding. On the other hand, serum progesterone level remained at basal level on day of induced oestrus and then increased significantly on day 20 of breeding in the pregnant cows. The serum calcium and phosphorus level did not differ significantly between various treatment regimes.

# **Metagenomics of Uterine Bacteria of Repeat Breeder Cows and Therapeutic Management of Endometritis**

*Sabera Islam Chowdhury*

The present study was conducted on 610 dairy animals with a view to study the incidence and etiology and metagenomics of uterine bacteria of repeat breeding animals and comparative efficacy of intrauterine treatment of endometritis. The incidence of reproductive disorders of dairy cattle was 42.95 per cent. The incidence of different reproductive disorder out of the total reproductive disorders were anestrus (24.04%), uterine prolapse (4.58%), cervico-vaginal prolapse (2.29%), dystocia (6.87%) and repeat breeding (62.21%). The incidence of various reproductive disorders out of total number of animal examined were anestrus (10.32%), uterine prolapsed (1.96%), cervico-vaginal prolapse (0.98%), dystocia (2.95%) and repeat breeding(26.72%).The incidence of anatomical, functional, infectious and managerial cause of repeat breeding in dairy cattle were 1.22, 29.44, 33.74 and 35.58 per cent, respectively. The incidence of repeat breeding in 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> parity out of the total animals examined having reproductive disorder was found to be 16.41, 20.61 and 25.19 per cent , respectively. Higher incidence of repeat breeding was observed in animals of 3<sup>rd</sup> and above parity. The incidence of repeat breeding in age group of  $\leq 3$  yrs, 4-5 yrs and  $\geq 6$  yrs out of total repeat breeder animals were 20.85, 34.35 and 44.70 per cent, respectively and out of total reproductive disorder it was found to be 12.97, 21.37 and 27.86 per cent, respectively. Highest incidence of repeat breeder was recorded in  $\geq 6$  yrs age group. Taxonomic profiling of the bacterial metagenome of uterine lavage of repeat breeding animals after amplification of V<sub>3</sub> and V<sub>4</sub> regions of bacterial 16S rRNA gene and sequencing by using Next Generation sequencing technology revealed presence of eleven bacterial phyla and they were *Proteobacteria* (33.76%), *Firmicutes* (27.04%), *Bacteroidetes* (14.91%), *Actinobacteria* (14.85%), *Fusobacteria* (3.94%), *Tenericutes* (3.72%), *Spirochaetes* (0.54%), *Synergistetes* (0.53%), *Verrucomicrobia* (0.49%), *Porphyromonas* (0.16%) and *Cyanobacteria* (0.05%). The different organisms isolated from uterine lavages were *Escherichia coli* (35.71%), *Streptococcus* sp. (28.57%),

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*Staphylococcus* sp.(14.28%), *Klebsiella* sp.(7.14%) and *Pseudomonas* sp. (14.28%).The overall mean bacterial load of the nine uterine samples was 12533.33 with a range from 1900 to 63000.The samples positive for single isolate and more than one isolates were 21.42 and 50.00 per cent, respectively. The overall sensitivity of 14 bacterial isolates to Levofloxacin, Cefotaxim, Metronidazole, Amoxicillin, Ceftriaxone and Tetracycline were 85.71, 28.57, 35.71, 21.43, 71.43 and 28.57 per cent, respectively. *E.coli* LPS (100ug), proteolytic enzymes (Trypsin-8mg, Chymotrypsin-8mg, Papain-4mg, Tocopherol-120mg and Retinopalmitate-58mg +20ml normal saline) and Lenovo-AP (Levofloxacin+ Ornidazole+ Alpha Tocopherol) were administered intrauterine in endometritic animals. The percentage of PMN cell of 4.9, 5.2 and 4.4 before treatment reduced to 2.2, 2.3 and 1.6 per cent in subsequent estrus after treatment with *E.coli* LPS, proteolytic enzymes and Lenovo AP, respectively. All the animals were positive before treatment and negative after treatment for white side test. Insemination was carried out in the subsequent estrus and the conception rate was 50.00, 60.00 and 60.00 per cent in cows treated with *E.coli* LPS, proteolytic enzymes and Lenovo AP, respectively.

## **Effect of Preservation on Quality of HD-K75 Boar Semen and Its Molecular Evaluation**

*Surabhi Basumatary*

A total of 24 ejaculates, 6 ejaculates from each of four HD-K75 boars of 10-12 months age maintained at ICAR – All India Coordinated Research Project (AICRP) on Pig, C. V. Sc., A.A.U., Khanapara, Guwahati, are being selected for the present study. The semen was collected by simple fist method once weekly, to study the effect of three different extenders on the quality of boar semen during preservation. After initial evaluation (volume, concentration and initial motility), fresh semen was split into three parts, extended (1:4) with BTS, GEPS and MODENA extenders and hold at 22°C for 4 hours. Then extended semen was incubated at 15°C in BOD incubator upto 120 hours and evaluated for sperm motility, Hyperactivated spermatozoa, live spermatozoa, live acrosome reacted spermatozoa, HOST reacted spermatozoa, DNA integrity and expression pattern of stress and apoptotic related gene at 0, 24, 48, 72, 96 and 120 hours of preservation.

The mean percentage of sperm motility differed significantly ( $P<0.01$ ) between BTS, GEPS and MODENA extenders at 0, 24, 48, 72, 96 and 120 hours of preservation. The mean percentage of sperm motility at each hours of preservation differed significantly ( $P<0.01$ ) between GEPS and MODENA extenders but not between BTS and GEPS extenders. Irrespective of extender there was significant difference ( $P<0.01$ ) between 0, 24, 48, 72, 96 and 120 hours of preservation. Mean sperm motility in MODENA was comparatively higher than BTS and GEPS extender at each hour of preservation.

The mean per cent hyperactivated spermatozoa did not differed significantly between BTS, GEPS and MODENA extender at 0 hours of preservation. However, at 24, 48, 72, 96 and 120 hours significant difference ( $P<0.01$ ) was observed between GEPS and MODENA extender while no significant difference between BTS and GEPS extender. At different hours of preservation it was found significantly differed ( $P<0.01$ ). It was also found that the mean hyperactivated spermatozoa in MODENA extender was

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comparatively higher than BTS and GEPS at each hour of preservation. Moreover, the overall mean value also tends to decrease with increase in hours of preservation.

The mean percentage of live spermatozoa at 0 and 24 hours did not differ significantly between BTS, GEPS and MODENA extenders. However, at 48, 72, 96 and 120 hours of preservation significant difference was observed ( $P < 0.01$ ) between GEPS and MODENA extender, but not between BTS and GEPS extender. Irrespective of extender it was found that there exist significant difference ( $P < 0.01$ ) between 0, 24, 48, 72, 96 and 120 hours of preservation. The mean per cent of sperm motility was found to be higher in MODENA as compared to BTS and GEPS at all hour of preservation.

The mean percentage of live acrosome reacted spermatozoa differed significantly ( $P < 0.01$ ) between GEPS and MODENA and BTS and MODENA extenders at different hours of preservation. However, in GEPS and BTS the findings at 48 and 72 hour and 96 and 120 hour were in close conformity. In MODENA extender, observations in 0, 24 and 48 hours were close to each other. On critical difference test (Duncan method) the means of live acrosome reacted spermatozoa in MODENA extender was significantly ( $P < 0.01$ ) higher than that of BTS and GEPS at 0, 24, 48, 72, 96 and 120 hours of preservation. Between hours of preservation the means of live acrosome reacted spermatozoa was nonsignificant in BTS, GEPS and MODENA extender. The means of live acrosome reacted spermatozoa at 72 hours of preservation was  $65.79 \pm 1.51$ ,  $66.67 \pm 1.42$  and  $67.54 \pm 1.53$  in BTS, GEPS and MODENA respectively.

The mean percentage of HOST reacted spermatozoa differed significantly ( $P < 0.01$ ) between BTS, GEPS and MODENA extender at 48, 72 and 96 hours of preservation. But at all hours of preservation it was higher in MODENA extender as compared to BTS and GEPS. There was significant difference ( $P < 0.01$ ) of HOST reacted spermatozoa at each hour of preservation in BTS, GEPS and MODENA extender. Moreover, overall mean of GEPS and BTS extender was in close proximity to each other. Again, the mean HOST reacted spermatozoa in GEPS extender at 96 and 120 hours were close to each other and the findings of GEPS exceeds that of MODENA and BTS.

The percentage of DNA integrity revealed that in BTS, GEPS and MODENA extender there is no spermatozoa with damaged DNA from 0 to 72 hours of preservation. However, at 96 and 120 hours 0.50% of damaged spermatozoa was observed in BTS extender. It was also found that at 96 hours there was no DNA damaged spermatozoa in GEPS and MODENA but at 120 hours 1.00% DNA damaged spermatozoa was observed in GEPS extender. Further no DNA damaged spermatozoa was observed in MODENA extender from 0 to 120 hours of preservation period.

The mean relative expression of *HSP70* gene in terms of fold change within preservation period was elucidated that at 0, 24 and 48 hours of preservation the expression of *HSP70* gene differed significantly ( $P < 0.01$ ) in BTS extender. In GEPS and MODENA, significant difference ( $P < 0.01$ ) was observed only at 0 and 24 hours of

preservation. On critical difference test (Duncan method) the relative expression of *HSP70* gene in BTS, GEPS and MODENA was found to differ significantly ( $P<0.01$ ) at 24 hours of preservation, with GEPS having the highest expression of *HSP70* gene followed by MODENA than BTS extender. However, it was observed that at 0, 48, 72, 96 and 120 hours of preservation no significant difference was observed between BTS, GEPS and MODENA extenders.

The mean fold change in relative expression of *Cas3* gene in BTS, GEPS and MODENA extender differed significantly ( $P<0.01$ ) at 0, 72 and 96 hours of preservation. On 24, 48 and 120 hours of preservation there was significant difference between BTS and GEPS and BTS and MODENA extenders, but no significant difference was observed

between GEPS and MODENA extender. In BTS extender the means of expression of apoptotic gene differed significantly ( $P<0.01$ ) in between hours of preservation. However no significant difference was observed in GEPS at 48 and 72 hours of preservation and in MODENA at 0 and 120 hours of preservation. The overall fold change value of expression of apoptotic gene was found to be higher in BTS extender followed by MODENA and GEPS.

## **Effect of Commercial Extender and Curcumin as Additive on Quality of Frozen Beetal Buck Semen**

*Bhubaneswar Sahoo*

Forty pooled ejaculates from five Beetal bucks maintained at Goat Research Station, A.A.U., Burnihat collected by artificial vagina method were used to study the effect of commercial extender and curcumin as additive on quality of frozen Beetal buck semen. Twenty pooled ejaculates in experiment I were used to study the effect of two commercial extenders (Bioxcell and Optixcell) on quality of unwashed frozen buck semen taking Tris extender in washed semen as control. In experiment II, using the best extender of Optixcell remaining twenty pooled ejaculates were used for studying the effect of two concentrations (0.25 mM and 0.5 mM) of curcumin and 2 mM vitamin E (control) as additives on quality of frozen semen. Freezing of semen was done in French mini straws by rapid horizontal vapour freezing technique.

The post thaw percentages of sperm motility, live sperm, intact acrosome, HOST-reacted sperm and extracellular ALT and AST activities differed significantly ( $P < 0.0001$ ) between Optixcell, Bioxcell and Tris extenders, but did not differ significantly between extenders for DNA-damaged sperm. On critical difference test mean sperm motility and HOST-reacted sperm after freezing were significantly ( $P < 0.05$ ) higher in Optixcell extender than in Bioxcell and Tris extenders, and also in Tris extender than that in Bioxcell extender. The live sperm and intact acrosome after freezing were significantly ( $P < 0.05$ ) higher in Optixcell and Tris extenders than that in Bioxcell extender. The mean values of extracellular release of ALT and AST after freezing were significantly ( $P < 0.05$ ) lower in semen frozen with Optixcell extender than that with Bioxcell and Tris extenders, and also with Tris than that with Bioxcell extender.

On freezing of unwashed Beetal buck semen in commercial Optixcell extender containing two concentrations (0.25 mM and 0.5 mM) of Curcumin and 2 mM Vitamin E (control), the sperm motility, live sperm and extracellular ALT and AST activities differed significantly ( $P = 0.0073$ ;  $0.0007$ ;  $0.0022$ ;  $< 0.0001$ ), but did not differ significantly for incidence of intact acrosome, HOST-reacted sperm and DNA-damaged

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sperm between additives. Critical difference test revealed that the mean sperm motility and live sperm after freezing were significantly ( $P<0.05$ ) higher in Optixcell extender containing 0.25 mM Curcumin and 2 mM Vitamin E than that in 0.5 mM Curcumin, difference between the former two being non-significant. The extracellular ALT activity was significantly ( $P<0.05$ ) lower in semen frozen with Optixcell extender containing 2.0 mM vitamin E and 0.25 mM curcumin than that with 0.5 mM curcumin while no significant difference in the parameter was observed between the former two additives. The extracellular release of AST was significantly ( $P<0.05$ ) lower for 2 mM vitamin E than that for 0.25 mM and 0.5 mM of curcumin, and also for 0.25 mM curcumin than for 0.5 mM curcumin.

Based on post thaw parameters studied commercial Optixcell extender was found to be superior to Bioxcell and Tris extenders for cryopreservation of Beetal buck semen, and supplementing 0.25 mM curcumin in the extender was found to be at par with 2 mM vitamin E in improving post thaw semen quality as compared to 0.5 mM curcumin.

## **Effect of Different Cryoprotectants on Post Thaw Quality of Porcine Spermatogonial Stem Cell**

*Sunita Thakuria*

A study was conducted to know the effect of different cryoprotectants on post thaw quality of porcine spermatogonial stem cells (SSCs). Testes sample were collected from 7-15 days old pre-pubertal male Crossbred piglets (Local× Hampshire) and transported to the laboratory under aseptic cold condition (15 – 25 °C) within 2 hour to isolate, enrich and culture the porcine spermatogonial stem cells. Isolation of spermatogonial stem cell like cells was done by double enzymatic digestion. The isolated cells were enriched by differential plating and percoll density gradient centrifugation method. Sertoli cell feeder layer obtained from lectin coated dishes after differential plating was also cultured. The SSCs that obtained after enrichment were cultured in DMEM containing growth factor with Sertoli cell feeder layer. Characterization of SSCs was done by alkaline phosphatase staining, immunofluorescence staining using *OCT4* and *SSEA1*, RT-PCR using *OCT4*, *SOX2*, *C-Kit*, *PPARγ* and gel electrophoresis analysis. SSCs were cryopreserved in three different freezing media to compare the best media for cryopreservation of SSCs by analysing morphobiometry and viability of SSCs before and after cryopreservation.

Sertoli cells showed typical morphology having dramatically spread cytoplasm and spindle shaped or fibroblasts like cells having nuclei. SSCs were dome shaped round or oval cell colonies and formed grape like colonies with boundary on 16-18 days of culture. SSCs showed positive alkaline phosphatase staining, positive immunofluorescence staining for both *OCT4* and *SSEA1*. In RT-PCR analysis, expression of specific marker was observed i.e. *OCT4* and *SOX2* but *C-Kit* and *PPARγ* were not expressed and similar result was also obtained in gel electrophoresis. Cells started to distort with irregular boundary and clump formation after cryopreservation in all the three media. SSCs colony number was also significantly higher ( $P < 0.01$ ) before freezing ( $94.89 \pm 1.62$ ) than after freezing in all the three media. Among the three media, higher colony number was found in media 1 ( $68.10 \pm 3.78$ ) than the other two

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**Major Advisor : Dr. Dipak Bhuyan**

media after freezing and thawing. No significant difference was observed in colony diameter among the three media and also before and after freezing. Percentage of SSCs viability was significantly higher ( $P < 0.01$ ) before freezing ( $87.47 \pm 3.68$ ) than after freezing in all the media. Media 1 also showed higher viable cells ( $59.75 \pm 5.92$ ) among the three media after cryopreservation. Media 1 containing ethylene glycol, dimethyl sulfoxide and fructose was found to be the best for cryopreservation of porcine SSCs.



## **Extrapolation of Gestational Curve and Whelping Time in Bitch**

*Chayanika Das*

To study extrapolation of gestational curve and determination of whelping time, gestation period of six (6) crossbred bitches were divided into first, second and third phases; planned to study on 0-day (day of mating), 10th, 20th, 30th, 40th, 50th day and on the day of term or whelping. Different parameters of physical and behavioural signs, extrafoetal and foetal structures, vaginal cytology and haematobiochemical parameters were taken for the study. The per cent mean of enlarged belly (50.00%) and enlarged udder and teats (83.33%) were first found to be recorded from second phase, while, oozing of milk (100.00%) and vulvar swelling (100.00%) were recorded on third phase of gestation, respectively. The occurrence of reduced appetite, decreased activity, restlessness and nesting behaviour of behavioural signs were found 100.00% on day of whelping. Gestational Sac Diameter (GSD) was first recorded ( $02.17 \pm 0.07$  mm) on 20th day of first phase of gestation. Inner Chorionic Cavity (ICC), Crown Rump Length (CRL) and Foetal Head Diameter (FHD) was first recorded as  $15.03 \pm 0.27$  mm,  $12.98 \pm 0.29$  mm and  $07.05 \pm 0.09$  mm, respectively on 30th day of second phase of gestation in crossbred bitch. The FHD was increasing throughout phases of gestation and found  $29.28 \pm 1.11$  mm diameter on day of whelping. There was highly significant ( $P < 0.01$ ) difference between groups, between day of gestation and between interaction groups x days of gestation. The Foetal Heart Rate (FHR) was first recorded on 30th day of second phase of gestation which was found  $207.17 \pm 4.93$  beats/min. FHR was significantly ( $P < 0.01$ ) differed between days; recorded  $146.00 \pm 7.52$  beats/min on day of whelping. On day of mating (0-day), the Large Intermediate and Superficial Keratinized cells were recorded as  $9.00 \pm 0.52\%$  and  $91.00 \pm 0.52\%$ , respectively. On day of whelping, highest ( $59.67 \pm 0.56\%$ ) and lowest ( $2.67 \pm 1.43\%$ ) values were recorded in case of Small Intermediate cells and Superficial Keratinized cells. There was significant difference ( $P < 0.01$ ) between types of cells on different days of first, second and third phase of gestation. While between days of gestation no significant difference was found. Highly significant ( $P < 0.01$ ) difference recorded in interaction between days of gestation x types of cells. Level of progesterone was increasing from 10th day of gestation ( $29.97 \pm 0.54$

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ng/ml) which dropped on day of whelping to  $1.66 \pm 0.25$  ng/ml. Relaxin level reduced on 10th day of gestation ( $0.39 \pm 0.03$  ng/ml) which then gradually was increasing till 50th day of gestation ( $5.54 \pm 0.39$  ng/ml); on day of whelping recorded as  $3.71 \pm 0.86$  ng/ml. Both progesterone and relaxin were significantly ( $P < 0.01$ ) differed between day of gestation in crossbred bitches. There was highly significant ( $P < 0.01$ ) difference of C-Reactive Protein between day of gestation. On day of whelping C-Reactive Protein was recorded as  $11.62 \pm 2.32$  mg/L. There was significant ( $P < 0.01$ ) difference between calcium and phosphorus; significantly ( $P < 0.05$ ) differed on each day of first, second and third phase of gestation. But, non-significant difference recorded between days of gestation and in interaction between minerals  $\times$  days of gestation. On day of whelping, level of calcium and phosphorus was recorded as  $10.21 \pm 0.31$  mg/L and  $4.47 \pm 0.31$  mg/L, respectively. Haemoglobin and glucose per cent was recorded on day of whelping as  $11.07 \pm 0.54$  gm/dl and  $108.18 \pm 2.90$  mg/dl, respectively. The values were differed non-significantly between days of gestation. From this study it was concluded that pregnancy could be first confirmed based on GSD and FHR, respectively by 20th and 30th day of first and second phase of gestation. On day of whelping, examination of vaginal cytology revealed significantly ( $P < 0.05$ ) increased Small Intermediate cells (SIC), while, Superficial Keratinized Cells (SKC) significantly ( $P < 0.05$ ) decreased. Level of progesterone and relaxin hormone significantly ( $P < 0.05$ ) decreased on the day of whelping.

## **Effect of Nano Zinc Supplementation on Reproductive Performance of Assam Hill Goat**

*Dipika Deori*

Zinc is considered to be an essential element required for reproduction. Nanotechnology to produce nano size zinc with their novel properties as large surface area, higher bioavailability, better absorption has been an effective alteration for both organic and inorganic zinc sources. A study was conducted with a primary objectives of evaluating the efficiency of nano zinc (NZn) as feed supplementation on reproductive performance and to extrapolate fertility associated blood biochemical and hormonal profiles of Assam Hill Goat. Twenty-four numbers of 7 days post kidding doe maintained at Goat Research Station, Assam Agricultural University, Burnihat were randomly selected into 4 groups comprising 6 animals each where control group of animals were fed with basal diet without zinc supplementation, for treatment 1 group 25mg NZn, for treatment 2 group 35 mg NZn and for treatment 3 group 50 mg NZn/kg concentrate mixture with basal diet were fed for a period of three months. Blood was collected from each does upto 3 months before treatment, every fortnightly and on the day of oestrus. Does were bred naturally at 24 hours from the onset of oestrus and confirmed for pregnancy after two months. Results indicated that supplementation of different doses of nano zinc significantly ( $P < 0.01$ ) varied with the interval between kidding and occurrence of first post-partum oestrus among the groups without affecting the duration of oestrus, intensity of oestrus, behavioural and physical signs of oestrus. Feeding of NZn-35 and NZn-50 mg resulted higher conception rate of 83.33 per cent as compared to NZn-25 and control (66.66%). As regards to birth shape, lying posture was found to be highest (100.00%) followed by standing posture (33.33%) and very few animals (16.66%) were in attempting to stand while giving birth. The duration of stage I, stage II, stage III of parturition and total time taken for parturition were found to be ranging from  $84.17 \pm 12.54$  to  $86.17 \pm 12.48$ ,  $14.00 \pm 1.46$  to  $17.50 \pm 2.62$ ,  $100.00 \pm 10.57$  to  $105.50 \pm 10.83$  and  $198 \pm 12.23$  to  $209.17 \pm 18.16$  minutes respectively among all the group. Placental weight and number of cotyledons were found to be non-significant

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( $P > 0.05$ ) among the groups. Supplementation of nano zinc had no effect ( $P > 0.05$ ) on haematological parameter viz. PCV (%), haemoglobin (g/dL), RBC ( $10^6/\mu\text{l}$ ) and WBC ( $10^3/\mu\text{l}$ ). However, among other biochemical parameter studied, serum zinc level varied significantly ( $P < 0.01$ ) among the groups without affecting the serum calcium, phosphorous and iron level. The serum zinc level was found to be higher in NZn-50 mg as compared to control and NZn-25 and NZn-35 mg. Catalase and superoxide dismutase activity were higher ( $P < 0.01$ ) in 25 mg and 35 mg NZn/kg concentrate mixture supplemented diets as compared to the group fed with 50 mg NZn/kg concentrate mixture and control. Serum progesterone level varied significantly ( $P < 0.01$ ) between treatment and days interaction with higher values in treatment 2 and treatment 3 group at 70<sup>th</sup> and 84<sup>th</sup> day of observation whereas serum estrogen level did not differ significantly ( $P > 0.05$ ) among the group. Hence, zinc supplementation in the form of nano zinc improved the reproductive performance by shortening the interval between kidding and first post partum oestrus and conception rate without much affecting the other reproductive parameter in Assam Hill goats.

# **Diagnostic and Therapeutic Management of Canine Transmissible Venereal Tumour (CTVT)**

*H. Phunchu Bappo*

A total of 30 numbers of dogs affected with Canine Transmissible Venereal Tumour (CTVT) reported to the Gynaecology O.P.D., Veterinary Clinical Complex, Assam Agricultural University, Khanapara, Guwahati-22 during a period of 1 year from October 1<sup>st</sup> 2021 to September 30<sup>th</sup> 2021 were taken for the present study. CTVT was diagnosed based on the history, clinical examination, cytological and histopathological examination. It was observed that the incidence of CTVT was highest (51.02%) in young sexually active dogs of 0-3 years of age of local breeds specially during winter season. The cytological examination revealed the presence of the characteristic cytoplasmic vacuoles with a high nucleus to cytoplasmic ratio. The histopathological examination revealed multiple mitotic figures, cluster of neoplastic cells with distinct nuclei surrounded by fibrous sheath of connective tissues. The dogs were randomly divided into 3 groups based on the treatment protocol *viz.*, Group A, treated with Vincristine sulphate, Group B, treated with a combination of Vincristine Sulphate and Ivermectin and Group C, treated with a combination of Vincristine Sulphate, Ivermectin and Antioxidant injection, with 10 number of animals in each group. The Haemato-biochemical analysis showed leucocytosis, neutrophilia, monocytosis, lymphopenia, anaemia and hypoglycemia and hypoproteinemia with elevated levels of blood urea nitrogen (BUN) and creatinine in the CTVT affected dogs which normalized with the progression of the treatment. There was also a significant increase in the levels of alkaline amino transferase (ALT), aspartate amino transferase (AST) and alkaline phosphatase (ALP) at the end of the study period. The estimation of free radicals and antioxidants revealed an increase in the level of malaondialdehyde and nitric oxide and a reduced level of catalase, glutathione peroxidase and superoxide dismutase in the CTVT affected dogs. The study of the DNA damagebiomarker revealed an increased levels of 8-Hydroxy 2'deoxyguanosine in all the dogs affected with CTVT. All the dogs in the group treated with a single drug therapy with Vincristine sulphate required a minimum

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**Department : Animal Reproduction, Gynaecology and Obstetrics**

**Major Advisor : Dr. Manjyoti Bhuyan**

of 2 doses of chemotherapy for the complete remission of the tumour while 6 out of the 10 dogs in the group treated with a combination of Vincristine sulphate, Ivermectin and Antioxidant injection needed a single dose of chemotherapy for complete recovery. Seven of the ten dogs in the group treated with a combination of Vincristine and Ivermectin showed complete remission of the tumour with just a single dose of chemotherapy.

## **Preservation of Dog Semen in CLC Loaded Soyabean Extender**

*Kanchan Joshi*

A total of 24 ejaculates were collected two times a week from four clinically healthy dogs, aged between two to six years by digital manipulation method. Four different breeds of dog viz., German Shepherd, Labrador Retriever, Golden Retriever and French Bulldog, reared singly by individual owners residing in different locations of Guwahati were used in the present study. The fresh ejaculates were examined for colour, volume, p<sup>H</sup>, mass activity, sperm motility, live sperm, sperm concentration, acrosome integrity, morphological abnormalities and HOST-reacted sperm by routine methods.

The physical characteristics of freshly collected semen between dogs differ significantly for HOST-reacted sperm and sperm motility, ejaculate volume, sperm concentration and acrosome integrity but mass motility and p<sup>H</sup> did not differ significantly between animals.

Total 24 ejaculates were extended in Tris-soya lecithin-citric acid-fructose and Tris-soya lecithin-citric acid-fructose + CLC extender and preserved at 4-5°C for 72 hours. The semen was assessed at 0, 24, 48 and 72 hours of preservation for sperm motility, plasma membrane integrity (HOST), morphological abnormalities and acrosome integrity. Six out of 24 ejaculates were used to assess DNA integrity and acrosome integrity at 0 and 72 hours of preservation using fluorescent stains acridine orange and FITC-PSA respectively. The sperm motility, HOST-reacted sperm and morphological abnormalities differed significantly (P<0.01) between extenders and between preservation periods. The interaction of extenders and preservation periods was non-significant in sperm motility and HOST-reacted sperm but was significant in morphological abnormalities. The addition of CLC showed significant improvement in motility, and HOST-reacted sperm (P<0.01) but morphological abnormalities were significantly higher (P<0.05) in CLC loaded semen extender. Acrosome integrity differed significantly (P<0.01) between preservation periods but the difference between extenders and interaction of extenders and preservation period was non-significant. DNA integrity of sperms differed significantly (P<0.01) between preservation periods

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but the difference between extenders and interaction of extenders and preservation periods was non-significant. The acrosome integrity (using FITC-PSA) of sperms differed significantly ( $P<0.05$ ;  $P<0.01$ ) between extenders and between preservation periods while the interaction between extenders and preservation periods was non-significant.



## **Performance of Hampshire Piglets Reared on Hot Water Treated Floor**

*Sweta Pachani*

A total of 6 healthy crossbred female dogs were selected to conduct the present study. Observation of physical and behavioural signs along with examination of vaginal cytology was performed on day 1-3, day 4-6, day 7-9 and day 10-12 of proestrual phase for determination of breeding time. On day 10-12 of proestrual phase swollen vulva, bloody discharge and serous discharge of physical signs were recorded as 00.00%, 16.67% and 33.33%, respectively. On the other hand, the behavioural signs of restlessness, attraction of male dog, flagging of tail and acceptance of male were recorded as 00.00%, 100, 0.00%, 66.67% and 66.67% respectively.

Vaginal cytology revealed highest number of anuclear cells ( $92.66 \pm 0.80\%$ ) and lowest number of parabasal cells ( $0.67 \pm 0.33$ ) on day 10-12 of proestrual phase. Mean level of progesterone and relaxin was significantly ( $P < 0.05$ ) found to be highest on day 10-12 and day 7-9 of proestrual phase, respectively. Value of C-Reactive Protein was significantly ( $P < 0.05$ ) the highest on day 10-12 of proestrual phase. Level of calcium was found significantly ( $P < 0.05$ ) higher than phosphorus on day 1-3, day 4-6, day 7-9 and day 10-12 of proestrual phase in crossbred bitch.

For diagnosis of pregnancy gestation period was divided into four periods and accordingly, examination was done on 0-15 days, 16-30 days, 31-45 days and 46-day of whelping.

The gestational sac was detected by using B-mode ultrasonography as early as on day  $20 \pm 0.58$  (19-21 day) and embryo was detected as early as on day  $24 \pm 0.58$  (23-25 day). Fetal Heart Beat, fetal limb buds, fetal movement, fetal head, fetal stomach, urinary bladder and fetal skeleton were detected as early as on day  $29 \pm 0.58$  (28-30 day),  $37 \pm 0.71$  (35-38 day),  $37 \pm 0.71$  (35-38 day),  $40.5 \pm 0.65$  (38-41 day),  $40.5 \pm 0.65$  (38-41 day),  $40.5 \pm 0.65$  (38-41 day) and  $43.5 \pm 0.65$  (41-45 day), respectively. The diameter of gestational sac was recorded as  $12.13 \pm 1.70$  mm on 16-30 days of gestation while on 31-45 days of gestation the crown rump length and fetal head diameter was first found to be recorded as  $55.78 \pm 9.93$  mm and  $17.48 \pm 0.50$  mm, respectively. Fetal Heart Rate could be recorded first on 16-30 days of gestation as  $227.50 \pm 0.50$  beat/minute. Level of

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**Major Advisor : Dr. P. M. Barua**

progesterone and relaxin was significantly increased ( $P < 0.05$ ) in 16-30 days and 31-45 days of gestation, respectively. While, at 46-day of whelping mean level of progesterone was found to be decreased and recorded  $2.51 \pm 0.13 \text{ ng/mL}$ . Level of CReactive protein was significantly ( $P < 0.05$ ) increased in 16-30 days of gestation ( $97.53 \pm 1.62 \text{ mg/L}$ ). In case of calcium and phosphorus no significant difference was observed between period of gestation. There was significant difference ( $P < 0.05$ ) between minerals. Interaction between periods x minerals revealed non-significant difference. The study revealed that breeding time can be determined by behavioural signs of flagging of tail and acceptance of male, increased level of anuclear cells in vaginal cytology, progesterone and C-Reactive Protein in blood serum. Early pregnancy can be diagnosed based on appearance of Gestational Sac, Embryo and Fetal Heart Beat between 16-30 days period of gestation.

# **Influence of Zinc Oxide Nanoparticle on The Growth of Intestinal Epithelium and Microflora in Broiler Chicken (*Gallus gallus domesticus*)**

*Alline Josph Pathil*

Zinc is an essential micronutrient. It is a trace mineral found in feed. Zinc plays a major role in both growing and adult animals. Zinc has a wide range of activities like maintaining the intestinal mucosal integrity, helps in wound healing, as an antidiarrhoeal agent especially in infants, development of gut micro flora, epithelial integrity and as co-factor to very many enzymes. Broilers are the most preferred meat of the people in India. Hence, in the present study zinc oxide nanoparticle was used because of better absorbing and adsorption capacity due to its increased surface area and higher bioavailability. As the application of nanotechnology is on the rise, it is essential to find a optimum dose rate to meet the needs of broiler for increasing their growth performance without hampering their normal health.

A total of 96 broiler chickens were utilized in the present study. The birds were divided into 4 groups; one control ( $E_0$ ) and 3 experimental groups [ $E_1$ (40mg/kg ZONP),  $E_2$ (80mg/kg ZONP) and  $E_3$ (120mg/kg ZONP)]. The birds were slaughtered at 4 different ages viz. 7 days, 14 days, 28 days and 42 days and were utilized for studying the gross characteristics, histomorphology, micrometry and the intestinal microbial load. Six (6) birds from each of the experimental groups of respective ages were sacrificed. Haemato-biochemical parameters of all the birds were studied to check the effects of zinc nanoparticle. Antioxidant profiles of the birds were studied to estimate the zinc antioxidant levels at the various levels in the different experimental groups.

Epithelial height recorded for the various levels of ZONP administered birds were  $27.13 \pm 1.21 \mu$ ,  $22.27 \pm 1.25 \mu$ ,  $25.38 \pm 1.91 \mu$  and  $25.18 \pm 2.07 \mu$  for the experimental groups  $E_0$ ,  $E_1$ ,  $E_2$  and  $E_3$  respectively for the duodenum. The duodenal villi height were recorded as  $1047.71 \pm 83.85 \mu$ ,  $987.67 \pm 80.81 \mu$ ,  $1326.93 \pm 83.70 \mu$  and  $873.20 \pm 104.40 \mu$  for  $E_0$ ,  $E_1$ ,  $E_2$  and  $E_3$  respectively. Duodenal crypt depth for the groups  $E_0$ ,  $E_1$ ,  $E_2$  and  $E_3$  are  $171.98 \pm 17.17 \mu$ ,  $111.10 \pm 5.05 \mu$ ,  $158.14 \pm 14.98 \mu$  and  $147.36 \pm 7.88 \mu$  respectively.

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**Department : Veterinary Anatomy and Histology**

**Major Advisor : Dr. Munmun Sarma**

The jejunal villi length were recorded as  $737.40 \pm 83.31 \mu$ ,  $1156.10 \pm 63.01 \mu$ ,  $1144.46 \pm 118.77 \mu$  and  $593.02 \pm 30.50 \mu$ ; epithelial height were recorded as  $29.08 \pm 2.19 \mu$ ,  $26.79 \pm 1.35 \mu$ ,  $39.03 \pm 0.74 \mu$  and  $31.84 \pm 2.11 \mu$ ; crypt depth were recorded as  $146.00 \pm 10.86 \mu$ ,  $143.64 \pm 12.98 \mu$ ,  $137.02 \pm 7.67 \mu$  and  $86.54 \pm 2.97 \mu$  for the groups E<sub>0</sub>, E<sub>1</sub>, E<sub>2</sub> and E<sub>3</sub> respectively.

The ileal villi length were recorded as  $527.83 \pm 61.79 \mu$ ,  $465.14 \pm 35.74 \mu$ ,  $623.75 \pm 80.54 \mu$  and  $410.10 \pm 22.92 \mu$ , and ileal crypt depth were recorded as  $105.65 \pm 5.31 \mu$ ,  $146.85 \pm 13.25 \mu$ ,  $94.76 \pm 3.92 \mu$  and  $96.63 \pm 4.62 \mu$ ; and ileal epithelial height were recorded as  $21.44 \pm 1.25 \mu$ ,  $18.36 \pm 0.67 \mu$ ,  $25.55 \pm 1.72 \mu$  and  $24.93 \pm 1.74 \mu$  for the experimental groups E<sub>0</sub>, E<sub>1</sub>, E<sub>2</sub> and E<sub>3</sub> respectively.

Histochemical studies revealed that the activity of zinc oxide nanoparticle on the brush border enzymes of the intestinal epithelium increased with the dose of zinc supplemented. Alkaline phosphatase activity and Adenosine triphosphatase activity showed a very strong activity with increase in the age and increase in the administration of zinc oxide nanoparticle. Maximum activity was shown at 80mg/kg ZONP. Acid phosphatase showed a very weak activity, no change with ZONP was observed. Non specific esterase showed a faint to moderate activity, 80mg/kg ZONP administered group showed a moderate activity.

Biochemical activity showed an increase in the liver and kidney markers but they were recorded within the normal range. Antioxidant markers used showed maximum activity for the experimental group where 80mg/kg ZONP was administered. All the biochemical parameters showed a highly significant difference ( $P < 0.01$ ) between the groups and the age groups.

The intestinal microbial count showed a constant growth in all the experimental groups at all the age groups, zinc maintained the microbial load of the intestine. No significant difference was observed between the groups.

The growth performance of the birds increased with the increase in administration of zinc oxide in comparison to the control group. The E<sub>2</sub> group (80mg/kg ZONP) showed the best feed conversion ratio of 1.34 followed by E<sub>3</sub> (120mg/kg ZONP). The highest body weight was recorded in the groups E<sub>3</sub> followed by E<sub>2</sub>. E<sub>2</sub> showed the best dressing percentage of 77.72%. Carcass characteristics did not vary considerably between the groups. Liver weight alone showed an increase in the E<sub>2</sub> and E<sub>3</sub> group.

From the present study therefore, it was evident that there was a highly significant ( $P < 0.01$ ) increase in the anatomical, biochemical and performance traits of the birds in the E<sub>2</sub> group. This could be due to the higher bioavailability of zinc in the system and zinc acts as a natural anti stress factor, hence giving the birds an ambient growth condition. Zinc has a direct effect on the epithelium of the intestine, thereby increasing the enzyme activity of epithelial cells, which increase the functional state of the intestine and thereby increasing the growth performance of the birds.

# **Comparative Anatomical, Haemato-Biochemical and Hormonal Studies on The Female Reproductive System of Kamrupa Variety and Indigenous Chicken (*Gallus domesticus*) of Assam During Different Stages of Laying**

*Mansil M. Sangma*

The present study was conducted on 36 numbers of apparently healthy female chicken which were divided into two groups as Experimental Group A (indigenous chicken of Assam) and Experimental Group B {Kamrupa variety, AICRP (PB)} which were further divided into 3 sub-groups viz., pre-laying, laying and post-laying birds. Forty (40) apparently healthy chicks of each group were raised from day old to maturity and sexing was done after the sexual characteristics were visible and utilized for research purpose. Comparative gross anatomical and histomorphological, histochemical, ultrastructural, hormonal and biochemical parameters were undertaken.

Average weight of entire reproductive system of Kamrupa variety ( $58.24 \pm 8.47$  gm) was significantly higher than indigenous chicken of Assam ( $27.28 \pm 4.25$  gm,  $p < .001$ ). Average weight of the ovary of Kamrupa (laying:  $54.91 \pm 4.92$  gm; post laying:  $6.53 \pm 0.33$  gm) was significantly higher than that indigenous one (laying:  $29.2 \pm 0.76$  gm; post-laying:  $2.26 \pm 0.24$  gm,  $p < 0.05$ ).

Relative mean length of the oviduct of Kamrupa variety (laying:  $753.73 \pm 4.25$  mm; post-laying:  $576.49 \pm 5.27$  mm) was significantly greater than indigenous chicken of Assam (laying:  $358.91 \pm 3.63$  mm; post-laying:  $278.84 \pm 15.48$  mm,  $p < 0.05$ ) respectively. Average diameter of infundibulum of Kamrupa variety (laying:  $4.48 \pm 0.22$  mm; post-laying:  $4.38 \pm 0.04$  mm) was significantly higher than that of indigenous chicken of Assam (laying:  $1.74 \pm 0.08$  mm; post-laying:  $1.9 \pm 0.29$  mm,  $p < 0.05$ ). However, the mean diameter in vagina during post-laying period ( $4.98 \pm 0.15$  mm) of indigenous chicken was significantly greater than Kamrupa variety ( $3.61 \pm 0.18$  mm,  $p < 0.05$ ). The mean diameter was also significantly different within different laying periods in magnum of the indigenous chicken and the vagina of Kamrupa variety ( $p < 0.05$ ).

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**Abstract of M.Sc. Thesis**

**Department : Veterinary Anatomy and Histology**

**Major Advisor : Dr. Kamal Bihari Dev Choudhury**

Histological section of ovary of both the indigenous chicken and Kamrupa variety consisted of an outer cortex and inner medulla, which were intermingled during the early pre-laying stages. However, cortex and medulla were distinctly differentiated during laying period in all the groups. The ovarian medulla was surrounded by elongated bands of smooth muscle along with the presence of connective tissues, blood vessels and fibroblasts in the medulla with aggregation of nerve cells (Ganglion).

The entire oviduct was lined by pseudostratified ciliated columnar epithelium however, the luminal surface of the funnel and tubular part of the infundibulum was lined prominently by ciliated simple columnar epithelium with numerous goblet cells. Relative average height of the epithelium was significantly different during the laying and post-laying period in infundibulum, pre-laying and post-laying period of magnum, laying period of uterus, pre-laying and laying period of isthmus, laying and post-laying period of vagina between the two experimental groups ( $p < 0.05$ ). The average height of the epithelium was also significantly different within the infundibulum of indigenous chicken, magnum of both the varieties, isthmus of Kamrupa and the vagina of Kamrupa variety ( $p < 0.05$ ). Comparative mean height of the glandular epithelium of magnum, isthmus and uterus was highly significant at  $p < 0.05$ , within and between all the experimental groups. The sperm host glands (SHG) were present maximum in indigenous chicken of Assam in uterus and vagina during laying period. Lining epithelium of SHG was cuboidal to columnar.

Histochemically, the intensity for ALP increased from pre-laying to laying period and reduced towards post-laying period. The ACP decreased from pre-laying to post laying period. The ATP activity increased during the laying period. PAS activity was highest in the epithelium of infundibulum and vagina while the rest of the oviduct showed moderate activity during laying. However, PAS activity was more in vaginal epithelium of indigenous chicken of Assam.

Scanning electron microscopic (SEM) study of the infundibulum revealed distinct primary and secondary folding lined by long cilia among the non-ciliated epithelium in both the indigenous chicken of Assam and Kamrupa variety. SEM study of magnum revealed the presence of thick folding which were lined by ciliated epithelium and numerous opening of glands in pre laying, laying and post laying birds in all the experimental groups. The cilia were studded with numerous secretory products which was also observed in uterus and vagina. The isthmus in SEM showed some parallel primary folds with evidence of secondary folding in all the experimental groups. In cross sectional view, the tunica sub-mucosa of isthmus and uterus showed numerous connective tissue in all the experimental groups. The SEM revealed that uterus of Kamrupa variety and indigenous chicken showed numerous thick folds. In the laying Kamrupa variety it was observed that the surface epithelium was constituted with numerous ciliated epithelium with numerous openings of uterine glands. The SEM of vagina revealed longitudinal primary and secondary folds.

Average serum estrogen and progesterone levels were significantly different within the group ( $p < 0.05$ ), however estrogen, progesterone and cortisol were statistically insignificant between the groups with an exception to cortisol which was significantly higher ( $p < 0.05$ ) in indigenous chicken  $12.13 \pm 3.29$  nmol/L than the Kamrupa variety  $3.54 \pm 0.82$  nmol/L respectively.

The average serum total protein level was significantly higher in indigenous chicken than that of Kamrupa during the pre-laying period, ( $p < 0.05$ ). The same was true within the indigenous chicken at the different stages of laying ( $p < 0.05$ ). The mean serum glucose level was highest in the laying period in indigenous chicken and then decreased significantly ( $p < 0.05$ ) in the post laying period. But in Kamrupa variety there was significant ( $p < 0.01$ ) decrease in the laying period in comparison to the pre laying period. Similarly, serum phosphorus level was significantly different during the different stages of laying within the indigenous chicken ( $p < 0.05$ ). The serum cholesterol level was also significantly different during the post-laying period between the two experimental groups ( $p < 0.05$ ) and also during the different stages of laying within both the groups. The serum calcium level was significantly different ( $p < 0.05$ ) during the pre-laying period, between the two experimental groups and during the different stages of laying within the indigenous chicken. The mean 25 OH Vitamin D in the Kamrupa variety was significantly higher than the indigenous chicken of Assam during all the stages of the laying period ( $p < 0.05$ ) and the highest being observed during the post-laying period in Kamrupa variety ( $134.28 \pm 1.33$  ng/dl).

Relative mean hematological parameters revealed significant differences in respect of WBC count and MCV within the Kamrupa variety ( $p < 0.05$ ). Similar differences in lymphocyte percentage, RBC count, MCHC and Hb levels were recorded in both the experimental groups. Significant difference in WBC count was observed during the post-laying period, eosinophil percentage during laying period, MCV during post-laying, MCHC and Hb during the pre-laying and post-laying period between the experimental groups ( $p < 0.05$ ).

From the above study it can be concluded that the age at first laying in indigenous chicken under intensive management system was less than Kamrupa variety, however the cortisol level which showed stress was more in the indigenous chicken of Assam. Further, it can be concluded that the performance was better in Kamrupa variety in terms of gross parameters, lining epithelial thickness with certain blood biochemical constituents and hormonal parameters.

# **Anatomical Studies on Liver and Pancreas of *Pati* Ducks (*Anas platyrhynchos domesticus*) of Assam During Post-Natal Development**

*Kulajit Kalita*

Duck is one of the most important species in poultry industry and also in intensifying farming system. Since there is very scanty literature on the detailed anatomy of liver and pancreas of *Pati* duck of Assam, hence the present study was designed to establish anatomical norms on the liver and pancreas of *Pati* ducks during post-natal development up to 24 weeks of age. The outcome of these research findings shall help physiologist, pathologist and poultry scientists for carrying out further research work as well as to develop the disease control regime.

A total of 24 ducks divided into 4 (four) groups, consisting of 6 ducks in each group according to their age were utilized in the present study and were utilized for detailed anatomical study on gross, histomorphological, histochemical, biochemical and hematological parameters.

In the current study, the gross morphometry viz. length, breadth, thickness and weight of liver and pancreas in *Pati* ducks were observed with age. Morphometrical parameters of the liver and pancreas in *Pati* ducks at different ages showed an increasing trend with increase in age. The average weight of the liver was  $3.92 \pm 0.24$  gm at 1 week and  $39.65 \pm 0.99$  gm at 24 weeks of *Pati* duck of Assam. The average weight of the pancreas was  $0.28 \pm 0.04$  gm and  $3.66 \pm 0.22$  gm at 1 week and 24 weeks of *Pati* duck respectively.

Histological study showed that the liver of *Pati* duck was covered by a thin capsule. The connective tissue of the capsule contained collagen, reticular and elastic fibers. The thickness of the capsule of the liver increased slightly along the advancement of the age. Presence of fine nerve fiber was observed in the capsule penetrating into the parenchyma through trabeculae. The lobules of liver of *Pati* ducks were not distinct due to presence of less amount of interlobular connective tissue though the connective tissue was prominent in the portal triads. Hepatocytes were arranged as branching and

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**Department : Veterinary Anatomy and Histology**

**Major Advisor : Dr. Jiten Rajkhowa**



anastomosing cords and each hepatic cord consisted of double layers of cells. The spherical to ovoid vesicular nucleus of hepatocytes was observed in the basal half of the cells.

The pancreas of *Pati* was encapsulated by a thin connective tissue capsule from which trabeculae entered the parenchyma dividing that organ into a number of incomplete lobules. Pancreas parenchyma comprised of two distinct components i.e. exocrine and endocrine part. Exocrine part composed of tubulo acinar gland and endocrine part constituted of Islets of Langerhans. Two types of cells of Islets of Langerhans i.e. alpha (dark) and beta (light) were recorded. Nerve fibres were also observed in the islets within the reticular network.

Histochemical study revealed that the activity of alkaline phosphatase enzyme of liver was shown strong in 1<sup>st</sup> week and weak in 24<sup>th</sup> week age. The strong activity observed in the capsular area of the liver. The activity of the acid phosphatase was weak in all age groups. However, strong acid phosphatase activity was observed in the bile canaliculi. The ATPase activity was same in the all age groups. The activity of non specific esterase was moderate in the liver.

The activity of alkaline phosphatase enzyme of pancreas was strong in 1 week and weak in 24 weeks old age group. The overall activity of acid phosphatase enzyme was weak in all age groups of birds. However, strong acid phosphatase activity was observed in ducts. Adenosine triphosphatase and non-specific esterase activity were strong in all age group of birds.

Biochemically, The serum AST level in 1 week old duckling was  $7.91 \pm 1.06$  U/L and in 24 weeks old ducks was  $15.31 \pm 2.45$  U/L. The mean serum ALT level in 1 week and 24 weeks of age were  $12.52 \pm 1.46$  U/L and  $54.46 \pm 4.96$  U/L respectively. The average serum ALP level in 1 week old ducklings was  $64.33 \pm 4.70$  U/L and in 24 weeks old ducks was  $17.00 \pm 3.59$  U/L. The mean serum GGT level in 1 week old ducklings was  $3.96 \pm 1.08$  U/L and in 24 weeks old ducks was  $4.44 \pm 1.73$  U/L. All the biochemical parameters showed highly significant difference between the various age groups.

The average Red Blood Cell count of *Pati* duck in 1 week was  $2.82 \pm 0.16$  million/mm<sup>3</sup> and 24 weeks of age was  $2.83 \pm 0.38$  million/mm<sup>3</sup>. The WBC count was found significantly ( $P < 0.01$ ) lower at 1 week of *Pati* duck as compared to the other age groups. The average value of Hemoglobin in 1 week and 24 weeks of age were  $7.63 \pm 0.17$  g/dl and  $11.43 \pm 0.21$  g/dl respectively. The average concentrations of PCV in 1 week was  $37.12 \pm 1.26$  % and 24 weeks of age was  $42.7 \pm 0.81$  %.

From the present investigation it might be inferred that most of the parameters under study showed a significantly higher values between the various groups of *Pati* ducks under study. This might be due to the various anatomical, biochemical and physiological changes in body pertaining to growth with the advancement of age in *Pati* ducks.

# **Post-Natal Development of Tongue, Oesophagus and Proventriculus of Pati Duck (*Anas Platyrhynchos Domesticus*) of Assam at Different Age Groups**

*Tanu Dogra*

North-East India is famous for rearing different breeds of ducks under traditional systems of management. Desi duck rearing plays an important role in the socio-economic development of the rural poor people of Assam. The study of the tongue, oesophagus and proventriculus of Pati duck of Assam is of great value in regard to the normal academic and biochemical research aspects. Since, there is scanty of literature on the Post-natal development of tongue, oesophagus and proventriculus of Pati duck, the present study is designed to establish anatomical norms on tongue, oesophagus and proventriculus with age.

Twenty four healthy Pati ducks at 1<sup>st</sup> week, 8<sup>th</sup> week, 16<sup>th</sup> week and 24<sup>th</sup> week, irrespective of sex with each group having six birds were utilized to study the gross morphology, morphometry, histomorphology, histomorphometry and histochemical characteristics of tongue, oesophagus and proventriculus. Different hematological, biochemical and hormonal profiles of Pati duck of Assam were estimated accordingly.

In the present study, gross morphology of tongue consisted of an apex, body with lingual prominence and a root. Rows of papillae were presented on the lateral borders of the body of tongue. Oesophagus was a tubular organ presented between pharynx and proventriculus. A fusiform expansion in the middle of oesophagus was observed in all the age groups. Proventriculus was tubular organ presented between oesophagus and gizzard. Morphometrical parameters like length, weight, width, thickness and diameter of the organ increased with the increase of age of Pati duck. Relative percentage length of organs with respect to body weight decreased with the increase of age. Relative percentage weight of the organs in terms of body weight was observed maximum in 8<sup>th</sup> week and decreased subsequently to 24<sup>th</sup> week of age of Pati duck.

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**Major Advisor : Dr. Manmath Talukdar**

Histologically, tongue of the Pati duck consisted of stratified squamous epithelium. Intraepithelial taste buds were observed. Conical and filiform papillae were observed in all age groups of tongue. Histological sections of oesophagus and proventriculus revealed the presence of four layers. Lining epithelium of oesophagus was stratified squamous epithelium. Oesophageal glands were observed in the lamina propria of the tunica mucosa. Lining epithelium of proventriculus consisted of simple columnar epithelium. Tunica submucosa occupied major portion of proventricular wall and consisted of proventricular glands. Thickness of different layers of oesophagus and proventriculus increased with the increase of age. The width and depth of the proventricular glands also increased with the increase of age of Pati duck of Assam.

Histochemical study revealed the presence of neutral, acid and sulphated mucopolysaccharides by Periodic Acid Schiff–Alcian blue in oesophageal glands, lining epithelium of proventriculus and in the papilla of the of proventricular glands. The epithelium of the tongue showed affinity towards Periodic Acid Schiff. Underlying connective tissue and entoglossum showed reaction towards Alcian blue. Neuroendocrine cells were observed in the proventriculus at 16<sup>th</sup> and 24<sup>th</sup> weeks of age of Pati duck of Assam.

Biochemically, serum glucose, total protein and cholesterol level increased significantly with the increase of age. Haemological parameters like WBCs, PCV and Hb were significantly different at different age groups of Pati duck. However, no significant difference was observed in RBCs count at different age groups.

Hormonal profiles of Triiodothyronine (T3) and Thyroxine (T4) decreased with the increase of age of Pati duck. Serum Cortisol level was observed to follow an irregular pattern with the increase of age which could be due to stress inducing external factors.

# **Effect of TOLR Deletion Mutation on Release of OMV of *Salmonella typhimurium* and Evaluation of Nano – and Microparticles Conjugated Vaccines**

*Anisha Sultana*

*Salmonella enterica* serovar Typhimurium is a gram-negative, rod shaped, facultatively anaerobic bacteria which is responsible for invasive nontyphoidal Salmonellosis. Outer membrane vesicles (OMVs) are the bacterial nanovesicles which are released by Gram-negative bacteria. The OMVs serve an attractive and powerful vaccine platform that can induce both humoral and cell-mediated immune responses. The yield of OMVs are required to be high for commercially making them more profitable for vaccine production. However, most of the wild type strains of *Salmonella Typhimurium* are inefficient in release of large quantities of OMVs due to the linkage and attachment of bacterial outer membrane with the inner cell wall membrane of *Salmonella* by tolR protein. The genetic alteration of the standard strain of *Salmonella Typhimurium* can increase the production of OMVs. In the present study, this alteration was accomplished by disruption of the Tol-Pal system, through knockout of the tolR gene of *Salmonella Typhimurium* MTCC -98 strain. After successful deletion of the tolR gene of *Salmonella Typhimurium*, the yield of OMVs were determined in terms of protein concentration from both the mutant strain and wild type strain of *Salmonella Typhimurium* in mg per litre of BHI broth. The mutant strain showed a significantly ( $p < 0.05$ ) higher yield of OMVs compared to the wild type strain in terms of protein concentration. However, the significant variation was observed in the protein profile in terms of band intensity in the OMVs isolated from tolR gene deleted mutant and wild type strain of *Salmonella Typhimurium*.

The conjugation of outer membrane vesicles with chitosan nanoparticles, poly (anhydride) nanoparticles and poly-lactide co-glycolide microparticles was carried out in different conditions of pH, temperature and nanoparticles/microparticles to OMV ratio. The optimized conditions were determined in terms of entrapment efficiency of

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**Department : Veterinary Biochemistry**

**Major Advisor : Dr. (Mrs.) Rita Nath**

OMV using response surface method (RSM). The optimized conditions were found at pH of 7.0 and temperature of 24°C for poly (anhydride) nanoparticles, ratio of 1:10 (nanoparticle:OMV) and 1:9 (microparticle:OMV) for chitosan nanoparticles and polylactide co-glycolide microparticles in terms of OMV entrapment efficiency. The pH and temperature in the range of 6.5 to 7.5 and 20°C to 25°C did not have any influence on the OMV entrapment efficiency of chitosan nanoparticles and poly (anhydride) nanoparticles.

The optimized conditions did not alter the OMV protein profile in SDS-PAGE and immunogenic potential in mice.

# **Development of Nanoparticle based Oral Vaccine against Necrotic Enteritis and Evaluation of its Immuno-potential**

*Samiron Borah*

Necrotic enteritis (NE) is an economically devastating disease in broiler industry. It has a great negative impact on broiler industry due to production losses, increased mortality and decreased feed conversion ratio. Most common age of outbreaks of NE in broiler flocks raised on litter are between the second and fifth week of age.

The present study was carried out for development of poly(anhydride) nanoparticle based oral toxoid vaccine against necrotic enteritis and evaluation of its immunopotential in poultry birds. The protein profile of the toxoid prepared from *C. perfringens* culture was studied by SDS-PAGE. The major protein bands detected in SDS-PAGE was 11, 33, 40 and 45 kDa that corresponds to perforin, NetB toxin, GPD and Alpha toxin respectively. The toxoid of *C. perfringens* type G was conjugated with poly(anhydride) nanoparticles for preparation of oral vaccine. Five experimental group of birds (n=6) were taken for the present study. Group I was administered the saponin adjuvanted toxoid vaccine subcutaneously, Group II, III and Group IV were administered orally poly(anhydride) nanoparticle conjugated toxoid vaccine at the dose rate of 200µg, 400µg, 800µg per bird respectively. Group V was taken as control group where PBS was administered.

The humoral immune response in terms of serum IgG and secretory IgA was evaluated. It was found that except the control group in all the groups serum IgG and secretory IgA level started rising from day 7 to day 35. The highest serum IgG and secretory IgA level was found in Group IV followed by Group I, Group III, and Group II. The poly(anhydride) nanoparticle-toxoid oral vaccine preparation at the dose rate of 800 µg per bird and saponin adjuvanted toxoid parenteral vaccine preparation were able to elicit 100% immunoprotection against homologous challenge of *Clostridium perfringens*.

The poly(anhydride) nanoparticle-toxoid vaccine did not induce any toxic effect on liver and kidney function (at biochemical level). In addition, the vaccine preparation did not induce any oxidative stress in the birds.

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**Department : Veterinary Biochemistry**

**Major Advisor : Dr. S. Tamuli**

## **Prevalence of Eye Diseases in Dog with Special Reference to Bacterial Infection**

*Dibyajyoti Das*

Ocular disease is a common problem in dogs, occurs mostly due to bacterial infection, trauma, injury, viral infection, allergic condition, vitamin deficiency, old age and hereditary. In the study period 9138 numbers of dogs were screened and ocular disease was recorded in 71 numbers of dog. The prevalence of ocular diseases in dog was recorded 0.78%.

On the basis of clinical categorization, the highest prevalence of ocular disease was recorded as conjunctivitis (49.29%) and lowest in corneal opacity (7.05%). In the present study, the highest affection of eye was recorded in both eye (45.07%) and highest clinical findings recorded in congested mucous membrane (84.50%). The season wise prevalence of ocular disease in dogs was highest in winter (45.07%) and lowest in pre-monsoon (8.45%) season. In present study sex wise prevalence of ocular diseases were more in male (64.78%) than female (35.22%). Age - wise prevalence was highest in the >3 years – 6 years (29.58%) age group and lowest in below 1 year (4.22%) age group and breed wise prevalence the highest was recorded in German Shepherd (19.72%) and lowest in Boxer (2.82%).

The most common species of bacteria isolated were Staphylococcus (22.39%), Streptococcus (19.40%) and Pseudomonas (8.95%) species. More number of coagulase positive Staphylococcus species were recorded. Staphylococcus and Streptococcus species were mostly isolated from conjunctivitis condition and Pseudomonas species were highest isolated from keratitis condition. The sensitivity pattern of the isolates showed highest sensitivity to ciprofloxacin whereas less sensitive to ofloxacin. For therapeutic management of bacterial infection (conjunctivitis and keratitis) of eye, 36 dogs were randomly divided into 2 groups, Group I and Group II. In group I, ciprofloxacin was found effective on 14th day post-treatment in subgroup A and C dogs and in group II, gentamicin was found effective on 14th day post-treatment in subgroup D and F dogs.

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**Abstract of M.Sc. Thesis**

**Department : Veterinary Clinical Medicine, Ethics and Jurisprudence**

**Major Advisor : Dr. A. Phukan**

# **Management of Hypovitaminosis-D for the Prevention of Periparturient Hypocalcaemia in Dairy Cows**

*Patel Nisha Manish*

The present study entitled “Management of hypovitaminosis-D for the prevention of peri-parturient hypocalcaemia in dairy cows” was undertaken w.e.f. 1st September, 2018 to 31st March, 2019. The objectives of the study were to know the status of vitamin-D and calcium in crossbred dairy cows reared under intensive system, along with alterations of serum levels of related minerals and biochemical parameters associated with peri-partum hypocalcaemia and to assess the efficacy of parentally administered synthetic analogue of vitamin-D for the prevention of peri-parturient hypocalcaemia. From the study, the prevalence of pre-partum hypocalcaemia in crossbred dairy cows was recorded as 33.33%, with a higher occurrence (34.48%) in Jersey crossbred cows compared to HF crossbred cows (32.55%) and a predominance in cows of 6-8 years age (40.90%). However, there were statistically no significant differences in prevalence between the two breeds and among the different age groups. The only observed clinical signs associated with the recorded hypocalcaemia were lowered appetite and a rough body coat. Biochemical studies revealed a significant increase ( $P<0.01$ ) in the levels of serum total vitamin-D (cholecalciferol), blood urea nitrogen and creatinine, which reduced significantly ( $P<0.01$ ) after treatment to the levels of the control group towards at the end of the study. A significant increase ( $P<0.01$ ) was recorded in the levels of serum calcium and phosphorus after treatment however, no abnormal variation was recorded in the levels of serum magnesium throughout the study. Use of synthetic ( $\alpha$ ) analogue of vitamin-D (cholecalciferol) was found to be effective in increasing the serum calcium level and thereby preventing the occurrence of peri-parturient hypocalcaemia in crossbred dairy cows.

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**Abstract of M.Sc. Thesis**

**Department : Veterinary Clinical Medicine, Ethics and Jurisprudence**

**Major Advisor : Dr. B. C. Baishya**



# Canine Pyoderma : Diagnosis and Therapeutic Management

*Sabetini S. Marak*

The present study entitled “Canine pyoderma: Diagnosis and therapeutic management” was undertaken w.e.f. 1st August 2018 to 31st May 2019 with the objective to study the prevalence, identification of causative organism, hemato-biochemical alteration and to assess therapeutic efficacy in canine pyoderma. The overall prevalence of pyoderma in dogs was 14.59% with higher occurrence in Labrador breed (40%) with males (63.75%) being predominantly affected and in age group below 1 year (33.75%). Clinical signs associated with canine pyoderma were pruritis, pustules, alopecia, papule, scale and crust, patches, erythema, moth eaten appearance, dry coat, epidermal collaret, hyperpigmentation, abscess, lichnefication, edema, erosion and fissure. The causative organisms isolated from canine pyoderma were *Staphylococcus* species (100%) of which highest was *Staphylococcus intermedius* (43.75%) followed by *Staphylococcus aureus* (13.75%), coagulase negative *Staphylococcus* species (12.5%), *Staphylococcus intermedius* and *Staphylococcus aureus* (5%), *Staphylococcus intermedius* with *Pseudomonas* species (6.25%) and *Staphylococcus intermedius* with *Klebsiella* species (11.25%), *Staphylococcus aureus* with *Pseudomonas* species (5%) and Coagulase negative *Staphylococcus* species and *Pseudomonas* species (2.5%). The antibiotic sensitivity test for *Staphylococcus intermedius* isolates revealed highest sensitivity to linezolid (100%); *Staphylococcus aureus* to cephalixin and linezolid (94.73%); Coagulase negative *Staphylococcus* species to cephalixin and linezolid (100%); however gram negative organisms like *Pseudomonas species* and *Klebsiella species* revealed highest sensitivity to enrofloxacin (100%) but complete resistant to cephalixin and linezolid. Hematobiochemistry revealed anaemia (Low Hb and TEC), leukocytosis, neutrophilia, reduction in serum albumin, A:G ratio and zinc when compared with apparently healthy dogs. Dogs treated with cefpodoxime, ceftriaxone and tazobactam and linezolid showed faster recovery in clinical symptoms weekly than that of cephalixin and enrofloxacin but complete remission of clinical signs in all the animals was observed only in cephalixin treated group.

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**Abstract of M.Sc. Thesis**

**Department : Veterinary Clinical Medicine, Ethics and Jurisprudence**

**Major Advisor : Dr. (Mrs.) Bendangla Changkija**

## **Sub-Clinical Mastitis in Dairy Cow and Its Therapeutic Management**

*Gaurab Kafle*

The present study entitled “SUBCLINICAL MASTITIS IN DAIRY COW AND ITS THERAPEUTIC MANAGEMENT” was done for a period of 8 months viz. from December 2021 to July 2022 with the objectives to study the prevalence, etiology, diagnosis of subclinical mastitis (SCM), antibiogram of the isolates and to evaluate the therapeutic efficacy of three different treatment regimen on SCM in dairy cows in private dairy farms located in and around Guwahati city. Total 508 quarter milk samples from 127 dairy cows were screened for SCM by Modified California mastitis test (MCMT) and recorded animal wise, quarter wise prevalence as 67.71 and 28.34 per cent, respectively. Age wise prevalence was recorded highest in cows aged between >5-7 years (70 per cent), whereas lactation wise prevalence was recorded highest in the cows in fourth lactation (72.72 per cent) and least in first lactation (58.82 per cent). Similarly, prevalence of SCM was found higher in late stage of lactation (71.42 per cent) as compared to mid (70.45 per cent) and early stage of lactation (60.97). The right hind quarter (33.07 per cent) and the left hind quarter (28.34 per cent) were mostly affected as compared to other two quarters. The quarter wise prevalence of subclinical mastitis was recorded highest in single quarter followed by two quarters, four quarters and least in three quarters with 33.07 per cent, 28.34 per cent, 4.7 per cent, and 1.57 per cent respectively. A total of 164 bacterial isolates were obtained from 508 quarter milk samples, Staphylococcus spp. was found as the most prevalent organism (65.24 per cent) followed by Streptococcus spp. (9.14 per cent), Escherichia coli (32.31 per cent) and Klebsiella spp. (1.82 per cent). Enrofloxacin was found to be most effective antimicrobial drug against the isolates followed by ceftriaxone, cefaperazone, oxytetracycline and amoxicillin.

Before treatment mean values of SCC and pH in group A, B and C were significantly high ( $P < 0.001$ ) when compared to healthy control group, whereas fat and SNF were significantly ( $P < 0.001$ ) low. However, after therapy the mean value of SCC and pH were significantly ( $P < 0.001$ ) decreased whereas, fat and SNF increased significantly ( $P < 0.001$ ). Therapeutic regimen of group A viz. HTM injection (A, E and

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**Major Advisor : Dr. Bhaben Chandra Baishya**

iodine) along with antibiotic therapy was found more effective and helped the affected cows to recover early as compared to group B viz. Levamisole HCl and antibiotic and group C viz. mineral mixture and antibiotic.

# **L Inico-Haematobiochemical and Therapeutic Management of Anaemia Associated with Chronic Kidney Disease (CKD) In Dog**

*Pradyout Pallav Hazarika*

The present study entitled “CLINICO-HAEMATOBIOCHEMICAL AND THERAPEUTIC MANAGEMENT OF ANAEMIA ASSOCIATED WITH CHRONIC KIDNEY DISEASE (CKD) IN DOGS” was done for a period of 10 months viz. from October 2021 to July 2022 with the objectives to study the prevalence of anaemia and associated clinical and haemato-biochemical alterations in dogs presented at Veterinary Clinical Complex (VCC), College of Veterinary Science, Khanapara, Assam, and to evaluate the comparative therapeutic efficacy of recombinant human erythropoietin (rHuEPO) and parenteral iron alone or in a combination along with conservative therapy in anaemic dogs associated with CKD.

The study revealed overall prevalence of 43.55% anaemia with higher prevalence in Mongrel (56.13%), male predominance (47.12%) and in age group of >6-10 years (64.63%). Clinical signs associated with anaemia were hypothermia, tachycardia, tachypnoea, pale mucous membrane, increased capillary refill time, anorexia, diarrhoea, halitosis, dental tartar and melena. Haemato-biochemical assessment revealed a normocytic normochromic anaemia with a significant decrease in the values of Hb, PCV and TEC in anaemic dogs. Hypoproteinemia and hypoalbuminemia with a significantly increased BUN, serum creatinine, ALT, AST and total bilirubin were also observed in anaemic dogs.

The prevalence of anaemia associated with CKD was found to be 3.11%. Nephrosonogram of affected dogs revealed hyperechoic and hypoechoic thick renal cortices with partial to complete loss of cortico-medullary differentiation along with hyperechoic medullary rim, mild to complete loss of renal parenchyma and moderate to complete capsular disorientation. Proteinuria along with significant elevation in UPCR and significant decrease in urine creatinine was recorded in affected dogs. Haematobiochemical assessment revealed normochromic normocytic anaemia,

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hyperproteinemia, hyperalbuminemia and hyperphosphatemia along with significant elevation of BUN, serum creatinine, ALT, AST and total bilirubin in anaemic dogs associated with CKD. Combination of rHuEPO and parenteral iron along with conservative therapy was found to be more effective in the therapeutic management of anaemia associated with CKD with a survival rate of 75% (28 days) when compared to rHuEPO and parenteral iron given alone along with conservative therapy.

## **Sub Clinical Mastitis In Buffalo and Its Therapeutic Management**

*Chainmoy Sarma*

The present study “Sub clinical Mastitis in Buffalo and its therapeutic management” was under taken with an objective to estimate the prevalence, etiology, diagnosis of sub clinical mastitis (SCM) and to evaluate the therapeutic potential of three different herbal regimens and also a compare the therapeutic efficacy, cost with available antibiotic on SCM in buffaloes in and around Kamrup (rural) and Nagaon Districts of Assam during the period from December 2021 to July 2022. Total of 528 quarter milk samples from 132 buffaloes were screened for sub clinical mastitis by Modified California Mastitis test (MCMT). The recorded prevalence was animal wise 68.93% and quarter wise was 29.35%, respectively. Age wise prevalence was highest in buffaloes aged between 5-7 years (79.71%) and lowest in >7 years (37.50%) of age. Further, highest prevalence was recorded in organized farms(79.41%) compared to unorganized farms(65.30%).

Highest incidence of SCM was recorded in murreh buffalo (77.55%) compared to Luit (native breeds) (63.85%). In relation to lactation number prevalence was highest during 4th (87.50%) lactation and was least in first lactation(33.33%) . According to stage of lactation, late lactations was having more prevalence per cent (75.00%). Prevalence of SCM was highest in right- hind quarters (15.10%) followed by right-fore quarters (10.98%) and was least in left-fore (6.31%) by taking single quarter into consideration. Out of 528 quarter milk samples, 155 were found positive in bacterial culture and among these 54 (34.83%) were pure Staphylococcus spp. colonies, 20 (12.90%) for Streptococcus spp., 26 (16.80 %) for Escherichia coli, 10 (6.45%) for Bacillus spp., 15 numbers of sample having Staphylococcus spp. + E. coli. (9.70%) ,whereas 14 numbers sample was having Escherichia coli + Streptococcus spp. (9.02%) and combined infection of Bacillus spp + Streptococcus spp. was found in 16 samples with 10.32% of prevalence .

In the In-vitro drug sensitivity test of the positive sample revealed that enrofloxacin, ceftriaxone, cefoperazone, amoxicillin was sensitive with 96.19%, 97.14%, 96.19%, 96.19% respectively. In the study of antibacterial property of Ocimum

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**Abstract of M.Sc. Thesis**

**Department : Veterinary Clinical Medicine, Ethics and Jurisprudence**

**Major Advisor : Dr. Ditul Barman**

sanctum, Moringa oleifera leaves extract and Curcuma longa root extract Moringa oleifera extract showed highest zone of inhibition at a concentration of 30mg/ml, followed by at 10mg/ml. Similarly, Ocimum sanctum extract showed highest zone of inhibition at 50mg followed by at 40mg , 30mg and also Curcuma longa also showing maximum zone of inhibition at 200 mg/ml, followed by 100 mg/ml, 50 mg/ml.

Sub clinically affected buffaloes were randomly divided into 5 groups comprising 10 buffalo; viz: Group I, Group II, Group III, Group IV and Group V. Group I was treated with a paste of 100g of Moringa olifera leaves, 10g of Curcuma longa powder was applied topically over the udder twice daily for 7 days and feeding of aqueous extract of Ocimum sanctum @ 150 mg/kg body weight orally for seven days. In group II was administered with Enrofloxacin @ 4 mg/kg b.wt. intramuscularly daily for 5 days. Group III was treated with antibiotic Enrofloxacin 4 mg/kg b.wt. intramuscularly daily for 5 days and prepared extract of Ocimum sanctum @ 150 mg/kg body weight, orally daily for 7 days and topical application of 100g of Moringa olifera leaves , 10g of Curcuma longa powder paste twice daily for 7 days. Group IV was treated with 100g of prepared paste of Moringa oleifera leave topically twice daily for 7 days and the group V was treated with Intramammary infusion with antibiotic ( procaine penicillin (Pendristin- SH , Twice a day for 3 days)

The mean values of SCC, pH, EC was significantly higher ( $P < 0.01$ ) in all the samples along with significant low in milk production as compared to healthy control group. In the post therapeutic regimen aafter 7 days, the mean value of SCC, EC and pH were significantly ( $P < 0.01$ ) decreased in the Group I,II, III and V but not decreased in group IV where only Moringa oleifera leaves paste applied topically. On day 7th The mean values of milk yield did not increased significantly in group II and group V where only antibiotics were applied. In group I and group III the mean value of milk yield was significantly increased after 7th day of treatment . The ean values of SCC,pH , EC came to normal in group IV after 14 days of treatment.

In the analysis of cost per therapeutic regimen, it was observed that Group I comprises with the treatment of a paste of 100g of Moringa olifera leaves, 10g of Curcuma longa powder was applied topically over the udder twice daily having a cost of Rs. 135.00. In Group II a cost of Rs.3164.00 was observed where Enrofloxacin @ 4 mg/kg b.wt. adminsterd intramuscularly daily for 5 days. A cost of Rs.3299.00 was observed for Group III where antibiotic Enrofloxacin 4 mg/kg b.wt. intra muscularly daily for 5 days and prepared extract of Ocimum sanctum @ 150 mg/kg body weight, orally daily for 7 days and topical application of 100g of Moringa olifera leaves , 10g of turmeric powder paste twice daily for 7 days. On the other hand Rs.0.00 was cost for Group IV where only 100g of prepared paste of Moringa oleifera leave topically twice daily for 7 days. In Group V the cost was Rs. 2190.00 treated with Intra mammary infusion with antibiotic ( Pendristin-SH , Twice a day for 3 days).

# Otitis in Dog and Its Therapeutic Management

*Arpana Barua*

The present study entitled “**Otitis in dog and its therapeutic management**” was undertaken w.e.f. 1st August’2019 to 31st July’2020 with the objective to study the prevalence of otitis in dogs and to investigate the fundamental etiological agent responsible for the condition along with therapeutic regimen based on antibiotic sensitivity test. The prevalence of otitis in dog was 2.11% with higher occurrence in Labrador breed (16.07%) with males (56.25%) being predominantly affected and in age group above 4- 6 years (30.36%). Clinical signs associated with otitis were ear puritus, restlessness, head shaking, pawing at the ear, tilting of affected ear, circling, purulent discharge, pain on palpation, swelling, foul smell, hyperaemia, and hyperpigmentation. The bacterial causative organisms isolated from otitic dogs were Coagulase positive *Staphylococcus* species (35.48 %) followed by *Escherichia coli* (22.58%), *Streptococcus* species (14.51%), coagulase negative *Staphylococcus* species (9.68%), *Pseudomonas* species (6.45 %). The fungal causative organisms were *Malassezia pachydermatis* (16.07%) and *Candida* species (2.67%). The antibiotic sensitivity test for coagulase positive *Staphylococcus* species revealed highest sensitive to Ceftriaxone & tazobactam (100.00%), Coagulase negative *Staphylococcus* species to Ceftriaxone & tazobactam and Enrofloxacin (100.00%), *Streptococcus* species to Enrofloxacin & Ofloxacin (88.88%); however Gram negative organisms like *Escherichia coli* and *Pseudomonas* species revealed highest sensitivity to Enrofloxacin (100.00%). Dogs treated with Enrofloxacin ear drop alone showed highest clinical improvement followed by Ofloxacin and Gentamicin. Combined therapy using Ofloxacin ear drop, parenteral Ceftriaxone & tazobactam and Itraconazole orally showed faster recovery in the treatment of otitis in dog.

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**Abstract of M.Sc. Thesis**

**Department : Veterinary Clinical Medicine, Ethics and Jurisprudence**

**Major Advisor : Dr. Ditul Barman**



## **Anthelmintic Activity of *Acorus calamus* Rhizome Extract Against *Haemonchus* Species in Goats**

*Champa Sharma*

The present investigation was carried out with the view to study the anthelmintic activity of *Acorus calamus* rhizome extract against *Haemonchus* species in goats. *Haemonchus contortus* worms were found to be the predominant worm in the goat population of the farm.

The qualitative phytochemical analysis of hydroethanolic extract of *Acorus calamus* rhizome revealed the presence of terpenoids, steroid, diterpenes, flavonoids, tannin, glycoside, saponin and phenolic compound.

In *in-vitro* study, *Haemonchus* worms were exposed to different concentration of hydroethanolic and aqueous extract of *Acorus calamus* rhizome. The hydroethanolic extract was found to be more effective against *Haemonchus contortus* than aqueous extract. A dose dependant anthelmintic activity was exhibited by rhizome extract and highest efficacy was observed at 1000 µg/ml.

The goats positive for *Haemonchosis* showed a significant decrease in Hb, PCV, TEC, total serum protein, albumin A:G ration and serum iron and a significant increase in TLC, neutrophil and eosinophil percentage and liver enzymes (ALT and AST).

*In-vivo* anthelmintic study of hydroethanolic extract of *Acorus calamus* rhizome @ 500 mg/kg b.wt. orally (two doses, 0 day and 21<sup>st</sup> day) and fenbendazole @ 5 mg/ kg b.wt. orally were given to *Haemonchus* infected goats. EPG count, haemato-biochemical parameters and clinical improvement were evaluated on '0', 7<sup>th</sup>, 14<sup>th</sup>, 21<sup>st</sup> and 28<sup>th</sup> day post treatment. In Group I, EPG became 0 on 28<sup>th</sup> day after administration of second dose on 21<sup>st</sup> day. In Group II, treated with fenbendazole, EPG count became 0 on 7<sup>th</sup> day. Haematological parameters showed increase in Hb, PCV, TEC, lymphocyte % and decrease in TLC, neutrophil and eosinophil % post treatment and biochemical analysis showed increase in values of TSP, Serum Albumin, A:G ratio and Serum Iron after treatment. Globulin, ALT and AST values decreased significantly post treatment.

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**Abstract of M.Sc. Thesis**

**Department : Veterinary Clinical Medicine, Ethics and Jurisprudence**

**Major Advisor : Dr. Bendangla Changkija**

On the basis of reduction of EPG count and haemato-biochemical changes, the therapeutic efficacy of hydroethanolic extract of *Acorus calamus* rhizome was 100% on 28<sup>th</sup> day post treatment with administration of second dose orally on 21<sup>st</sup> day. Fenbendazole showed a higher efficacy with 100% reduction of EPG on 7<sup>th</sup> day post treatment.

## **Osteomalacia : Its Diagnosis and Management in Dairy Cows**

*Gunajit Barman*

A total of 325 dairy cows of private dairy farms in and around Guwahati city and Instructional Livestock Farm, College of veterinary science, Assam Agricultural University, Khanapara, Guwahati-22 were screened and 23 cows were confirmed positive for osteomalacia on the basis of clinical symptoms and biochemical parameters. The prevalence of Osteomalacia was recorded 7.08 per cent with the highest distribution in the age group of >6-9 years (47.82%), followed by >3-6 years (34.78%), >9 years (13.04%) and < 3 years (4.35%). The highest distribution of osteomalacia was found between 4th-6th lactation and lowest in >6th lactation.

The clinical symptoms of osteomalacia recorded in this present study were lordosis, kyphosis, bowing of legs, difficulty in getting up, reduced body conditions. The positive cows showed low levels of serum calcium (7.60 to 8.90 mg/dl), phosphorus (1.82 to 3.76 mg/dl) and vitamin D3 (15.31 to 31.72 ng/ml) and high rise of serum alkaline phosphatase enzyme (182.9 to 286.2 Unit/L). The hock angles were also lower than the healthy animals.

In the therapeutic trial the treatment regimen for cows of group A, that were administered buffered phosphorus injection @ 25 ml intravenously to each animals followed by calcium, phosphorus and vitamin D3 supplementation (Calphos D3 bolus) @ 1 bolus twice daily for 30 days was found to be more effective than the others.

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**Abstract of M.Sc. Thesis**

**Department : Veterinary Clinical Medicine, Ethics and Jurisprudence**

**Major Advisor : Dr. B. C. Baishya**

# **Haemoprotozoal Diseases of Cat and Its Therapeutic Management**

*Pooja Kapil Marwaha*

The present study entitled “Haemoprotozoal diseases of cat and its therapeutic management” was conducted for a period of 12 months, from June 2019 to May 2020, with the objectives to study the prevalence of haemoprotozoal infection in domestic cats, haemato-biochemical alterations in affected cats and to formulate an effective therapeutic regimen for the most prevalent haemoprotozoal infection in cat.

Prevalence was determined based on direct microscopy and confirmed via PCR. *Babesia* spp. were the only haemoprotozoa that were detected in the present study. The study revealed a 3.74% prevalence of babesiosis in hospital registered cat cases, and the incidence based on number of cases screened was found to be 10.4%. Age-wise distribution showed the highest incidence in cats over 2 years of age (34.62%) and lowest in cats from 13-24 months (15.38%). Season-wise distribution showed highest incidence in pre-monsoon and winter season (30.77%) and lowest in the post-monsoon season (15.38%).

The most prominent clinical signs associated with babesiosis in domestic cats were weakness, fever, anorexia, inappetence, jaundice, diarrhoea, dehydration including pale pink and papery white mucous membranes. A rare manifestation of babesiosis (cerebral form) was observed in 2 affected animals, where nervous symptoms were seen.

Haematology revealed significant anemia with a significant ( $p < 0.05$ ) decrease in the haemoglobin value, total erythrocyte count and thrombocyte count, and a marked elevation of total leucocyte count. Biochemistry revealed a significant ( $p < 0.05$ ) elevation in the levels of liver enzymes (ALT and AST) as well as indirect, direct and total bilirubin, indicating hepatic damage.

Treatment response was evaluated based on microscopic examination, haemato-biochemical alterations and clinical recovery using mean clinical score. Based on these parameters, the combined therapy of diminazene diacetate showed a superior efficacy in the treatment of babesiosis in domestic cats when compared to diminazene diacetate alone.

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**Abstract of M.Sc. Thesis**

**Department : Veterinary Clinical Medicine, Ethics and Jurisprudence**

**Major Advisor : Dr. T. C. Dutta**

## **Studies on Anthelmintic Efficacy of *Zanthoxylum armatum* against Gastrointestinal Parasites of Goat**

*Jakir Hussain*

The present investigation was carried out to study the anthelmintic efficacy of hydroethanolic seed extract of *Zanthoxylum armatum* against gastrointestinal parasites of goats. The overall prevalence of gastrointestinal parasites in goats was recorded to be 65.41% under prevailing agro-climatic conditions of Goat Research Station, AAU, Burnihat and private farms in and around Guwahati city, Assam from January- March 2021 & September - November 2021. Out of the different gastrointestinal parasites recorded in goats the prevalence of *Haemonchus* spp. (54.14%) was found to be the highest and *Trichostrongylus* spp. (18.78%) the lowest. In most of the animals, mixed infestations with 2-3 types of gastrointestinal parasites were also recorded.

Phytochemical analysis of hydroethanolic seed extract of *Zanthoxylum armatum* revealed the presence of alkaloid, terpenoid, diterpene, flavonoid, steroid, glycosides, saponin and phenolic compounds but it was found negative for tannin. The acute oral toxicity study in mice showed that the hydroethanolic seed extract of *Zanthoxylum armatum* is safe up to 2000 mg/kg body weight when administered orally. *In-vitro* study of hydroethanolic seed extract of *Zanthoxylum armatum* showed dose-dependent and time-dependent anthelmintic activity and the highest efficacy was observed at 1000 µg/ml against adult parasite of *Haemonchus contortus* at 60 minutes.

Based on the reduction of EPG count in the present study, Group A, animals which were treated with hydroethanolic seed extract of *Zanthoxylum armatum* @250 mg/kg body weight, orally and repeated on the 21<sup>st</sup> day showed the highest efficacy on post-treatment days i.e. 100% on the 28<sup>th</sup> day followed by the animals in Group C, treated with hydroethanolic seed extract of *Zanthoxylum armatum* @125 mg/kg body weight and ethanolic seed extract of *Butea frondosa* @ 50 mg/kg body weight, Group B, treated with hydroethanolic seed extract of *Zanthoxylum armatum* @125 mg/kg body weight and methanolic seed extract of *Entada phaseoloides* @ 250 mg/kg body weight

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and Group D, treated with hydroethanolic seed extract of *Zanthoxylum armatum* @125 mg/kg body weight, methanolic plant extract of *Entada phaseoloides* @250 mg/kg body weight and ethanolic seed extract of *Butea frondosa* @50mg/kg body weight, orally and repeated on 21<sup>st</sup> day.

The *In-vivo* study showed that the hydroethanolic seed extract of *Zanthoxylum armatum* individually or in combination with methanolic seed extract of *Entada phaseoloides* and ethanolic seed extract of *Butea frondosa* were effective against gastrointestinal parasites of goats. Based on the improvement in body weight and haemato-biochemical parameters with reduction of EPG of faeces it was observed that hydroethanolic seed extract of *Zanthoxylum armatum* was more effective as anthelmintic when used alone than in combination against gastrointestinal parasites of goats.

## **Urinary Tract Infection in Dog and its Therapeutic Management**

*Pooja Sonar*

The present study entitled “Urinary tract infection in dog and its therapeutic management” was undertaken w.e.f. November,2020 to April,2021 with the objectives to study the prevalence, isolation and identification of causative organisms & comparative efficacy of different drugs for UTI in dogs. Urine samples were collected aseptically by catheterization and blood samples were collected for therapeutic evaluation. In the study period, 240 numbers of dogs were screened and UTI was positive in 18 numbers of dogs. The overall prevalence of UTI in the dog was recorded 7.5%. The present study revealed the age-wise prevalence of UTI was found to be the highest (10.90 %) in the age group 1 to 3 years. The breed wise prevalence of UTI in dogs was found to be highest in Pug (11.11%) and sex-wise variation of UTI in dogs was found to be apparently higher in females (11.34%) than males (4.89%) in the present study. The predominant clinical signs associated with UTI was pollakiuria in 83.33%, hematuria in 55.55% and stranguria in 44.44%. The most prominent urinalysis findings were proteinuria (66.66%), acidic urine pH (61.11%) and cloudy urine (55.55%) in affected dogs. The most prevalent organism isolated was *Escherichia coli* followed by *Staphylococcus* spp. and *Klebsiella* spp. *In-vitro* antibiotic sensitivity test revealed the highest sensitivity towards cefpodoxime followed by enrofloxacin and ceftriaxone tazobactam, least sensitivity towards gentamicin and amoxicillin and resistance to clotrimazole and nalidixic acid. The ultrasonographic examination revealed the most prominent finding as cystitis (66.66%) followed by cystic calculi (33.33%) and renal degeneration (22.22%). The haematological alteration revealed a significant decrease in levels of Hb, TEC and lymphocyte (DLC) and an increase in TLC and neutrophil (DLC). On biochemical examination, a significant increase in value of BUN, serum creatinine, potassium and phosphorus whereas there was a decrease in the value of total serum protein (TSP), albumin, sodium and calcium in the affected dogs. In the present study, the 18 UTI positive dogs were randomly divided into two treatment groups A and B consisting of 9 animals in each group. Based on the *in-vitro* antibiotic

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**Department : Veterinary Clinical Medicine, Ethics and Jurisprudence**

**Major Advisor : Dr. T. N. Kalita**

sensitivity test performed, dogs of group A were treated with cefpodoxime proxetil @ 10 mg/kg body weight once daily orally and group B was treated with enrofloxacin @ 10 mg/kg body weight once daily orally for 21 days. Hence, based on clinical improvement, negative culture and haematobiochemical improvement, cefpodoxime proxetil was found to be more effective than enrofloxacin. Hence, cefpodoxime proxetil may be a drug of choice for the treatment of UTIs in the present study.



# **Congestive Heart Failure in Dogs and Its Therapeutic Management**

*Prerona Patowary*

The present study entitled “Congestive heart failure in dogs & its therapeutic management” was undertaken w.e.f. 1<sup>st</sup> November 2020 to 30<sup>th</sup> June 2021 with the objectives to study the prevalence, hemato-biochemical alterations & efficacy of different therapeutic regimens of congestive heart failure in dogs. The study revealed overall prevalence of 0.20% with highest prevalence in Labrador retriever breed (0.53%) with male predominance (0.22%) and in the age group of >10 years of age (0.50%). The observed clinical signs included exercise intolerance, dyspnoea, coughing, ascites, syncope, inappetance and weakness. Tachycardia crackles and murmurs were the common clinical findings in the CHF affected dogs. ECG findings in CHF affected dogs included sinus tachycardia (37.50%), sinus bradycardia (8.33%), sinus arrhythmia (25%), sick sinus syndrome (8.33%), 1<sup>st</sup> degree heart block (8.33%), atrial fibrillation (12.50), atrial flutter (4.17%) and low voltage QRS complex (12.50%). Radiographic findings of CHF included cardiomegaly (87.50%), upward deviation of trachea (33.33%), pleural effusion (70.83%) & pericardial effusion (25.00%) with significantly elevated VHS. Ultrasonography of abdomen showed presence of ascites (66.67%), hepatic congestion (75.00%), hepatomegaly (62.50%), renal degeneration (41.67%), splenomegaly (12.50%) and cystitis (8.33%). Echocardiographic findings in CHF were DCM (75.00%), Cardiomegaly (83.33%), mitral valve regurgitation (91.67%), tricuspid valve regurgitation (41.67%), and pericardial effusion (25.00%). The LVIDd, LVIDs, EPSS, LA/AO dimensions were increased with a decrease in IVSd, IVSs, LVPWd, LVPWs and contractility indices (EF and FS) in affected dogs. There was a significant mosaic pattern appearance on color flow doppler found in mitral & tricuspid valve regurgitation.

Hematological assessment showed no significant changes. Serum biochemical assessment showed significant increase in the level of SGOT, SGPT, BUN, serum creatinine and LDH. Moreover significant decrease in the level of total serum protein and albumin was recorded.

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**Abstract of M.Sc. Thesis**

**Department : Veterinary Clinical Medicine, Ethics and Jurisprudence**

**Major Advisor : Dr. A. Phukan**

All the CHF affected dogs were divided into three groups, viz: group A, B and C each having 8 numbers of dogs. Dogs in group A treated with furosemide + spiranolactone, pimobendane and ramipril orally daily. Dogs in group B treated with hydrochlorothiazide + spiranolactone, pimobendane and ramipril orally daily. Dogs in group C treated with torsemide + spiranolactone, pimobendane and ramipril orally daily. All the dogs under treatment for 42 days were monitored and the efficacy was assessed at fortnight intervals based on improvement of clinical signs, hemtobiochemical alterations, ECG, thoracic radiography, USG of abdomen and echocardiography features. There was a significant improvement in the serum biochemical parameters of CHF dogs during therapy. Radiographically, no appreciable reduction in heart size was observed in any of the CHF dogs after 42days of therapy except substantial reduction in the pleural & pericardial effusion. There was improvement & disappearance of cardiac arrhythmia in ECG. A significant difference in left ventricular dimensions (LVIDd, LVIDs,IVSd, IVSs, LVPWd, LVPWs and EPSS) and contractility indices ( EF and FS) were noticed in affected dogs by the end of the trial.

Based on resolution of clinical signs, improvement in hemato-biochemical alterations and echocardiographic features it was found that a combination of torsemide + spiranolactone, pimobendane and ramipril was found superior to other two combinations as indicated by faster disappearance signs and early recovery with no adverse drug reaction both during and after therapy. Hence this therapeutic regimen is indicated in dogs with congestive heart failure.

## **Evaluation of Salivary Biomarkers for Chronic Kidney Disease in Dogs**

*Tanu Sharma*

The present study entitled “Evaluation of salivary biomarkers for chronic kidney disease in dogs” was done for a period of 6 months i.e., February, March, April, September, October and November 2021 with the objective to evaluate and correlate the levels of salivary and serum creatinine and urea in dogs with CKD. The prevalence of CKD in dogs was 0.25%. The highest breed distribution was recorded in Labrador (44.74%); highest distribution was seen in dogs between >6-10 years of age (52.63%) and was predominant in male dogs (60.53%). Most prominent clinical signs of CKD observed were inappetance (84.21%), vomiting (57.89%), oral manifestations (55.26%), pale mucous membrane (34.21%), lethargy/depression (28.95%), congested mucus membrane (23.68%), polyuria/polydipsia (15.79%), weight loss (15.79%), diarrhoea (7.89%), and anuria (2.63%). The most prominent oral manifestations observed were halitosis (26.31%) followed by dental tartar (18.42%), dental carries (7.89%) and oral ulcer (2.63%). Haemoglobin and Packed cell volume was significantly lower in dogs with CKD. Ultra-sonographic changes observed in the kidneys of dogs suffering from CKD were hyper-echoic and thick renal cortex, partial or complete loss of corticomedullary differentiation, wrinkled capsule and hyper-echoic medullary rim. Serum and salivary concentration of creatinine and urea were significantly higher in dogs with CKD. A positive correlation between salivary and serum creatinine and salivary and serum urea was noted. Salivary biomarkers (creatinine and urea) were found to be almost equally sensitive and specific when compared to serum biomarkers (creatinine and urea) in reflecting kidney disease. Cut off value of salivary creatinine was 0.89 mg/dl and salivary urea was 18.50 mg/dl.

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**Abstract of M.Sc. Thesis**

**Department : Veterinary Clinical Medicine, Ethics and Jurisprudence**

**Major Advisor : Dr. Bendangla Changkija**

# **Transmission of Newcastle Disease Virus at Domestic-Wild Bird Interface**

*Abhilasha Sharma*

Wild birds have been known to be reservoirs of Newcastle disease virus and the disease has been identified as one of the endemic diseases in India despite vaccination. Moreover, wildlife-livestock interfaces have come into light as the most overlooked areas of disease emergence. In that context, to demonstrate and establish spillover and spillback of Newcastle disease virus in wild and domestic birds as well to identify epidemiological means facilitating transmission at interface areas, a study was undertaken to detect and characterize NDV in the pool maintained in wild and domestic birds along with some epidemiological studies. Samples were collected from a total of 321 birds, both wild (n=81) and domestic (n=240) and subjected to haemagglutination inhibition (HI) and RT-PCR. The apparent prevalence of NDV in wild birds was found to be 22.2% (95% CI: 13.2-31.3%) and 14.6% (95% CI: 10.1-19.1%) in domestic birds at the sampled areas in this study from April, 2021 to August, 2022 revealing that wild birds had a higher likelihood of being affected with NDV than that of domestic (OR=1.67, 95% CI: 0.89-3.16, P=.101). The highest proportion of NDV positive wild birds were from the interface areas of Kaziranga National Park (32.21%) and in domestic birds from the interface areas of Assam State Zoo (25%). The study revealed that NDV positive cases in were highest among the raptors in wild (56.3%) and granivores (7.78%) in case of domestic birds. 14.3% and 4% of the sampled swabs collected from wild (n=56) and domestic birds (n=151) respectively to be positive for NDV thereby illuminating the dominant shedding nature of the virus. Similarly, 23.9% and 12.6% of the sampled tissues collected from wild (n=67) and domestic birds (n=261) were found to be positive for the virus. Additionally, it was found that in wild birds, highest proportion of NDV detection was seen in winter (44.44%) whereas in domestic birds, it was seen highest in pre-monsoon season (31.42%). Furthermore, detection of NDV was found to be significantly correlated with species and colony of birds as well as with the type of samples collected. A total of 11 NDV isolates from wild (n=6) and domestic birds (n=5) were subjected to biological and molecular pathotyping on the basis of MDT and FPCS respectively. MDT for NDV isolates of wild birds

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**Department : Epidemiology and Preventive Medicine**

**Major Advisor : Dr. (Mrs.) Jyoti B. Dutta**

ranged between  $31.02 \pm 2.98$  to  $48.56 \pm 2.79$  and  $40.67 \pm 2.03$  to  $59.01 \pm 0.77$  for NDV isolates of domestic rendering them to be of velogenic nature. Molecular pathotyping based on F protein cleavage site motif revealed the 11 isolates from both wild and domestic birds to be of the virulent nature with 112RRQKRF117 amino acid sequence at their F protein cleavage site. Representative NDV isolates from wild (n=6) and domestic (n=5) were sequenced and subjected to phylogenetic analysis which revealed all the wild isolates to be clustered under genotype VII in class II NDV, whereas isolates from wild birds were grouped under both genotype VII and XIII. A questionnaire survey was conducted to evaluate the risk factors enabling transmission of Newcastle disease virus at interface areas. Analysis of risk factors associated with NDV transmission showed that change in weather had 37 times significantly higher risk of mass mortality of Newcastle disease than that of no changes in weather, OR=37 95% CI :9.34- 146.65, P<.001. Similarly, farms in close proximity significantly had higher chances of NDV affection, OR=3.96 95% CI :1.38-11.36, P=.008. The presence of waterbody nearby had a 5.11 times higher risk of being exposed to NDV than absence of waterbody nearby, OR=5.11 95% CI :1.78-14.67, P=.002. Other animals housed in the premises was also a significant risk factor, OR=3.87 95% CI :1.45-10.33, P=.006. Linear regression analysis revealed risk factors including mortality after weather change, presence of water body nearby, unavailability of clean drinking water, unavailability of chlorinated water, not practising all-in-all-out system; not practising down-time, interaction of other birds while feeding, mixing with neighbourhood ducks and geese, being housed with pigeons, deworming not carried out, no use of foot-baths, biosecurity not followed, being housed with pigeons, presence of bamboo groves in the farm, crows visiting the farm, predation by rodents, wild birds interacting while feeding and seasonal migration of wild birds observed nearby to be significant risk factors at flock level. Knowledge and attitudes were found to have positive correlations with practices adopted by bird owners. A statistically insignificant link was found between knowledge and attitudes, but a positive trend line was observed between the two. The derived data base regression explained about 36.82% of total variation in practice.

## **Management of Clostridial Infection with Special Reference to *Clostridium perfringens* in Asiatic Elephant (*Elephas maximus*) In Assam**

*Ashit Chakraborty*

Clostridial infection is an anaerobic Gram +ve bacterial disease of both wild and captive elephant. This organism is generally recorded in deep seated wound infection. A total number of 40 elephants were examined during the study period with 10 wild and 30 captive elephants. 8 numbers of *Clostridium perfringens* were isolated from different types of sample which were found to be positive for *cpa* gene after PCR analysis confirming the isolates to be of *Clostridium perfringens* Type A with highest prevalence from Intestinal content (50.00%) and one number of *Clostridium difficile* was isolated from faecal sample which was found to be positive for *gluD* gene with a prevalence of 4.16 per cent.

The prevalence of Clostridial infection in wild elephant was 20.00 per cent and in captive elephant 23.33 per cent with the overall prevalence of 22.50 per cent. The prevalence of Clostridial infection as per spatial distribution in captive elephant of Forest Department (Govt. of Assam) was 23.33 per cent. However, in wild the highest prevalence was recorded in Rani Forest Reserve. Season-wise the prevalence was higher during rainy season (40.00%) and lower in summer (13.33%). Age-wise prevalence was highest in less than 10 years of age group (40.00%) and lower in age group above 51 years (10.00%). Sex-wise the prevalence was found to be highest in wild male elephants (50.00%).

There was an increase in total leucocyte count (TLC), neutrophil and monocyte level with decreased level was observed in haemoglobin (Hb), red blood cell (RBC) and packed cell volume (PCV) in Clostridial infected elephants. *Clostridium perfringens* and *Clostridium difficile* were the two *Clostridial* species, isolated from different samples. The antibiogram test showed highest sensitivity to Enrofloxacin, Cefotaxime and Gentamicin whereas partial resistance to Ceftriaxone and Tazobactam, Tetracycline.

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**Department : Epidemiology and Preventive Medicine**

**Major Advisor : Dr. G. Mahato**

Therapeutic management of deep-seated wound infection was done with potassium permanganate solution (1:1000) and dressed with povidone iodine (5%) solution. Topical antiseptic cream (Charmil ointment) was applied over the wound for 10-15 days along with Enrofloxacin (Flobac SA) injection. Vitamin B complex (Conciplex) and meloxicam (Melonex) injection was given as a supportive therapy. The elephants showed recovery within 20-24 days. The *Clostridium difficile* isolated from faeces of the affected elephant was rendered treatment with Cefotaxime (Taxim) injection. Intalyte, Vitamin B complex (Conciplex) and meloxicam (Melonex), and iron (Ferritas) injection was given as supportive therapy. Unfortunately the calf died during the course of treatment due to several other concurrent infections.

# **Epidemiology and Economic Impact of Rabies In Animals of Kamrup Metro District of Assam and West District of Tripura**

*Bishal Debbarma*

Rabies is a neglected tropical fatal viral zoonosis caused by *Lyssavirus* genus of *Rhabdoviridae* family, mostly mediated by dog-bites. It is 100 per cent preventable by timely and appropriate post-exposure prophylaxis (PEP). Globally 60,000 people die from canine-mediated rabies annually. India reports approximately 30 per cent of global burden annually. The economic impact of rabies on farmers includes the post-exposure expenses of vaccination and/or losses due to livestock mortality. In the present study, post-mortem brain tissue samples were collected from three different locations as per OIE for diagnosis of rabies using Lateral Flow Assay (LFA) kit, and confirmed by Direct Fluorescent Antibody Technique to determine the incidence of rabies. The economic impact was analysed on disability-adjusted life years (DALYs) and total cost of PEP of dog-bite cases from the retrospective data for five years. The incidence of rabies was 76.47 per cent in animals in the present study. Species-wise, canines (76.92%) had the highest incidence of rabies followed by bovine (15.38%) and caprine (7.69%). Retrospective study for five years (2016-2020) revealed 1093 and 1735 dog-bite cases in the Veterinary Clinical Complex (VCC), CVSc, AAU, Khanapara and the State Veterinary Hospital (SVH), Chenikuthi, Kamrup Metro of Assam, respectively. On the other hand, 655 dog-bite cases were recorded in the State Veterinary Hospital (SVH), Abhoynagar, West district of Tripura during 2019 and 2020. The incidence of dog-bite cases were recorded highest in 2019 in all the three hospitals. Month-wise, August and October recorded the highest dog-bite cases. Gender-wise, dog-bite cases were higher in males (57.63%) than females (43.37%). The cost of PEP per dog-bite case was estimated at Rs. 215-703, Rs. 171-536 and Rs. 161-610 for VCC, SVH (Chenikuthi) and SVH (Abhoynagar) respectively. For 4-dose regimen (Essen regimen) PEP, the cost per dog-bite case ranged from Rs. 860-2,812, Rs. 684-2,144 and Rs. 644-2,440 for the same hospitals, respectively. The total cost of 4-dose regimen PEP for the VCC ranged between Rs. 939,980-3,073,516 while for the SVH, Chenikuthi, it ranged

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between Rs. 1,186,740-3,716,960 for the years under study. On the other hand, 4-dose regimen PEP cost for the SVH, Abhoynagar, it ranged between Rs. 421,820-1,598,200 for two years (2019-2020). The disability-adjusted life years (DALY) for 2019 was between 6200-6210 days in bovine, 35,469-35,559 days in canine and 4,740-4,750 days in caprine with 11 mortalities. The DALY for 2020 ranged between 7112.5-7122.5 days in bovine and 3800-3810 days in canine with 2 mortalities due to rabies. Estimating the actual burden of rabies is a priority for devising control and prevention strategies.

# **Detection and Genotypic Characterization of Rotavirus In Dog and Its Management**

*Chayanika Mazumder*

Rotavirus (RV) has been recognized as an important enteric pathogen of many species, including human and dogs. The study has been undertaken to detect rotaviral antigen from faecal samples of dogs and to characterize G and P genotypes from positive samples along with the management of the rotavirus induced diarrhoea in dogs. A total of 157 faecal samples were collected aseptically from dogs with gastroenteritis with effect from November, 2020 and December, 2021. All the samples were screened for the presence of rotavirus by using ribonucleic acid-polyacrylamide gel electrophoresis (RNA-PAGE) and rotavirus by reverse transcriptase-polymerase chain reaction (RT-PCR). Rotavirus positive samples were further analyzed by nested-multiplex RT-PCR for detection of G and P genotypes in dog.

Canine rotavirus (CRV) was detected in 8 samples out of 157 diarrhoeic faecal samples by RNA-PAGE. The incidence of canine rotavirus infection was 5.09% by RNA-PAGE. RNA-PAGE positive samples revealed migration pattern of 4:2:3:2 in 4 different clusters, indicating group A rotavirus.

Out of 157 diarrhoeic faecal samples processed for amplification of VP6 gene of rotavirus, 17 samples were found to be positive for canine rotavirus by RT-PCR. The incidence of canine rotavirus infection was 10.83% by RT-PCR. In the study, pups less than 3 months of age were found to be more susceptible to the CRV infection (16.25%). The incidence was higher in male (12.79%), but statistically there was no significant difference ( $p>0.05$ ) in relation to the age and sex.

Genotypic characterization of rotavirus by nested multiplex RT-PCR, revealed presence of G3 (10/17, 58.82%) genotypes in G-genotyping and P[3] (7/17, 41.18%) genotypes in P-genotyping. Thus, the distribution of G-P genotype during the study was found to be G3P[3] combination.

A significant increase of haemoglobin (Hb), packed cell volume (PCV), Total erythrocyte count (TEC), monocyte, lymphocyte, aspartate aminotransferase (AST), alanine aminotransferase (ALT), Blood urea nitrogen (BUN) and creatinine (cr), while

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significant decrease of total leukocyte count (TLC), neutrophil, total protein (TP), sodium (Na), potassium (K) and chloride (Cl) were recorded in RV infected dogs.

Management of RV infected dogs were done with conventional therapy comprising of fluid therapy viz. NS/RL/DNS, antiemetic (Ondansetron), antibiotic (Ceftriaxone), acid blocker (pantoprazole), multivitamin/vitamin B complex (Tribivet) and haemostatic (Botropase) through intravenous route. After treatment, all the infected dogs recovered completely and all the haemato-biochemical parameters have reached almost to the normal values of control group.

# **Tick Infestation In Dogs: Its Epidemiology and Therapeutic Management**

*Dhritismita Boruah*

Tick infestation is a common problem in dogs, causing itching, irritation, rashes leading to some self-inflicted traumas. Severe infestation causes anemia, weight loss and even death due to consumption of large quantity of blood. More significantly they carry and spread blood borne infection both in human and animals. In the study period 10315 numbers of dogs were screened and tick infestation was recorded in 45 numbers of dogs. The prevalence of tick infestation in dog was recorded 0.43%.

In the present study age-wise prevalence was highest in 1 to 3 years (0.69%) age group. Sex-wise prevalence of tick infestation were more in males (0.63%) than in females (0.20%) and breed-wise prevalence was recorded highest in the Non- Descript dogs (0.80%). Highest prevalence (0.65%) was recorded in monsoon season.

The most common clinical sign associated with tick infestation is pruritus which is present in 100% of the cases. As per the distribution of ticks on different body regions of dogs, ear was found to be the most common site for attachment of ticks. The only species of tick found in the present study is the *Rhipicephalus sanguineus* tick, i.e. the brown dog tick.

The haemato-biochemical alterations in tick infested dogs revealed a significant decrease in the vales of Haemoglobin, TEC, PCV and MCV and an increase in the TLC values when compared to apparently healthy dogs.

For therapeutic management of tick infestation in dogs, treatment were given to 18 dogs which were divided into 3 groups, Group I, Group II and Group III containing 6 dogs in each groups using three acaricides, i.e. Fipronil, Amitraz and Selamectin topically for a period of 30 days. Group III (Selamectin) was found to be most suitable and effective acaricide against tick infestation.

In an attempt to detect *Babesia* DNA in tick vectors, pooled tick samples were taken from 16 different dogs and were subjected to PCR and ticks from 2 dogs were found to harbor the *Babesia* DNA.

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## ***Escherichia coli* Associated Diarrhoea In Calves and Its Management**

***Gautam Ramjibhai Parikh***

The present investigation was carried out for isolation and identification of *E. coli* and the virulence genes associated with pathogenic *E. coli*, haemato-biochemical alterations, *in vitro* antibiogram as well as therapeutic management of diarrhoeic calves. A total of 153 faecal swabs were screened from various cattle farms located in and around Guwahati of which, 78 samples showed positive for *E. coli* with a prevalence of 50.98 per cent. The highest prevalence was recorded in 0-15 (26.14%) followed by 16-30 (22.87%), 31-45 (1.31%), and 46-60 (0.65%) days old calves, respectively. Breed-wise, the highest prevalence was recorded in jersey cross followed by Holstein Friesian-cross and Sahiwal calves. Male calves showed higher prevalence of *E. coli* associated diarrhoea as compared to female calves.

Estimation of pathogenic genes *viz. stx1, stx2, est, elt and eaeA* through PCR out of 25 random *E. coli* isolates showed that 28.00 per cent and 24.00 per cent of the isolates possessed *stx1* and *stx2* genes, respectively. None of the other samples carried *est, elt and eaeA* genes.

Haemato-biochemical parameter in treatment trial revealed significant increase in Hb, PCV, TEC, TLC, TSP, Cl- and decrease in glucose and Na+ in diarrhoeic calves in comparison to apparently healthy control.

Ciprofloxacin, norfloxacin and ofloxacin were highly sensitive (100%) to *E. coli* isolates whereas, ceftriaxone, amoxicillin, ampicillin, oxytetracycline, doxycycline hydrochloride and tetracycline showed resistance. Ciprofloxacin @ 10mg per kg body weight along with GutLyte-GS+orally twice daily for 5 days was found to be most suitable (100%) therapy on the basis of clinical recovery as well as improvement in the haemato-biochemical parameters.

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# **Epidemiological Study and Economic Impact of African Swine Fever in Few Affected Districts of Assam**

*Jahnabi Doley*

African Swine Fever (ASF) is a highly contagious and economically devastating important viral disease, causing 100 per cent mortality in domestic pig irrespective of breed, age and sex. The present study was undertaken to identify the epidemiological determinants of ASF, its sero-surveillance and the economic impact of the disease on pig farmers of three affected districts of Assam, i.e., Lakhimpur, Dhemaji and Majuli, during the period of October 2021 to August 2022. Assessment of risk factors associated with the outbreaks of ASF revealed presence of 'kutcha' (earthen) floors ( $p<0.01$ ), free-range rearing system ( $p<0.01$ ), biosecurity practices like allowing entry of visitors into the farm ( $p<0.01$ ), presence of weekly market within 2.5km proximity of the farm ( $p<0.01$ ), and pig slaughter point less than 1 km vicinity of the farm ( $p<0.01$ ), was found to have high significant association. Factors like swill feeding ( $p<0.05$ ), non-usage of disinfectants ( $p<0.05$ ), presence of households or farms within 500m distance ( $p<0.05$ ) and river within 1 km range of the farm ( $p<0.05$ ), farmers unawareness regarding the clinical signs of ASF ( $p<0.05$ ), selling or slaughtering of pig during the outbreak ( $p<0.05$ ), showed significant association with the outbreak and were considered to be the major risk factors of occurrence as well as spread of ASF. A sero-surveillance study was conducted in the three affected districts of Assam from which a total of 130 representative sera samples were collected and subjected to ELISA test, the overall sero- prevalence of ASF were recorded to be zero per cent. A total of 82 market samples were collected to detect the presence of ASFV from the three affected districts and subjected to PCR test, the overall incidence rate was recorded to be 15.85% (13/82). District wise analysis of presence of ASFV in market samples were recorded to be 29.16% (7/24), 14.63% (6/41) and 0.0% (0/17) in Lakhimpur, Dhemaji and Majuli district respectively. Assessment of total economic loss due to ASF during the outbreak was recorded to be Rs 50,47,830.00 among the study population, concluding ASF as a disease of economic importance. Awareness of the farmers along with adoption of rigorous bio-security measures can break the disease transmission chain and contain the outbreak.

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# **Hormonal and Mineral Status of Captive Asian Elephants (*Elephas maximus*) under Stress Condition and Its Management**

*Nikita Thingom Chanu*

The present study was conducted to know the hormonal and mineral status of captive Asian elephants of Assam under stress condition by evaluating the stress hormones and related haemato-biochemical parameters. The study areas were Kaziranga National Park, Manas National Park, Orang National Park, Pobitora Wildlife Sanctuary as well as captive elephants of Sonapur (Guwahati-metro district) area. The captive elephants under different National Parks and Wildlife Sanctuary were considered as apparently healthy and their physiological parameters were considered as baseline values for the study. Those captive elephants maintained by private owners of Sonapur area were considered as stressed animals and the stress hormones were evaluated and compared with the free ranging captive elephants of different National Parks and Wildlife Sanctuaries.

The serum cortisol (nmol/L), T<sub>3</sub> (nmol/L) and T<sub>4</sub> (nmol/L) concentrations were estimated using radioimmunoassay. Haematological parameters such as haemoglobin (g/dl), PCV (%), RBC (10<sup>6</sup>/mm<sup>3</sup>), TLC (10<sup>3</sup>/mm<sup>3</sup>) and DLC (%) were also studied manually using standard protocols. Likewise, blood biochemical profiles viz. blood glucose (mg/dl), cholesterol (mg/dl), AST (U/L), ALT (U/L), total protein (g/dl), iron (µg/dl) and phosphorus (mg/dl) were estimated using different diagnostic kits.

The mean cortisol concentration was higher and T<sub>3</sub> and T<sub>4</sub> were in low level in elephants of experimental group (captive elephants of private owners) in comparison to the baseline values of free ranging captive elephants of different National Parks and Wildlife Sanctuaries. Increase in haemoglobin, PCV, RBC and neutrophils and decrease in lymphocytes were also recorded in experimental group of elephants in comparison to baseline value. Blood biochemical profiles revealed higher level of blood glucose, cholesterol and low level of total protein and iron in privately owned captive elephants.

Therapeutic management of stressed elephants was done with Vitamin C injection along with B-complex and liver tonics as supportive therapy. Following

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treatment, there was significant improvement ( $p < 0.05$ ) in the level of cortisol,  $T_3$  and  $T_4$  hormones. Haematological parameters *viz.*, haemoglobin, PCV, RBC, TLC, neutrophils and lymphocytes showed significant differences ( $p < 0.05$ ) after treatment. Likewise, significant difference ( $p < 0.05$ ) were recorded in blood biochemical values of blood glucose, cholesterol, total protein, iron and phosphorus after treatment. The findings in the present study revealed that management of stress in captive elephants with vitamin C, B-complex vitamins and liver tonics were found to be effective.



# **Prevalence of Newcastle Disease Virus in Backyard and Commercial Poultry in Assam**

*Pubaleem Deka*

Newcastle disease (ND) is a highly contagious and economically important viral disease of poultry. This study was undertaken to have a detailed study of the prevalence of ND and to characterize the circulating Newcastle disease virus (NDV) along with some epidemiological studies. A seroprevalence study was conducted in 18 districts of Assam, where a total of 925 sera samples from 231 unvaccinated backyard poultry flocks were collected and subjected to haemagglutination test (HI) test to determine the level of antibodies against NDV. An overall seroprevalence was recorded to be 23.89%. Age-wise seroprevalence revealed that the adult birds >12 months of age had higher antibody titre. A total of 274 tissue samples and 158 cloacal swabs were collected and subjected to HI and RT-PCR targeting *F* gene. NDV could be detected in 61.68% tissue samples. Subsequently, NDV was also detected from 22.15% cloacal swabs from clinically affected vaccinated birds providing evidence of shedding of the virus despite of vaccination. Representative samples were sequenced and subjected to phylogenetic analysis. A phylogenetic tree was constructed which revealed that the sequences clustered with Genotype XIII in Class II. Molecular pathotyping which comprised of *F* protein cleavage site analysis revealed that all the seven isolates had amino acid sequences of 112RRKQRF117 revealing them to be of virulent type. Restriction mapping revealed the presence of cleavage site for *HhaI* restriction enzyme in the sequence confirming the sequences to be of mesogenic pathotype. Further, mean death time (MDT) of the present NDV isolates were between 76.0±2.69 to 87.6±1.00 hours confirming them to be of mesogenic strain. A questionnaire survey was conducted to evaluate the risk factors for ND occurrence. The analysis showed that the factors like close proximity of nearby poultry farms (OR=30, 95% CI: 10.38-86.68, p<0.0001), frequent contact with wild birds (OR=16.92, 95% CI: 6.57-43.59, p<0.0001), floor space of the poultry house (OR=4.33, 95% CI: 1.96-9.59, p=0.003), usage of non-chlorinated drinking water (OR=10.68, 95% CI: 4.43- 25.70, p<0.0001), separation of diseased birds (OR= 2.64, CI: 1.13-6.17, p = 0.024), awareness of biosecurity procedures (OR= 14.80, CI: 5.40-

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40.55,  $p = <0.0001$ ) and frequent entry of visitors (OR= 28.88, CI: 6.41- 130.11,  $p = <0.0001$ ) etc had significant association and higher risk of ND outbreak. The present study reveals that the ND is endemic in Assam state and the presently circulating genotype of NDV falls under genotype XIII. Further, risk factors related to biosecurity and farm practices appear to have a significant role in the occurrence of ND outbreaks.

# **Evaluation of Immune Response in Broiler Chicks Immunized With A Minimum Cold Chain Dependent Newcastle Disease Virus Formulation**

*Rofique Ahmed*

Among the infectious diseases of poultry, Newcastle disease (ND) is considered one of the most economically fatal viral diseases causing morbidity and mortality of about 90-100% in its velogenic form. Only through vaccination the economic menace and clinical condition caused by NDV can be controlled. But commercially available vaccines against ND are generally thermolabile and lose their potency if kept at room temperature (25°C) for 1-2 hours. The recent COVID-19 pandemic clearly showed the weakness of the vaccine supply chain and its maintenance. The lack of thermostable formulations is one of the major limitations that the COVID-19 pandemic has brought to light. Addressing the need for thermostable vaccine development, the present study was carried out with the study of the thermal stability of a thermostable NDV vaccine formulation (As/Km/19/44) and its immunogenic potential in broiler chicks.

In the present study, after receiving the thermoadapted ND seed virus (As/Km/19/44) confirmation was done by haemagglutination test (HA) and by Reverse Transcription- Polymerase Chain Reaction (RT-PCR) by the amplification of the 363 bp partial *F* gene. After confirmation, a thermal stability test of the seed virus (As/Km/19/44) was done by subjecting the isolate at 40°C and 56°C for 120 minutes respectively. The thermoadapted ND seed virus (As/Km/19/44) retained its HA activity and infectivity at 40°C up to 120 minutes without any decay in virus titre and at 56°C, the thermoadapted ND seed virus (As/Km/19/44) retained its half-life for 83.13 and 96.60 minutes in terms of HA activity and infectivity respectively. Further, lyophilization of the seed virus (As/Km/19/44) was done using chemical excipients viz., Pullulan (10% w/v), Trehalose (0.5M) and Inulin (45mg/ml) to prepare the immunogenic formulation. After formulation, the comparative HA activity and infectivity before and after lyophilization showed no significant difference at  $P < 0.05$ . The lyophilized NDV immunogenic formulations (As/Km/19/44) were grouped and kept at different temperatures viz., 4°C for six months, room temperature (about 25°C) for six months, 37°C for one month, and 56°C for 15 days for evaluating the thermal

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stability. At 4°C, no fall of virus titer in terms of HA activity and infectivity were recorded for up to 6 months. The estimated half-life period of the live NDV immunogenic formulation exposed at room temperature (around 25°C), 37°C and 56°C in terms of HA activity and infectivity was found to be 1008 and 1037; 50.03 and 71.51; 2.194 and 2.764 days respectively.

For evaluation of humoral immune response, the minimum cold-chain dependent NDV formulation (As/Km/19/44) was administered in experimental chicks through an intra-nasal route with a standard dose of 10<sup>6</sup>EID<sub>50</sub> per chick and compared with the commercial LaSota® vaccine. The HI (log<sub>2</sub>) and I-ELISA (log<sub>10</sub>) antibody titers in the serum samples of the experimental chicks at different days post-immunization revealed that there was no significant difference between overall humoral immune response in immunized chicks with minimum cold chain dependent live NDV immunogenic formulation As/Km/19/44 and commercially available LaSota® vaccine strain at P<0.001. Therefore, the minimum cold-chain-dependent NDV immunogenic formulation As/Km/19/44 can be recommended as a suitable live thermostable ND vaccine candidate for prevention and control of ND in areas where cold chain facilities are usually unreliable and can lead to the reduction of vaccine wastage, increase in vaccine efficacy, reduction in cost, ease of application and transportability.

# **Parvoviral Enteritis in Puppies and Its Therapeutic Management**

*Sayed Nazrin Rumana Rahman*

The present investigation was carried out to study the epidemiology, screening and detection of canine parvovirus infection as well as haematobiochemical alteration, oxidative stress assay and effective therapeutic regimen for canine parvovirus infection in puppies.

A total 134 number of each faecal and blood sample from diarrhoeic dogs were collected from the Department of Veterinary Clinical Complex of College of Veterinary Science, A.A.U., Khanapara and in the greater Guwahati area under Kamrup Metro district of Assam.

Out 134 number of dogs examined with haemorrhagic gastroenteritis, 81 dogs were found positive in rapid antigen test with prevalence of 60.45% while on PCR revealed a prevalence of 80.25%.

Canine Parvovirus infection was most common in >3-6 months old dogs as compared to other age group (11.94%).

The sex- wise prevalence of CPV infection was significantly higher ( $P<0.01$ ) in males (62.65%) as compared to female dogs (56.86%).

Breed-wise distribution of CPV infection revealed highest prevalence of disease in Mongerls (21.64%) and was significantly higher ( $P<0.01$ ) as compared to other dog breeds.

CPV infection was found to be the highest (19.40%) in winter followed by monsoon (15.67%), pre-monsoon (14.18%) and post monsoon (11.19%) seasons.

The prevalence of canine parvovirus infection based on vaccination status out of 81 infected dogs, 26 (19.40%) were vaccinated for Parvovirus infection and 55(41.04%) dogs were not vaccinated. The highest Prevalence of canine parvovirus infection was recorded in the unvaccinated dogs (41.04%). The variation was found to be statistically significant ( $P<0.01$ ).

In the present investigation, the most predominant symptoms of CPV infection were dullness (98.77%), followed by bloody diarrhoea (97.53%), vomition (96.21%),

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Anorexia (90.12%), dehydration (39.51%), Pyrexia (33.33%) and pale mucous membrane (64.11%).

Polymerase Chain Reaction (PCR) was found to be highly sensitive and specific in detecting CPV infection as compared to LFA.

Haematological alterations in CPV infection revealed significant ( $P<0.01$ ) decrease in haemoglobin ( $7.01\pm 0.33$  g/dl), TEC ( $16\pm 0.09\times 10^6/\text{mm}^3$ ), TLC ( $4.03\pm 0.18\times 10^3/\mu\text{l}$ ), PCV ( $29.77\pm 0.48\%$ ), MCV ( $52.32\pm 0.88$  fl), MCH ( $16.45\pm 0.39$  pg), MCHC ( $31.39\pm 0.50$  g/dL), Thrombocyte count ( $102.87\pm 2.49\times 10^6/\mu\text{l}$ ), Neutropenia ( $40.73\pm 1.13\%$ ) and Lymphopenia ( $7.82\pm 0.27\%$ ) but no significant alteration was found in Eosinophil ( $1.84\pm 0.12\%$ ) and monocytic count ( $3.21\pm 0.53\%$ ).

The biochemical profile in CPV infected dogs revealed significant ( $P<0.01$ ) decrease in Albumin ( $2.11\pm 0.02$  g/dL), total protein ( $4.94\pm 0.04$  g/dL), glucose ( $50.54\pm 0.62$  g/dL), sodium ( $140.69\pm 11.96$  mmol/l), potassium ( $2.20\pm 0.10$  mmol/l), and chloride ( $89.75\pm 1.22$  mmol/l), with a significant ( $P<0.01$ ) increase in ALT ( $67.68\pm 1.09$  U/L), AST ( $63.01\pm 1.26$  U/L), BUN ( $65.54\pm 1.04$  mg/dL), ALP ( $262.04\pm 4.18$  U/L), and creatinine ( $1.87\pm 0.03$  mg/dL) values.

Antioxidant enzymes *viz.* Superoxide dismutase (SOD) ( $1.72\pm 0.25$  U/mg Hb) and Catalase ( $13.43\pm 2.53$  mU/mgHb) decreased significantly ( $P<0.01$ ) in CPV infected dogs with significant ( $P<0.01$ ) increase in Lipid peroxidation (LPO) assay ( $6.25\pm 0.66$  nmol /mg Hb)

Significant difference in the haemato-biochemical parameters was recorded in all the treated groups in pre treatment period as compared to healthy control group. The parameters improved significantly in post treatment period *viz.*, on 7<sup>th</sup> and 15<sup>th</sup> day in all the treatment groups.

Among all the treated groups, dogs of group III treated with combined therapy comprising Conventional treatment + hyperimmune serum showed cent percent recovery by the end of Day 15 post treatment as compared to group-II (Conventional+ Egg derived protein) and group-I (Conventional).

## **Prevalence of Bat Lyssavirus In Assam**

*Tinku Das*

Rabies is one of the oldest known tropical viral zoonotic diseases caused by *Lyssavirus* of the family *Rhabdoviridae*, affecting all warm-blooded mammals. Annually ~ 60,000 people succumb to rabies every year, out of which, India alone bears the burden of 36 per cent of the global cases. Even though most of these cases are canine-mediated, but there is no dearth of data regarding bats being one of the primary reservoirs of the virus. Several species of bat *Lyssavirus* have been documented and bat-transmitted rabies in humans has been regularly reported since the last century. In the present study, 34 bat samples belonging to nine species of bats were collected from eight districts of Assam, namely, Kamrup (M), Baksa, Chirang, Barpeta, Kokrajhar, Golaghat, North Lakhimpur and Dhemaji, and tested for the presence of bat *Lyssavirus* as per the OIE guidelines. The samples were subjected to Lateral Flow Assay (LFA), Direct Fluorescent Antibody Technique (DFA), One-step PCR. None of the samples were positive for lyssavirus indicating absence of an active lyssaviral infection in the bats during the study period.

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# **Ehrlichiosis In Dogs: Its Epidemiology and Therapeutic Management**

*Queen Devi*

The present study entitled “Ehrlichiosis in dogs: its epidemiology and therapeutic management” was undertaken w.e.f. September 2021 to August 2022 with the objective to study occurrence, clinico-haematobiochemical and ultrasonographic alteration as well as to evolve an effective therapeutic regimen for *Ehrlichia* infection in the dog. The study revealed an overall prevalence of 4.68% on microscopy and a prevalence of 62.00% based on PCR assay. The study revealed the highest breed prevalence in German Shepherd (13.33%), largely affecting the age group of 1-3 years (9.80%) affecting male dogs predominantly (7.62%) with higher prevalence in monsoon season. Microscopic examination as well as nested PCR assay confirmed that *E. canis* is the species responsible for causing the disease. The present study revealed that ticks collected from affected dogs were *Rhipicephalus sanguineus*. The most prominent clinical signs of ehrlichiosis observed were inappetance (100 %) followed by depression (87.09%), tick infestation (80.64%), pale mucous membrane (80.64%), pyrexia (48.23%), diarrhoea (22.58) emesis (22.58%), respiratory distress/nasal discharge (12.90%), lameness (12.90%), haematemesis (12.90), epistaxis (9.68%), corneal opacity/ocular signs (9.68%), melena (9.68%), neurological signs (6.45%), petechial hemorrhages (6.45%), epistaxis (9.68%), icterus (3.22%), ascites/ edema/ abdominal distention (3.22%). Haematology revealed significantly lower level of haemoglobin, packed cell volume, total erythrocyte count, total leucocyte count and thrombocyte count. Serum biochemistry revealed hypoproteinemia and hypoalbuminemia. The level of glutathione peroxidase in the affected groups was found to be significantly lower than the control group whereas superoxide dismutase was significantly higher than the control group. Ultrasonographic changes observed were hepatomegaly, splenomegaly and kidney with hyperechoic cortex. Imidocarb dipropionate and doxycycline combination was found to be the most effective treatment against ehrlichiosis in dog.

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# **Empowerment of Women Through Milk Cooperative Societies in Selected Districts of Assam**

*Banani Das*

Taking into consideration the issues of success and failure of milk cooperatives in the state of Assam and the ever debatable topic of women empowerment the present study on “Empowerment of Women through Milk Cooperative Societies in Selected Districts of Assam” was undertaken. Two districts of Assam i.e., Darrang and Barpeta were purposively selected for the study with the objectives to explore a) The socio-economic status of women involved in dairy cooperatives of two selected districts of Assam, b) To find out the extent of involvement of women in different activities of dairy cooperatives, c) To assess the areas of empowerment through milk cooperatives, d) To find out the constraints related to dairy cooperatives as perceived by the respondents. From the two selected districts two blocks, Pathorighat and Bajali, were selected and from these blocks two milk cooperative societies were considered for the current research work. From both the cooperatives 60 women dairy farmers were selected by random sampling making the total sample size 120. A pretested, reliable and valid interview schedule was used for data collection. The data collected were analysed using standard statistical methods. Majority of the women dairy farmers i.e. 57.50 per cent were in middle age category and the average age was found to be 36.8 years. 95.83 per cent of respondents were married while only 4.16 percent were widow. Further, in Darrang district 83.33 per cent respondents and 51.66 per cent respondents in Barpeta district belonged to general caste. It was observed that 80.33 per cent women dairy farmers resided as nuclear family while 19.16 per cent as joint family. Majority of respondents in Darrang district i.e. 83.33 per cent had medium family size with 3-6 numbers of family members while in Barpeta 75.00 per cent had medium family size 3-6 numbers. It was found that in Darrang district 56.66 per cent respondents had medium level of educational qualification and in Barpeta district educational qualification of respondents was found to be 61.66 per cent which is of medium level. Majority of the respondents in both the districts Darrang and Barpeta had medium herd size i.e. 80.00

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**Major Advisor : Dr. (Mrs.) Leema Bora**

per cent and 71.66 per cent, respectively. It was observed from the study that 51.66 per cent of respondents in Darrang district and 63.33 per cent in Barpeta district had medium social participation. Maximum number of respondent i.e., 56.66 per cent in Darrang district and in Barpeta district 45.00 per cent had medium extension contact. A fairly large number of respondents i.e., 68.33 per cent of both Darrang and Barpeta district had medium level of mass media exposure. In case of Darrang district 86.66 per cent of respondent had medium level of daily milk contribution to the cooperative with 15-64 litres while in Barpeta the corresponding figure was 58.33 litres. It was observed that in Darrang district majority i.e., 78.33 per cent had medium land holding and in Barpeta district 70.00 per cent of respondent had medium land holding. 100.00 per cent respondents in Darrang district had medium annual income from dairying and in Barpeta district 55.00 per cent had medium income. It was found that in Darrang district 68.33 per cent of respondent had medium annual income from other sources while 51.66 per cent of respondents had medium income. The study depicted that in Darrang district 100 per cent respondents had medium total annual income of while in Barpeta district 56.66 per cent of respondent had medium level of total annual income. In Darrang district maximum number of respondents i.e., 71.66 per cent were in the medium category while 28.33 per cent were in high category of extent of involvement of women in different activities of dairy cooperatives. In case of Barpeta district majority of respondents i.e., 66.66 per cent were in medium level and 33.33 per cent in low level of involvement in dairying activity. The mean difference of the two districts was found to be highly significant ( $t=13.505^{**}$ ,  $p<0.01$ ). Majority of respondents in Darrang district i.e., 58.33 per cent had medium level of empowerment while 41.66 per cent had high level of empowerment. The mean value was 239.20 with standard deviation 10.79 and range 213-256. Among the respondents in Barpeta district majority of respondents i.e., 63.33 per cent had medium level of empowerment while 36.66 per cent had high level of empowerment. The mean difference of the two districts was found to be highly significant ( $t=10.658^{**}$ ,  $p<0.01$ ). In correlational analysis 3 independent variables *viz.* educational qualification land holding and annual income from other sources had positive and highly significant correlation with extent of involvement of women in different activities of dairy cooperatives and milk yield had negative and significant correlation in Darrang district. In Barpeta district educational qualification and land holding had negative and significant correlation with the dependent variable. Independent variables like age, land holding and annual income from other sources had positive and highly significant correlation with areas of empowerment through milk cooperatives while mass media exposure had negative and significant correlation and herd size had negative and highly significant correlation with areas of empowerment through milk cooperatives in Darrang district while none of the independent variable had significant correlation with the dependent variable in Barpeta district. In multiple regression analysis the co-efficient of multiple determination ( $R^2$ ) with 12 independent variables under study could explain 61.20 and 25.1 per cent variation in extent of involvement of women in different activities of dairy cooperatives in districts of

Darrang and Barpeta. The co-efficient of multiple determination ( $R^2$ ) revealed that the 12 independent variables under study could elucidate 47.70 per cent variation in areas of empowerment through milk cooperatives in Darrang district. It was found that as per the preferential ranking of constraint based upon Mean Rank Based Quotient (R.B.Q) “Lack of land for fodder cultivation” was ranked first among all the constraints faced by the women dairy farmers of Pathorighat Dugdha Utpadak Samiti followed by “High feed cost”, “Lack of emergency health services”. The rank correlation coefficient in Darrang district was found to be 0.731 which was highly significant at 0.01% level of significance. It was observed that as per the preferential ranking of constraint based upon Mean Rank Based Quotient (R.B.Q) “Lack of land for fodder cultivation” was ranked the most important constraint followed by “Lack of technical knowledge for management”, “Lack of training in dairy”. The rank correlation coefficient of respondents in Barpeta district was found to be 0.864 which was highly significant.

## **Adoption Level in Scientific Poultry Rearing Practices in Ri-Bhoi District of Meghalaya**

*David Teileng Sun*

The poultry industry in India represents a major success story. It forms a major portion and is one of the fastest growing sectors of agricultural sector in India today. It has shown a tremendous growth and has transformed itself from a backyard venture to a vibrant agribusiness over the last four decades. It plays major role for the rural poor and marginalized section of the people. It is a powerful tool for alleviation of rural poverty, eradication of malnutrition, employment generation, augmenting rural income in eggs, meat and compost. Poultry farming has become an important source of nutrition and livelihood security, especially in developing nations like India and other South East Asian countries.

Therefore, the study was conceptualized with the overall objective to study on “Adoption Level in Scientific Poultry Rearing Practices in Ri-Bhoi District of Meghalaya.” The study was carried out in two purposively selected blocks of Ri-Bhoi district namely Bhoirybong and Umsning development blocks. A total number of 1362 poultry households were involved in poultry farming from the selected blocks. From each block 50 (fifty) number of respondents were selected which made the total sample size of 100 (one hundred). The respondents were selected through proportionate stratified random sampling from the eight villages i.e., four villages from each block. Data on socio-economic status, adoption level of scientific poultry rearing practices and constraints in adoption of scientific rearing practices in poultry farming were gathered by the researcher through personal interview method.

The study revealed that majority (65.00 per cent) of the respondents average age were 40 years, (81.00 per cent) married, (51.00 per cent) males, (80.00 per cent) nuclear type of families, (63.00 per cent) medium sized family of around 6 members, (74.00 per cent) medium level of education and educated up to the middle to high school level in both the blocks. There was significant difference between the two blocks in age (‘t’ value=2.25\*, P<0.01). They had medium level of occupation (58.00 per cent) where animal husbandry cum veterinary was their primary occupation. There was highly significant difference between the two blocks in occupation (‘t’ value =2.86\*\*, P<0.01).

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They had medium level of information source (73.00 per cent) which used family members, friends or relatives, neighbours/peer groups, livestock dealers/sellers as their main source of information. There was highly significant difference between the two blocks in information source ('t' value =4.64\*\*, P<0.01), majority (68.00 per cent) had medium level of social participation, (82.00 per cent) extension contact for more than once a year, (86.00 per cent) had duration of time spent which was 3 hours a day in managing poultry birds. There was highly significant difference between the two blocks in social participation ('t' value =2.64\*\*, P<0.01). The farmers had medium level in total annual income from all sources (74.00 per cent), (78.00 per cent) annual income from poultry, (90.00 per cent) livestock and (70.00 per cent) from poultry and livestock. The majority (74.00 per cent) had medium length of experience of average seven years in poultry farming and (64.00 per cent) mass media exposure. The internet was the main source of mass media exposure followed by television, newspaper and radio. Majority (94.00 per cent) of respondents adopted intensive system followed by (6.00 per cent) semi-intensive system. Majority (92.00 per cent) used GI sheets, (6.00 per cent) thatch, (57.00 per cent) mud floor, (40.00 per cent) concrete floor, (2.00 per cent) wooden floor, (40.00 per cent) wire net and concrete wall, (30.00 per cent) other material like GI sheet and (27.00 per cent) bamboo. From the study it was revealed that majority of the respondents in all the dependent variables occupied medium group of frequency distribution in adoption level of scientific or improved practices which include (72.00 per cent) housing, (82.00 per cent) feeding, (92.00 per cent) source of chick, (89.00 per cent) management, (83.00 per cent) health care, (78.00 per cent) bio-security and (85.00 per cent) was the overall adoption level of scientific poultry rearing practices.

The study also found out that the relationship of adoption level by the poultry farmers with their socio-economic status, correlation coefficients were calculated which indicated that in the pooled sample adoption level exhibited highly positive and significant relationship with education ( $r=0.333^{**}$ ,  $P<0.01$ ) and extension contact ( $r=0.258^{**}$ ,  $P<0.01$ ) whereas mass media exposure ( $r=0.224^{*}$ ,  $P<0.05$ ) and farm size ( $r=0.202^{*}$ ,  $P<0.05$ ) exhibited positively significant relationship with adoption level. Annual income from other source ( $r = -0.409^{**}$ ,  $P<0.01$ ) showed negatively and highly significant relationship with adoption level. Family size ( $r = -0.218^{*}$ ,  $P<0.05$ ) exhibited negatively significant relationship with adoption level. The constraints of rearing poultry encountered by the farmers were feed and feeding related constraints - like less availability and high cost of feed as the most important constraint and expensive nature of all inputs day old chicks, feed, equipments, financial problem for maintenance of poultry farm, low or poor market and difficulty in supply chains of inputs especially in Covid-19 pandemic situation, lack of initial capital fund, market exploitation by middlemen were some of the common and important constraints of the respondents.

# **Impact of Female Participation in Livestock and Poultry Enterprises in Ensuring Women Empowerment and Household Food Security Among Selected Tribes/ Ethnic Group in Goalpara District of Assam**

*Deepjyoti Roy*

A study titled “Impact of Female Participation in Livestock and Poultry Enterprises in Ensuring Women Empowerment and Household Food Security among Selected Tribes/ Ethnic Group in Goalpara District of Assam” was conducted with a view to investigate gender participation in livestock enterprises, to find the socio-personal, socio-economic and psychological parameters of the women of four tribes/ ethnic group along with their time spent in livestock related activities, their nature and extent of participation and to assess the impact of their participation in these activities on their overall household empowerment and food security. The Goalpara district of Assam was purposively selected, from where a total of two hundred respondents- fifty each from Rabha, Garo, Hajong and Koch-Rajbongshi communities were surveyed for the study, the selection being done via snowball sampling method.

The study revealed that majority of the respondents belonged to young age category (54.00 per cent), had small sized family (54.00 per cent), lived in a joint family system (56.50 per cent), had small land holding (69.00 per cent), possessed small sized herd (59.50 per cent) and had low level of education (37.00 per cent), social participation (65.50 per cent), mass media exposure (65.00 per cent) and extension contact (55.50 per cent). They also earned low annual income from livestock and poultry rearing (61.50 per cent), from other sources (67.20 per cent) and as well as from all sources (66.00 per cent). In respect of experience in livestock and poultry rearing majority (61.50 per cent) of them had short experience, had favourable attitude towards improved livestock farming (51.00 per cent) and high level of liking for information sources (46.50 per cent). Majority (54.50 per cent) of the respondents considered animal husbandry as a secondary source of income. The highest number (38.00 per cent) of the

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respondents spent medium time engaged in various livestock rearing activities. Significant difference was observed among the communities in respect of their level of education (15.799\*\*,  $P < 0.01$ ), level of social participation (6.029\*\*,  $P < 0.01$ ), level of experience in livestock rearing (4.131\*\*,  $P < 0.01$ ), level of mass media exposure (16.890,  $P < 0.01$ ), level of extension contact (13.496\*\*,  $P < 0.01$ ), herd size (3.021\*,  $P < 0.05$ ), land holding (10.166\*\*,  $P < 0.01$ ), annual income from livestock and poultry rearing (7.197\*\*,  $P < 0.01$ ), annual income from sources other than livestock and poultry rearing (8.962\*\*,  $P < 0.01$ ), total annual income from all sources (9.552\*\*,  $P < 0.01$ ), liking of information sources (17.560\*\*,  $P < 0.01$ ), attitude towards improves livestock farming (19.586\*\*,  $P < 0.01$ ), time spent in livestock activities (7.595\*\*,  $P < 0.01$ ).

Gender-wise it was seen that all the activities involved the participation of both males and females. No such activity was observed where only lone male or lone female participation was present. The chi-square analysis revealed that the activities like 'collection of fodder' (18.361\*), 'milking' (12.989\*), 'selling of milk and milk products' (14.633\*), 'preparation of milk products' (14.010\*), 'collection of dung' (13.448\*), 'preparation of dung cake' (13.448\*) and 'bathing of animals' (19.215\*) revealed significant chi-square values at  $P < 0.05$  level of probability which indicated that gender was significantly associated with tribe/ethnicity in respect of these activities.

In respect of nature of participation, respondents alone participated in higher number in most of the activities in comparison to with husband, with in-laws, with children or together. In respect of extent of participation it was seen that the respondents regularly participated in the activities common to both livestock and poultry rearing.

The percentage of women who perceived high level of women empowerment through their participation in livestock and poultry rearing was 52.00 per cent while majority (71.00 per cent) of the respondents had a high level of perception that their participation in such activities ensured household food security.

Relational analysis was conducted between independent variables and the extent of participation, women empowerment and household food security which revealed that herd size ( $r = 0.292$ \*\*,  $P < 0.01$ ), land size ( $r = 0.208$ \*\*,  $P < 0.01$ ), attitude towards improved livestock farming ( $r = 0.409$ \*\*,  $P < 0.01$ ), time spent in livestock activities ( $r = 0.302$ \*\*,  $P < 0.01$ ) showed highly significant and positive correlation with extent of participation while education ( $r = -0.195$ \*\*,  $P < 0.01$ ) and total annual income from all sources ( $r = -0.200$ \*\*,  $P < 0.01$ ) exhibited highly significant and negative correlation with extent of participation. While mass media exposure ( $r = -0.179$ \*,  $P < 0.05$ ) showed significant and negative correlation with extent of participation. Regression analysis showed that herd size (2.706\*\*,  $P < 0.01$ ), land size (2.635\*\*,  $P < 0.01$ ), attitude towards improved livestock farming (4.953\*\*,  $P < 0.01$ ) and time spent in livestock activities (3.335\*\*,  $P < 0.01$ ) showed a highly significant effect on the extent of participation. The coefficient of determination ( $R^2$ ) was found to be 0.369 which indicated that 36.90 per cent of variation in extent of participation could be explained by these variables. The F value (7.164) was found to be positive and highly significant and indicated that these variables were good predictors of extent of participation.

In respect of women empowerment, it was observed that 7 out of 15 variables viz. age ( $r = 0.249^{**}$ ,  $P < 0.01$ ), social participation ( $r = 0.363^{**}$ ,  $P < 0.01$ ), experience in livestock farming ( $r = 0.235^{**}$ ,  $P < 0.01$ ), extension contact ( $r = 0.323^{**}$ ,  $P < 0.01$ ), annual income from livestock rearing ( $r = 0.335^{**}$ ,  $P < 0.01$ ), attitude towards improved livestock farming ( $r = 0.278^{**}$ ,  $P < 0.01$ ), time spent in livestock activities ( $r = 0.459^{**}$ ,  $P < 0.01$ ) exhibited highly significant and positive correlation with household women empowerment while family size ( $r = -0.211^{**}$ ,  $P < 0.01$ ) showed highly significant and negative correlation with household women empowerment. On the other hand, multiple regression analysis showed that age (2.680\*\*,  $P < 0.01$ ), social participation (4.208\*\*,  $P < 0.01$ ), herd size (-3.950\*\*,  $P < 0.01$ ), attitude towards improved livestock farming (5.456\*\*,  $P < 0.01$ ) and time spent in livestock activities (4.227\*\*,  $P < 0.01$ ) showed a highly significant contributing effect on household women empowerment and liking of information sources (-2.274\*,  $P < 0.05$ ) showed a significant contributing effect on women empowerment. The coefficient of determination ( $R^2$ ) was found to be 0.466 which indicated that 46.60 per cent of variation in household women empowerment could be explained by these variables. The F value (9.968) was found to be positive and highly significant and indicated that these variables were good predictors of household women empowerment.

While in case of household food security, out of 15 independent variables social participation ( $r = 0.242^{**}$ ,  $P < 0.01$ ), mass media exposure ( $r = 0.216^{**}$ ,  $P < 0.01$ ), annual income from livestock farming ( $r = 0.276^{**}$ ,  $P < 0.01$ ), attitude towards improved livestock rearing ( $r = 0.343^{**}$ ,  $P < 0.01$ ), liking of information sources ( $r = 0.204^{**}$ ,  $P < 0.01$ ), time spent in livestock activities ( $r = 0.228^{**}$ ,  $P < 0.01$ ) exhibited highly significant and positive correlation with household food security while extension contact ( $r = 0.162^*$ ,  $P < 0.05$ ) showed significant and positive relationship with household food security. The regression analysis further revealed that social participation (3.680\*\*,  $P < 0.01$ ), mass media exposure (2.678\*\*,  $P < 0.01$ ), attitude towards improved livestock farming (5.262\*\*,  $P < 0.01$ ) showed highly significant effect on household food security while herd size (-2.065\*,  $P < 0.05$ ) had significant effect on the same. The coefficient of determination ( $R^2$ ) was found to be 0.334 which indicated that 33.40 per cent of variation in food security could be explained by these variables. The F value (6.144) was found to be positive and highly significant and indicated that these variables were good predictors of the household food security.

Further correlation co-efficient was calculated of extent of participation with that of women empowerment and household food security. No significant relation between the extent of participation of the respondents in livestock and poultry enterprises with the level of household empowerment of women or household food security was present.



## **Empowerment of Women of Selected Tribes in Tripura Through Livestock Enterprises**

*Keshab Jamatia*

An investigation was undertaken to study the empowerment of women of selected tribes in Tripura through livestock enterprises. Two major tribes namely Deb Barma and Jamatia were selected from among the nineteen tribes that inhabit in Tripura and from each of the two tribes 100 respondents were selected by snow ball sampling technique from the purposively selected two districts namely Sepahijala and Gomati to make the sample size 200. The sole criterion of the respondent was that she should have atleast two pigs or two goats or ten poultry or one cattle. The data were collected by the researcher personally by using a pre-tested valid and reliable interview schedule which consisted of five parts:- first part dealt with socio-personal, economic and psychological traits of the respondents, second part assessed the gender participation of tribal people in livestock enterprises, third part was meant for measuring the empowerment level, fourth part was used to find out the constraints perceived by respondents in livestock enterprises and the last part was made in identifying and documenting the indigenous technical knowledge practised by the tribal people of Tripura in livestock enterprises. The data thus collected were subjected to statistical analysis like percentage, frequency, mean, SD, t-test, correlation and regression. The research study revealed that in pooled data majority (64.00 per cent) of the respondents from both the tribes belonged to middle (29-47 yrs.) age category and had nuclear families (68.50 per cent) with family size ranging from 3-6 members. Majority of the respondents had read upto high school level (33.00 per cent) with medium level in the traits like social participation (48.00 per cent), land holding (0.98-2.81 acre), herd size (0.195-2.864 nos.), experience in livestock farming (4-22 yrs.), mass media exposure (84.50 per cent), extension contact (79.00 per cent), entrepreneurship behaviour (75.00 per cent) and liking of information source (83.50 per cent). On the other hand, most of the respondents had neutral attitude towards improved livestock farming (77.50 per cent) with medium level of participation in livestock enterprises (74.50 per cent) and spent an average time of 1.94 hours daily in livestock enterprises. In respect of their occupation majority of the respondents were involved in agriculture along with animal husbandry and self-employment (28.00 per

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cent) with an average annual earning of Rs. 31,993.50 from livestock and poultry, Rs.1, 56,507.00 from sources other than livestock and poultry and average of Rs.1, 88,684.50 from all the sources. Most of the respondents performed alone in livestock related activities like collection of eggs, preparation of feed for animals, feeding and watering of birds, feeding and watering of animals, cleaning of animal shed, maintenance of bird shed, care of sick animals, care of new born animals, care of health condition of animals, bathing of animals and milking of animals. They also performed jointly the activities like selling of animal at market age, maintenance of animal shed, collection of fodder and grazing of animals and had medium level of participation in livestock enterprises (74.50 per cent). Majority of the respondents had medium level of perceived overall empowerment and in this regard their appeared no significant difference between the two tribes. Out of sixteen independent variables only five showed highly significant positive relationship with overall empowerment level. Similarly, out of seventeen variables only five variables had significant contributing effect on variation of empowerment level and the coefficient of determination was 4.66 which indicated that only 46.60 per cent variation could be explained by these variables. The significant F value (9.968) indicated that these five variables were good predictors of empowerment level. While assessing the constraints as many as 12 constraints were identified through R.B.Q. technique, where the perceived constraints “non-availability of grazing land due to rubber plantation” was ranked 1st by Deb Barma respondents and “feed and feed related problems like less availability of feed and improper growth even after proper feeding” was ranked 1st by Jamatia respondents. In respect of indigenous technical knowledge practised by the tribal people in Tripura a total of 24 medicinal plants (14 herbs, 5 shrubs and 5 trees) used in treating and feeding animals and 3 mixtures were identified and documented properly with the help of local healers and some respondents.

# **Participation of Tribal Farmwomen in Livestock Management Activities in Dima Hasao District of Assam**

*Komolika Bodo*

There are diverse ways in which livestock contributes to the household food and nutrition and rural women in India plays a crucial role in managing livestock. India has a long history of involving women in raising of livestock because domestic animals have long been an essential component of the family farming system. Studies on varied tasks shouldered by the rural women in livestock management are of utmost relevance in highlighting their contributions at the family level. For the planners, decision-makers and extension workers such studies serve as the baseline for initiating projects for rural development. With this reality in mind, the current study on the "Participation of Tribal Farm Women in Livestock Management Activities in Dima Hasao District of Assam" carried out. The study was conducted in two selected blocks of the Dima Hasao district i.e., Diyungbra ITDP Block and Jatinga Valley Development Block which were purposively selected in keeping adherence with the objectives to explore a) The socio-economic profile of the respondents in the study area, b) The extent of involvement of womenfolk in livestock management activities in the study area, c) The extent of participation of women in decision making process in livestock management activities, and d) The relationship between extent of involvement and decision making of womenfolk in livestock management activities. As such, 60 respondents or tribal women from each block i.e., Diyungbra ITDP Block and Jatinga Valley Development Block were selected snow ball sampling making the total sample size 120. A pretested, reliable, and valid interview schedule was used for data collection. The data collected were analyzed using IBM SPSS Statistics version 24. Majority of the tribal women livestock farmers i.e. 68.33 per cent were in middle age category and the average age was found to be 41.35 years. 96.67 per cent of respondents were married while only 2.50 percent were widows and 0.83 per cent were unmarried. It was observed that 81.67 per cent farm women resided as nuclear family while 18.33 per cent as a joint family. Majority of respondents in Diyungbra ITDP Block i.e. 81.67 per cent and Jatinga Valley

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Development Block 76.67 per cent had medium family size with 3-6 numbers. Majority (35.00 per cent) of the respondents were engaged in Agriculture + Animal husbandry + Weaving in Diyungbra ITDP Block and 33.33 per cent were engaged in Agriculture + Animal husbandry + Government employed in Jatinga Valley Development Block. It was found that most respondents in Diyungbra ITDP Block and Jatinga Valley Development Block i.e., 63.33 per cent and 50.00 per cent had medium educational qualification. The majority of respondents in both the blocks i.e. 81.67 per cent and 83.33 per cent had medium-sized herd. The majority of respondents in both the blocks i.e. 75.00 per cent and 73.33 per cent had a medium level of social participation. Most respondents in Diyungbra ITDP Block and Jatinga Valley Development Block showed low level of extension contact, i.e., 46.67 per cent and 48.33 per cent respectively. Majority of the respondents in Diyungbra ITDP Block, i.e., 93.33 per cent and 90.00 per cent in Jatinga Valley Development Block did not receive any training on livestock management. Mass media exposure in both the blocks was of medium level with 45.00 per cent respondents in Diyungbra ITDP Block and 70.00 per cent in Jatinga Valley Development Block. It was observed that in Diyungbra ITDP Block and Jatinga Valley Development Block most respondents i.e., 48.33 per cent and 58.33 per cent had low farm land holding. The majority of respondents in Diyungbra ITDP Block and Jatinga Valley Development Block i.e., 63.33 per cent and 71.67 per cent had medium total land holding. It was reflected in the study that most respondents in Diyungbra ITDP Block and Jatinga Valley Development Block had medium level of income from livestock with an average of Rs. 25983.33/year. Total annual income of respondents in Diyungbra ITDP Block and Jatinga Valley Development Block was of medium level with an average of Rs. 151166.67. Majority of the respondents i.e., 41.67 per cent faced a medium level of distance to reach the market. Most respondents i.e., 76.67 per cent had a medium level of involvement in livestock management activities with a mean of 13.72 in the sub-area of feeding and watering, 12.17 in breeding, 12.15 in general management and 11.59 in animal health care. Most respondents i.e., 71.67 per cent had a medium level of decision-making in livestock management activities with a mean of 14.48 in household activities followed by a mean of 12.42 in feeding and watering of animals, 10.75 in general management, 7.01 in animal health care, and 6.77 in breeding. In correlational analysis 3 independent variables viz. age had a positive and highly significant correlation and mass media exposure had a negative and highly significant correlation with the extent of involvement of womenfolk in livestock management activities in Diyungbra ITDP Block. In Jatinga Valley Development Block also age had a positive and highly significant correlation and mass media exposure had a negative and highly significant correlation with the extent of involvement of womenfolk in livestock management activities. In Diyungbra ITDP Block, 3 independent variables viz. age, herd size and extension contact, showed a positive and significant correlation but mass media exposure had a negative and significant correlation with the extent of participation of women in decision making process of women in livestock management. In Jatinga Valley Development Block, age had a positive and highly significant

correlation, extension contact had positive and significant correlation, mass media exposure had a negative and highly significant correlation and farm landholding showed a negative and significant correlation with the extent of participation of women in decisionmaking process of women in livestock management. Regression analysis between independent variables and the extent of involvement of womenfolk in livestock management activities could not attain a level of significance. The co-efficient of multiple determination (R<sup>2</sup>) value was found to be 0.269, and the F value for R was found to be non-significant. regression analysis between independent variables and the extent of decision-making process of women in livestock management showed that the age of respondents of Dima Hasao District had a positive and significant relation ( $p < 0.05$ ). Herd size also had a positive and significant relation ( $p < 0.05$ ). The co-efficient of multiple determination (R<sup>2</sup>) value was found to be 0.273, and the F value for R was found to be non-significant.

# **Assessment of Ethno-Veterinary Practices and Its Relevance for Livestock and Poultry in Majuli District of Assam**

*Migom Mili*

An investigation was undertaken to study the assessment of ethno-veterinary practices and its relevance for livestock and poultry in Majuli district of Assam. Two development blocks-Ujani block and Namani block of Majuli district were selected as the area of study. The traditional healers of the study area were identified through participatory mode involving the village headman, village elders and rural field level workers of Government departments in agriculture and allied sectors. To identify and document the plants used for feeding and treatment of Livestock and Poultry birds, a semi-structured interview schedule having close ended as well as open ended questions was constructed in consultation with the experts in the relevant field and studying available literature. Data in relevance to this study was collected from the identified traditional healers personally in their home. All data were recorded after taking Prior Informed Consent (PIC) from the traditional healers which is attached. Demographic details about the healers were collected and plants used for treatment were listed out.

For selecting the farmer respondents, farmers from two development blocks namely Ujani Majuli Block and Namoni Majuli Block of Majuli district, were selected purposively and from each block, five villages were again selected purposively for data collection. From each village, ten farmers were selected as respondents through snow ball sampling technique making the total sample size 100. Farmer having at least 2 to 3 livestock and few poultry birds in their backyard were considered as a respondent. A structured interview schedule was used for collection of data in regards to the socio-personal, economic and other dependent variables under study. The data were collected by the researcher personally by using a pre-tested valid and reliable interview schedules. The data thus collected were subjected to statistical analysis like percentage, frequency, mean, SD, and ethnobotanical indices like Use Value (UV), Fidelity Level (FL) and Relative Frequency of Citation (RFC). The research study revealed that majority (71.42 per cent) of the traditional healers of both the blocks belonged to middle (37-70 years)

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**Department : Extension Education**

**Major Advisor : Dr. (Mrs.) Leema Bora**

age category and majority (54.76 per cent) had nuclear families with family size ranging from 4-8 members. Majority (73.80 per cent) of the healers had medium level of educational qualification and had medium level in the traits like social participation (59.52 per cent). They possessed medium sized land holding (3.74 – 12.76 acres), medium herd size (2.77-10.21 nos.) and had experiences in traditional healing practices since last 12-38 years. Majority (78.57 per cent) of them had medium level of mass media exposure and extension contact. In respect of their occupation, majority (92.86 per cent) of the healers were involved in agriculture along with animal husbandry with an average annual earning of Rs. 58,619.05 and average annual income from livestock and agriculture of Rs. 42047.62. Information related to the plants used by the healers was collected and their ethnobotanical indices were calculated. a total of 102 plants species belonging to 57 families were documented in the current study. Among the identified plants, Fabaceae plant families had the highest number of 7 species, followed by 6 species of Zingiberaceae and 5 species Rutaceae and Lamiaceae, 4 species of Rubiaceae and 3 species of Areaceae, Poaceae, Malvaceae, Convolvulaceae, Piperaceae and Moraceae. Two plant species from each of Myrtaceae, Apocynaceae, Lauraceae Apiaceae, Amaryllidaceae, Vitaceae, Asteraceae, Oxalidaceae, Menispermaceae, Amaranthaceae and Solanaceae families were also identified which were used for treatment of various ailments. One species of plant belonging to each of the Papaveraceae, Gentianaceae, Anacardiaceae, Cucurbitaceae, Plantaginaceae, Dennstaedtiaceae, Urticaceae, Asphodelaceae, Bignoniaceae, Rosaceae, Rhizophoraceae, Euphorbiaceae, Capparaceae, Punicaceae, Musaceae, Caesalpiniaceae, Cannabinaceae, Dilleniaceae, Lythraceae, Rhamnaceae, Cyperaceae, Theaceae, Araceae, Oleaceae, Clusiaceae, Meliaceae, Caricaceae, Saururaceae, Thelypteridaceae, Combretaceae, Bromeliaceae, Asparagaceae, Phyllantaceae, Pedaliaceae and Scrophulariaceae families were also used for various purposes. *Paederia foetida*, *Rubus moluccanus*, *Crateva magna*, *Curcuma domestica* and *Spondius pinnata* of the families Rubiaceae, Rosaceae, Capparaceae, Zingiberaceae and Anacardiaceae respectively had the highest used values (UV) of 0.11 each. *Citrus limon* of Rutaceae family and *Carallia brachiata* of Rhizophoraceae family had the highest RFC value (1). *Carallia brachiata* and *Citrus limon* of the families Rhizophoraceae and Rutaceae respectively, had the highest fidelity level (FL) of 100 per cent.

Majority (66.00 per cent) of the livestock farmers of both the blocks belonged to middle age group (38-55 years) and 50.00 per cent resided as nuclear family and another 50.00 per cent as joint family with family size ranging from 4-8 members. Majority (52.00 per cent) of the farmers had medium level of educational qualification with medium level of social participation (55.00 per cent), had medium sized land holding (5.26 – 10.90 acres) and herd size (4-24 nos.). About 51.00 per cent of them had medium level of mass media exposure and 99.00 per cent had medium level of extension contact. In respect of their occupation majority (100.00 per cent) of the farmers were involved in agriculture along with animal husbandry with an average annual earning of Rs. 52470.00 and average income from livestock of Rs. 10760.00. It

was found that majority of the farmers of Ujani Majuli block had medium level of perception (56.00 per cent), followed by high perception level (24.00 per cent) and low level of perception (20.00 per cent). In case of the farmers of Namani Majuli block, majority of them had medium level of perception (52.00 per cent), followed by low perception level (32.00 per cent) and high level of perception (16.00 per cent). In relational analysis it was revealed that age of livestock farmers in case of Namani Majuli block was positive and highly significant correlation ( $r=0.537^{**}$ ,  $P<0.01$ ) with the perception toward Ethno-veterinary practices, whereas in case of Ujani Majuli block farmers, it failed to attain the statistical level of significance ( $r=-0.097$ , NS). Family size in case of the farmers of Namani Majuli block was positive and highly significantly correlated ( $r=0.579^{**}$ ,  $P<0.01$ ) with the perception toward Ethno-veterinary practices, where as in case of Ujani Majuli farmers, it was negative and failed to attain the statistical level of significance ( $r=-0.243$ , NS). The level of education of the farmers of Namani Majuli block was negative and highly significant correlation ( $r=-0.664^{**}$ ,  $P<0.01$ ) with the perception towards Ethno-veterinary, where as in case of Ujani Majuli block farmers, it failed to attain the statistical level of significance ( $r=0.207$ , NS). The herd size had positive and highly significant correlation in Namani Majuli block farmers ( $r=0.409^{**}$ ,  $P<0.01$ ) with perception towards Ethno-veterinary practices, where as in case of the farmers of Ujani Majuli, it was negative and non significant ( $r=-0.022$ , NS). For the pooled data, it failed to attain the statistical level of significance ( $r=0.0163$ , NS). Income from livestock had significant correlation in Namani Majuli farmers ( $r=0.349^{*}$ ,  $P<0.05$ ) with perceptions towards Ethno-veterinary practices, where as in case of Ujani Majuli farmers, it was negative and failed to attain the statistical level of significance ( $r=-0.046$ , NS). Total annual income in case of Namani Majuli farmer was found to be positive and significant ( $r=0.287^{*}$   $P<0.05$ ) with the perceptions towards Ethno-veterinary practices, where as in case of Ujani Majuli it failed to attain statistical level of significance ( $r=0.131$ , NS). Land holdings, mass media exposure and extension contact of the farmers of both the block failed to attain statistical level of significance with the perception towards Ethno-veterinary practices.



# **Dynamics of Urbanization in the Livelihood of Livestock Farmers in The Peri-Urban Areas of Guwahati City**

*Parag Sankar Choudhury*

Since urbanization is described under specific conditions and time period so going by the changes in the livelihood of livestock farmers in the Deepor Beel areas a study entitled “Dynamics of Urbanization in the Livelihood of Livestock Farmers in the Peri-Urban Areas of Guwahati city” is taken up which will give an insight into the livelihood status of the villagers in a holistic way. The study was conducted in the peri-urban areas in and around Deepor Beel in five revenue villages which was purposively selected namely Pamehi, Mikirpara, Chakardoe, Lakhara and Azara with four objectives-1) To study the socio- economic status of the livestock farmers in the fringe areas of Deepor Beel. 2) To explore the implications of rural-urban linkages in the livelihood of livestock farmers in the study area. 3) To find out the factors that influences the intensity of market participation of the farmers in Deepor Beel. 4) To study the relationship of rural urban linkages and intensity of market participation on socio-economic status of the farmers. Livestock farmers having two or more species of animals including poultry birds in their backyard were taken into account as respondents in the study. 20 livestock farmers from 5 revenue villages were taken into account to make a total sample size of 100. The data was collected personally by visiting the selected respondents through the use of a pretested, reliable and valid interview schedule. Data so collected was compiled, analyzed, tabulated and interpreted using appropriate statistical methods and software. Majority of the respondents (68.00 per cent) belonged to middle age group and average age was found to be around 43.82 years. Again majority, i.e., 71.00 per cent of the respondents were male. Further, majority of the farmers (87.00 per cent) were married and again majority (78.00 per cent) resided as nuclear family. It was observed that 82.00 per cent of livestock farmers had medium sized family with 5-6 members and majority of them (39.00 per cent) belonged to Scheduled Tribe category. Moreover, 76.00 per cent of respondents had education up to high school level and it was found from the study that 73.00 per cent of

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the respondents had medium herd size ranging from 1.91 to 14.58 cattle equivalent units. Again, majority (67.00 per cent) of respondents had medium level of experience in livestock farming ranging from 13.26 years to 34.54 years. However, in case of land holdings, majority of them (68.00 per cent) had low land holding i.e., <0.76 acres. It was indicated that majority (59.00 per cent) of respondents revealed medium distance from home to market (2.62 kms to 6.61 kms) and 99.00 per cent of the respondents reported good transportation/access to market. Again, majority (64.00 per cent) of livestock farmers was found to have medium exposure to mass media and majority of them (48.00 per cent) had medium extension contact. Moreover, Majority (69.00 per cent) of livestock farmers had medium annual family income from livestock and poultry (Rs. 14339.84 to Rs. 33142.16). Majority (66.00 per cent) of the livestock farmers belonged to medium income category on including annual income from all sources (Rs. 17118.00 to Rs. 287942.00). On assessing four sub-areas of implications namely social implications, implications on asset-base, implications on information flow and implications of house hold economy it was indicated that implications on asset- based is highest followed by household economy on livelihood of livestock farmers. A sum of total implications on mean, S.D. and range was found to be 46.82, 4.57 and 32-54 respectively. On distribution of respondents on the basis of implications of rural-urban linkages in the livelihood of livestock farmers it was further observed that majority of respondents (71.00 per cent) were in medium category. Furthermore, on distribution of respondents on basis of Intensity of Market Participation of Livestock Farmers on basis of 13 indicator statements it was found that majority of livestock farmers (66.00 per cent) were in medium category. In co-relational analysis age with respect to implications had a positive and significant correlation ( $r= 0.223^*$ ) among the livelihood of livestock farmers in rural-urban linkage. However, years of experience on livestock farming of the livestock farmers to implications was negatively and significantly correlated ( $r= - 0.197^*$ ). Mass media exposure was found to be positively and significantly correlated in the statistical level of significance ( $r= 0.213^*$ ) with intensity of market participation. Last but not the least, income from all sources was found to be positively and significantly correlated in the statistical level of significance ( $r= 0.196^*$ ) with intensity of market participation.

# **Women Empowerment Through Self-Help Group With Special Reference To Animal Husbandry: ASRLM Perspective**

*Rahul Kanti Deka*

In recent years the group approach to poverty alleviation is getting recognition in Asian countries. Mostly, women are mobilized in to groups for undertaking mutually beneficial social and economic activities. The group provides the women a base for self-employment and empowerment through group dynamics. In India these mutual help based groups are known as Self Help Group (SHG). In 1999, GOI introduced Swarn Jayanti Gram Swarojgar Yojana, a programme aimed at bringing families above the poverty line by ensuring sustainable level of income over a period of time which later in 2011 renamed as NRLM and in 2016 again renamed as DAY-NRLM. NRLM is being implemented in Assam by Assam State Rural Livelihoods Mission Society (ASRLMS) with the objectives laid by NRLM for enhancing the social and economic empowerment of the rural poor of Assam

Although several researches have been conducted on SHGs in general, negligible research has carried out in Animal husbandry in particular. So, the present study entitled “Women empowerment through self - help group with Special Reference To Animal Husbandry is proposed with the objectives a) to study the socio-personnel and economic profile of women SHG members, b) to appraise the organizational dynamics and financial management of SHG, c) to study different dimensions of empowerment of women SHG members, and d) to delineate the constraints as perceived by the respondents in rearing and marketing of livestock and poultry. Four block namely Rangia and Kamalpur from Kamrup (R) and Pub Nalbari and Paschim Nalbari from Nalbari district have selected. As such, 25 respondents or women SHG members from each block were selected randomly making the total sample size 100. A pretested, reliable, and valid interview schedule was used for data collection. The data collected were analyzed using standard statistical methods. Majority of the respondents i.e. 64.00 per cent were in middle age category and the average age was found to be 47.00 years. 87 per cent of respondents were married while only 5.00 percent were widows and 8.00

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per cent were unmarried. It was observed that 75.00 per cent farm women resided as nuclear family while 25.00 per cent as a joint family. 81.00 per cent of the respondents having medium family size with average size of 6. It was found that most respondents i.e. 78.00 per cent had medium educational qualification. Majority of the respondents 53.00 per cent were doing agriculture and animal husbandry as the major occupation. Majority of the respondents having medium level of experience in animal husbandry. Majority of the respondents i.e. 55.00 per cent are doing goater, dairy and poultry as their livestock occupation. 100 per cent of the respondents took loan from bank, village organization and cluster level federation. 47.00 per cent of the respondent's medium level of social participation. 100 per cent of the respondents attended either formal or consultancy based training. 62.00 per cent of the respondents having medium level of mass media exposure. 67.00 per cent of the respondents having medium level of extension agency contact. Majority i.e. 89.00 per cent of the respondents adopted middle man as the marketing channel. It was observed majority of the respondents having medium level of land holding. It was reflected in the study that most respondents in all four blocks, respondents had medium level of income from livestock with an average of Rs. 118819/year. Total annual income of respondents in selected block was of medium level with an average of Rs. 226667. Among 9 variables age shown negative correlation with women empowerment where as other 8 variables have shown positive correlation. In case of correlation with constraints, among 9 variables, age shown positive correlation whereas other 8 variables shown negative correlation. Significant relation in regression analysis between independent variables and women empowerment is shown by age ( $p < 0.05$ ) and educational qualification ( $p < 0.05$ ). In constraints with independent variables experience in animal husbandry showed a negative and significant relation ( $p < 0.05$ ). The co-efficient of multiple determination ( $R^2$ ) value was found to be 0.426, and the F value for R was found to be non-significant.

# **Effect of Floor Types on the Milk Quality and Health Status of Crossbred Cows Under Field Condition**

*Arup Deka*

The present study was carried out to assess the effect of floor type on the milk quality and health status of crossbred cows under field conditions. A total of 15 dairy sheds, consisting of 5 concrete, 5 brick and 5 wooden floors were identified, where there were similarities in management and feeding practices. A total of 90 cows (six from each type of shed) were selected for studying the milk quality, milk yield and other milk performance traits. The cows were selected keeping uniformity of their parity and utilized for the trial after the colostrum period was over. In addition to the above, records of 120 numbers of crossbred cows reared under similar management practices were observed for foot & leg disorders, the occurrence of mastitis, skin lesions, respiratory and alimentary tract disorders.

The overall daily milk yield (DMY) in G1 (concrete floor), G2 (brick floor) and G3 (wooden floor) was found as  $10.40 \pm 0.08$ ,  $10.15 \pm 0.07$  and  $9.56 \pm 0.07$  kg, respectively. The significantly ( $p < 0.01$ ) highest daily milk yield was recorded on the concrete floor, while the wooden floor experienced comparatively lower production. The overall mean peak milk yield (PMY) was  $12.37 \pm 0.24$ ,  $11.87 \pm 0.23$  and  $11.40 \pm 0.16$  kg in G1 (concrete floor), G2 (brick floor) and G3 (wooden floor), respectively. Significantly ( $p < 0.01$ ) highest peak milk yield was found in G1 (concrete floor) and the lowest was found in G3 (wooden floor). The overall mean of DAPMY in G1, G2 and G3 was  $44.87 \pm 0.90$ ,  $46.17 \pm 0.89$  and  $47.10 \pm 0.93$  days, respectively. There was no significant difference among the groups, but the concrete floor had comparatively lower DAPMY than that of the other groups. The service periods recorded in the various groups were  $121.10 \pm 5.53$ ,  $126.07 \pm 5.45$  and  $135.20 \pm 5.79$  days in G1 (concrete floor), G2 (brick floor) and G3 (wooden floor), respectively. The service period (SP) had a non-significant difference amongst the groups. SP was found comparatively shorter in G1 *i.e.* concrete floor than that of the other two groups. The average fat content of crossbred cow milk was  $4.29 \pm 0.07$ ,  $4.38 \pm 0.07$  and  $4.26 \pm 0.08$  percent in G1 (concrete

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floor), G2 (brick-bedded floor) and G3 (wooden floor) groups, respectively. The average SNF content was found to be  $9.16 \pm 0.04$ ,  $9.11 \pm 0.03$  and  $9.13 \pm 0.04$  in G1 (concrete floor), G2 (brick floor) and G3 (wooden floor) groups, respectively. The average protein content in different groups was observed to be  $3.50 \pm 0.01$ ,  $3.47 \pm 0.01$  and  $3.49 \pm 0.01$  percent in G1 (concrete floor), G2 (brick-floor) and G3 (wooden floor) groups, respectively. The average lactose was found as  $5.21 \pm 0.03$ ,  $5.18 \pm 0.02$  and  $5.15 \pm 0.03$  percent in different groups viz. G1 (concrete floor), G2 (brick floor) and G3 (wooden floor) groups, respectively. The overall ash content in different groups was noted to be  $0.77 \pm 0.01$ ,  $0.76 \pm 0.01$  and  $0.76 \pm 0.01$  percent in G1, G2 and G3 groups, respectively. The milk composition did not differ significantly amongst the groups. The overall specific gravity for various groups was found as  $1.0336 \pm 0.0002$ ,  $1.0332 \pm 0.0001$  and  $1.0331 \pm 0.0002$  in G1, G2 and G3 groups, respectively. Specific gravity was also recorded as non-significant among the various groups. The total viable count (TVC) in milk for different groups was found to be  $3.99 \pm 0.04$ ,  $4.24 \pm 0.05$  and  $4.37 \pm 0.07$  log cfu/ml in G1 (concrete floor), G2 (brick floor) and G3 (wooden floor) groups, respectively. The overall mean TVC was significantly ( $p < 0.01$ ) highest in milk of cows reared on the wooden floor (G3) and lowest on the concrete floor (G1). The mean TVC was significantly ( $p < 0.01$ ) highest in the 10<sup>th</sup> fortnight in all the groups. The frequency of cows affected with leg and foot disorders was observed to be 57.33, 62.86 and 41.54 percent in G1 (concrete floor), G2 (brick floor) and G3 (wooden floor) groups, respectively. Significantly ( $p < 0.05$ ) highest incidence of leg and foot disorders was observed on brick floors, followed by concrete and the lowest incidence was seen on wooden floors. The incidence of carpal hygroma was witnessed to be 18.67, 21.43 and 12.31 percent in G1, G2 and G3 groups, respectively. No significant difference ( $p > 0.05$ ) was observed between the groups for carpal hygroma. The incidence of hock swelling was 21.33, 24.29 and 10.77 percent in G1, G2 and G3 groups, respectively. Hock swelling did not differ significantly ( $p > 0.05$ ) due to floor type. The incidence of hoof elongation was 9.33, 41.43 and 36.92 percent in G1, G2 and G3 groups, respectively. There was a highly significant ( $p < 0.01$ ) effect of the floor on the occurrence of hoof elongation. Incidence of sole ulcers and others was 9.33, 21.43 and 18.46 percent in G1, G2 and G3 groups, respectively. There was no significant difference ( $p > 0.05$ ) among the groups for sole ulcer and others. The overall incidence of skin lesions was observed to be 68.00, 74.29 and 30.77 percent in G1 (concrete floor), G2 (brick floor) and G3 (wooden floor) groups, respectively. Significantly ( $p < 0.01$ ) highest incidence was observed in the brick floor, followed by the concrete floor and the lowest was seen on the wooden floor. The incidence of clinical mastitis was found to be 6.67, 10.00 and 21.54 percent in G1 (concrete floor), in G2 (brick floor) and in G3 (wooden floor) group, respectively. Significantly highest ( $p < 0.05$ ) incidence of clinical mastitis was recorded on wooden floors, followed by brick floors and the lowest on concrete floors. The incidence of respiratory disorders in different groups was found to be 10.67, 15.71 and 21.54 percent in G1 (concrete floor), G2 (brick floor) and G3 (wooden floor) groups, respectively. There was no significant ( $p > 0.05$ ) difference amongst the groups for the incidence of

respiratory disorders. But the incidence was comparatively higher on the wooden floor. The overall alimentary tract disorders were observed to be 14.67, 18.57 and 26.15 percent in G1 (concrete floor), G2 (brick floor) and G3 (wooden floor) groups, respectively. No significant ( $p > 0.05$ ) difference was observed for alimentary tract disorders among the groups. But the brick and wooden floors had comparatively higher incidences than the concrete floor.

The present study witnessed that the concrete floor shed was better for improving milk quality and yield of crossbred cows, except for the few incidences of foot & leg disorders and skin lesions, which are to be prevented by appropriate management tools.

## **Effects of Split-Weaning on the Performance and Behavioural Traits of Hampshire Piglets**

*Arunima Kalita*

An investigation was carried out under the Department of Livestock Production and Management, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati-22 during the period from September 2018 to February 2019.

Forty eight piglets of Hampshire pig of three weaning age groups from six sows, considering an average litter size of 8 were selected for the experiment and each group consisted with sixteen numbers of piglets. Two groups (Group I and II) were split weaned at 28<sup>th</sup> and 35<sup>th</sup> days of age where 50 per cent of higher body weight piglets of the litter were separated and rest 50 per cent were kept with mother up to 56 days of conventional weaning. Another litter was weaned as conventional weaning age, 56 days (Group III). After weaning, the piglets were reared up to 75 days for studying of post weaning effect. Common conventional feed was provided to all the groups as per NRC (1998).

The average split weaning body weight gain and total body weight of piglets weaned at 35 days of age (Group II) was found significantly higher followed by the piglets weaned at 56 days of age (Group III) and lower in piglets weaned at 28 days of age (Group I) while, the corresponding results also observed in the three experimental groups of piglets from birth to post weaning period till 75 days in respect to the average daily, total and final body weight gain. In regards to the average total feed consumption, feed consumption by per piglet, feed consumption by per piglet per day and total feed consumed till end of the experiment period was more or less equal; however the feed conversion efficiency was found to be comparatively higher in Group II than Group I and III.

From the study, the effect of behavioural traits *i.e.* playing, feeding, water intake, sleeping, huddling and suckling in the three split weaning groups found to be Group II was performed well in time spending on playing, water intake, sleeping and suckling except feeding and huddling, whereas Group I was showed maximum time spent for feeding and huddling and Group II showed in between the two groups.

Overall, it might be opined from the present investigation that split weaning could be carried out at 35 days old pigs for better performances and better behaviour after weaning.

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## Effect of Feeding Practices on the Performance of Crossbred Kids

*Biswajyoti Das*

Sixteen weaned crossbred kids of 4 months old were randomly assigned to two groups of eight kids each *viz.* Control (C) and Treatment (T) keeping equal number sexes. The C group received 1/3<sup>rd</sup> concentrate on DM basis with *ad-libitum* chopped roughages *i.e.* Para (*Brachiaria mutica*) and Napier (*Pennisetum purpureum*) grasses separately. The kids in T group received total mixed ration (TMR) prepared by thoroughly mixing the same concentrate and chopped roughages in the ratio of 1:3 on DM basis and fed *ad libitum* twice daily. The average initial body weight was 7.09±0.67 and 7.29±0.30 kg, in C and T groups, respectively.

The average body weight at 5<sup>th</sup> fortnight was 10.95±0.47 and 12.14±0.20 kg and at 6<sup>th</sup> fortnight was 12.15±0.46 and 13.79±0.18 kg, in C and T groups, respectively. There was highly significant (P<0.01) difference between the two groups in respect of average body weight of kids. The average total body weight gain during 6<sup>th</sup> fortnight was 1.20±0.12 and 1.65±0.10 kg and average daily body weight gain was 0.086±0.01 and 0.118±0.01 kg, in C and T groups, respectively. There was highly significant effect of treatment (P<0.01) on the body weight gain of crossbred kids.

The average height at withers at 5<sup>th</sup> fortnight was 43.85±2.36 and 48.50±0.50 cm and at 6<sup>th</sup> fortnight was 45.10±2.53 and 50.10±0.64 cm in C and T groups, respectively. The average body length at 5<sup>th</sup> fortnight was 42.63±2.19 and 46.11±0.41 cm and at 6<sup>th</sup> fortnight 44.48±2.07 and 48.69±0.66 cm, in C and T groups, respectively. The average chest girth at 5<sup>th</sup> fortnight was 44.34±2.02 and 49.01±0.63 cm and at 6<sup>th</sup> fortnight 46.40±2.11 and 50.54±0.39 cm, in C and T groups, respectively. There was significant (P<0.05) effect of treatment on height at wither and body length and the highly significant (P<0.01) effect of treatment on chest girth of crossbred kids. The correlation of body weight with height at wither, body length and chest girth was highly significant. The highest correlation was observed between body weight and chest girth *i.e.* 0.86 and 0.90 in C and T groups, respectively.

The average DM intake during 5<sup>th</sup> fortnight was 6.16 ± 0.68 and 6.58 ± 0.17 kg and during 6<sup>th</sup> fortnight were 6.58 ± 0.69 and 6.86 ± 0.19 kg in C and T groups,

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respectively. The average daily DM intake at 5<sup>th</sup> fortnight was  $0.44 \pm 0.05$  and  $0.47 \pm 0.01$  kg and 6<sup>th</sup> fortnight  $0.47 \pm 0.05$  and  $0.49 \pm 0.03$  kg in C and T groups, respectively. The overall daily DM intake during entire period of experiment was  $0.40 \pm 0.02$  and  $0.44 \pm 0.05$  kg in C and T groups, respectively. There was highly significant ( $P < 0.01$ ) difference of DM intake between C and T groups. The significant difference in DM intake was found from 1<sup>st</sup> to 6<sup>th</sup> fortnight. The overall feed conversion ratio (FCR) was  $6.93 \pm 1.42$  and  $5.95 \pm 0.96$  in C and T groups, respectively. There was significant effect of treatment on FCR of crossbred kids.

The average value of digestibility coefficient of dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF), nitrogen free extracts (NFE) and organic matter (OM) in crossbred kids was  $60.32 \pm 0.48$  and  $62.16 \pm 0.15$ ,  $72.28 \pm 0.48$  and  $75.81 \pm 0.54$ ,  $68.54 \pm 0.62$  and  $69.08 \pm 0.78$ ,  $55.24 \pm 0.54$  and  $59.73 \pm 0.36$ ,  $59.98 \pm 0.58$  and  $62.38 \pm 0.35$ ,  $60.57 \pm 0.85$  and  $67.02 \pm 1.14$  for control and treatment groups, respectively. The t-test showed highly significant difference ( $P < 0.01$ ) between the two groups for DM, CP, CF, NFE and OM but in case of EE, it was non-significant difference ( $P > 0.05$ ) between the two groups.

The cost of feeding per kids per day was higher in T (Rs. 6.23) group than the C group (Rs. 5.59). But the cost per kg body weight was lower in T group (Rs. 77.96) than the C (Rs. 92.79) group.

The crossbred kids on TMR feeding led to significant increased in the body weight and body weight gain along with improvement in skeletal growth. Moreover feed cost per kg body weight gain was also less on TMR feeding. Therefore, goat keepers may practice TMR feeding instead of conventional separate feeding for obtaining more profit.

## **Performance of Hampshire Piglets Fed on Indigenously Fermented Feed**

*Biswa Shankar Dutta*

An investigation was conducted to see the performance of Hampshire piglets fed on indigenously fermented feed. Twenty-eight Hampshire piglets of 2 weeks old were selected and were randomly assigned to two experimental groups viz. Group I (reared on conventional feed), and Group II (reared on indigenously fermented feed). The final body weight at 11th week for the piglets of Group I and II was  $12.77 \pm 0.23$  and  $13.04 \pm 0.18$  respectively. The total body weight gains recorded for Group I and Group II piglets were  $9.41 \pm 0.06$  and  $9.65 \pm 0.05$  kg respectively. The average daily gain was recorded as  $0.149 \pm 0.001$  and  $0.153 \pm 0.001$  kg in piglets of Group I and Group II respectively. The body weights and body weight gains of the piglets in the control and experimental group did not differ significantly. The average feed intake per piglet was recorded as 22.56 and 22.72 kg for Group I and II respectively with Group II piglets consuming more feed than Group I piglets. The overall feed conversion efficiency of the piglets of Group I and Group II was calculated as  $2.27 \pm 0.37$  and  $2.21 \pm 0.36$  respectively and there was no significant difference in the feed conversion efficiency between the groups. The mean lactobacilli count of feed samples of Group I and Group II in MRS (Man, Rogosa, and Sharpe) agar was  $2.32 \pm 0.01$  and  $6.59 \pm 0.01$  log<sub>10</sub>cfu/g respectively. The mean E. coli count of faecal samples of Group I and Group II at the beginning of the experiment (2nd week) was  $6.12 \pm 0.01$  and  $6.10 \pm 0.01$  log<sub>10</sub>cfu/g respectively and with the advancement of age the E. coli counts decreased in both Group I and Group II. At the mid of the experiment the E. coli count of Group I and Group II was  $6.01 \pm 0.01$  and  $5.91 \pm 0.04$  log<sub>10</sub>cfu/g respectively. The E. coli count of faecal samples of Group I and Group II at the end of the experiment (11th week) was  $5.94 \pm 0.01$  and  $5.76 \pm 0.02$  log<sub>10</sub>cfu/g respectively. The E. coli count was apparently lower in Group II than Group I and with the progress of time the count became further lower in the faecal samples of piglets fed with indigenously fermented feed. The cost of feeding per kg live weight gain for Group I piglets was Rs. 77.56 per piglet, while in Group II piglets it was Rs. 80.31 per piglet. Because all of the elements aren't taken into account when calculating the cost of feeding, these figures are simply estimating; in

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reality, they may be many times greater. Even though the study indicated that piglets fed with indigenously fermented feed can be fed in Hampshire pigs for better performance and without any adverse effect, yet considering the fact that only a small number of pigs were involved in the study, there is scope for conducting such studies with larger number of pigs as well as duration of study up to slaughter age so as to confirm the results of the present study.

## **Effect of Dietary Supplementation of Yeast (*Saccharomyces cerevisiae*) on Growth Performance of Crossbred Heifers**

*Chandrika Hazarika*

The aim of the experiment was to investigate the effect of dietary supplementation of yeast (*Saccharomyces cerevisiae*) on growth performance of crossbred heifers. Eighteen crossbred heifers of above 1 year of age (16-18 months) of similar body weight were selected and were divided equally into three groups namely Control (T0) , Treatment 1 (T1) and Treatment 2 (T2), each group consisting of six animals . All the heifers in the experimental group were fed with a basal diet of concentrate, para grass and paddy straw, along with a supplementation of 1.5gm/animal/day of dry yeast powder in T1 and 3gm/animal/day of dry yeast powder in T2 group respectively. The experiment was conducted for a period of 3 months (90 days) from 1st January to 31st March,2022.

The average initial and final body weight at the 6th fortnight of the heifers were 188.18  $\pm$ 1.07, 188.32  $\pm$ 0.89 and 188.61  $\pm$ 0.79 and 216.41  $\pm$ 1.18 , 218.55  $\pm$ 1.19 and 220.65  $\pm$ 1.33 kg in T0, T1 and T2 groups respectively. The results of the analysis of variance of data did not reveal any significant difference ( $P>0.05$ ) of average body weight in control and different treatment groups.

The overall mean daily gain of body weight found in T0, T1 and T2 groups were 0.31  $\pm$ 0.03 , 0.35  $\pm$ 0.06 and 0.36  $\pm$ 0.07 kg respectively. A significant difference ( $P<0.05$ ) of overall ADG was observed in T1 and T2 compared to T0 . The one way ANOVA revealed that the body weight in heifers increased significantly from 4th to 6th fortnight . Similarly, a significant increase ( $P<0.05$ ) in overall fortnightly gain in body weight was observed in T2 (5.31  $\pm$ 0.10)and T1 (4.94  $\pm$ 0.12)kg on comparison to T0 (4.56  $\pm$ 0.04)kg .

The overall mean values of the body conformation traits (cm) in T0, T1 and T2 groups, respectively were found to be as : 116.60  $\pm$ 0.27 , 116.76  $\pm$ 0.29 and 117.66  $\pm$ 0.24 cm in. body length, 136.96  $\pm$ 0.12 , 137.29  $\pm$ 0.99 and 137.69  $\pm$ 0.13 cm for heart girth, and 112.04  $\pm$ 0.22, 112.51  $\pm$ 0.20 and 113.17  $\pm$ 0.21 cm for height at wither. The

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conformation traits revealed a highly positive correlation with body weight. A linear increase in body measurements were observed in all the three experimental groups from 1st to 6th fortnight, along with the body weight. Analysis of data showed no significant ( $P>0.05$ ) difference in the three traits between T0, T1 and T2 groups, respectively.

The overall mean daily feed intake was found to be  $4.66 \pm 0.03$ ,  $4.68 \pm 0.03$  and  $4.72 \pm 0.02$  kg/day in T0, T1 and T2 groups, respectively. Supplementing the diets of the treatment groups with *S. cerevisiae* (1.5gm/head/day and 3gm/head/day in T1 and T2 respectively) showed a higher increase in feed intake compared to T0. However, no significant ( $P>0.05$ ) difference was observed in the average values of daily feed intake amongst T0, T1 and T2 groups.

The average FCE values were  $12.04 \pm 0.21$ ,  $12.22 \pm 0.30$  and  $11.58 \pm 0.35$  in the 1st fortnight and  $12.03 \pm 0.32$ ,  $10.93 \pm 0.25$  and  $10.28 \pm 0.23$  in the 6th fortnight. Overall mean FCE values in were  $12.18 \pm 0.08$ ,  $11.45 \pm 0.22$  and  $10.93 \pm 0.19$  in T0, T1 and T2 respectively. Results of analysis of variance revealed highly significant ( $P<0.01$ ) effect of supplementation of *S.cerevisiae* on feed conversion efficiency of the experimental animals. A post hoc test revealed that the FCE in T2 and T1 group was significantly higher from 3rd to 4th fortnight compared to T0 group.

All the blood parameters estimated under the haemato-biochemical parameters were found within the normal physiological range in the experimental heifers. The overall mean of RBC of heifers were calculated as  $6.44 \pm 0.11$ ,  $6.48 \pm 0.05$  and  $6.51 \pm 0.07$  m/mm<sup>3</sup> in T0, T1 and T2 groups respectively. The overall mean of TLC count in different groups during the entire experiment were  $7.26 \pm 0.09$ ,  $7.28 \pm 0.09$  and  $7.29 \pm 0.09$  m/mm<sup>3</sup> in T0, T1 and T2 groups respectively. The overall mean of PCV% in different groups during the entire experiment were  $26.74 \pm 0.15$ ,  $26.75 \pm 0.16$  and  $26.79 \pm 0.17$  in T0, T1 and T2 groups respectively. The overall mean of glucose (mg/dl) in different groups during the entire experiment were  $54.76 \pm 0.53$ ,  $54.92 \pm 0.65$  and  $55.31 \pm 0.63$  mg/dl in T0, T1 and T2 groups respectively. The overall mean of total protein were  $6.74 \pm 0.07$ ,  $6.75 \pm 0.40$  and  $6.78 \pm 0.07$  (g/dl) in the entire experiment in T0, T1 and T2 groups respectively. Results of the analysis showed no significant ( $P>0.05$ ) difference in the initial and final estimates of blood parameters in T0, T1 and T2 groups respectively.

The analysis of economics of feeding the experimental heifers revealed that the average daily cost of feed consumption per heifer were Rs.71.11, Rs. 72.38 and Rs. 74.27, average net cost of feed consumption per heifer were Rs. 6400.04, Rs. 6514.81 and Rs.6684.87, and the cost of feeding per kg body weight gain were Rs. 226.71, Rs.215.50 and Rs.208.64 in T0, T1 and T2 groups respectively. The higher total body weight gain in T1 and T2 than T0 resulted in lower cost of feeding per kg weight gain in the treatment groups than in the control group. On further calculation, a benefit over control (T0) of Rs.11.21 and Rs.17.82 in T1 and T2 were found.

## **Performance of Pre-Weaning Hampshire Piglets Reared on Rubber Mat Floor**

*Ibasani Sawian*

An investigation was conducted to see the performance of pre-weaning Hampshire piglets reared on rubber mat floor. Thirty six newborn piglets were divided into two groups of eighteen each and were randomly assigned to two floor treatments viz. concrete (Group I) and rubber mat (Group II). The final body weight at 8<sup>th</sup> week for the piglets on rubber mat and concrete floor was 9.97±0.06 kg and 9.53±0.20 kg respectively and the value being significantly ( $P<0.05$ ) higher in Group II.

The average weekly gain at 8<sup>th</sup> week in Group II was 1.56±0.01 kg which was significantly ( $P<0.01$ ) higher than Group I piglets which showed an average weekly gain value of 1.40±0.01 kg. The total body weight gains recorded for Group I and Group II piglets were 8.36±0.16 kg and 8.78±0.06 kg respectively. Average daily gains (ADG) were recorded as 0.149±0.003 kg and 0.157±0.001 kg for Group I and Group II respectively. The total and daily body weight gains appeared to be significantly ( $P<0.05$ ) higher in piglets housed on rubber mat floor. This puts forward that rubber mat floors had a positive influence on the body weight gains of the piglets.

The total feed intake by the piglets of Group I and Group II were recorded as 87.43 kg and 87.95 kg respectively, the weekly average feed intake for Group I and Group II was 14.57 kg and 14.66 kg respectively whereas the daily average intake was 2.08 kg and 2.09 kg respectively. Feed intake of the piglets did not exhibit any variation in respect to the floor type. The diarrhoea incidence rate was recorded as 9.79% in Group I which was higher than that of Group II piglets with a value of 5.88%.

The overall prevalence of sole bruising, sole erosion, limb abrasion, foot and limb swelling in Group I piglets was 23.61%, 28.47%, 29.17%, and 5.56% respectively. The corresponding values for Group II piglets were 21.53%, 11.81%, 8.33%, and 0.69% respectively. The piglets of Group II had lower severity and prevalence of foot and limb injuries that those of Group I piglets. The prevalence of alopecia was 67.37% and 80.55% in Group I and Group II respectively. Piglets exhibiting limb abrasion will not show alopecia in the same location and the abrasive nature of the concrete floor will rapidly replace alopecia into abrasion. Hence alopecia was observed more in piglets kept on rubber mat than those on concrete floor. No coronary band injuries and piglet mortality could be observed during the experimental period in both the groups.

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# **Physicochemical and Microbiological Quality of Drinking Water for Livestock Under Organized and Unorganized Sectors in the Brahmaputra Valley of Assam**

*Jiaur Rahman*

A study was conducted to identify the sources, assess the physicochemical and microbiological quality of drinking water for livestock under organized and unorganized sectors in the Brahmaputra valley of Assam. Five different agro-climatic zones of the valley were selected and one district was selected from each zone on the basis of livestock population. The study was carried out during the period of November 2018 and February 2019. A total of 60 samples were collected both from organized and unorganized sectors (farms). The sources were identified as well, tube well, bore well, pond and river in both the sectors. The physical as well as chemical parameters were studied using JalTara water testing kits and pH and turbidity were measured with the help of digital pH meter and digital turbidity meter respectively. The most widely used drinking water source in the study area was bore well. The physical parameters viz., colour, temperature and turbidity were within the IS 10500: 2004 and WHO (2011) permissible limit. The temperature of the water samples ranged from 16.15 to 18.88 °C. The chemical parameters viz., pH, TDS, total hardness, sulfate, arsenic, fluoride, chloride and nitrate were below the permissible limit except iron which was above the permissible limit (0.3mg/l). The iron content in Kamrup (R) and Nagaon ranged from 0.85 to 0.90 mg/l and 0.95 to 0.90 mg/l respectively and were highest among all the selected districts. The lowest iron content was found in Karbi Anglong district with a value of 0.33-0.41 mg/l. Out of sixty samples, seven samples from pond, river and bore well sources were found positive for coliform organism both in organized and unorganized farms.

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**Major Advisor : Dr. Naba Kr. Sarma**



## **Effect of Feeding Liver Tonic on Growth Performance of Crossbred Dairy Calves**

*Kayitha Madhukar*

The experiment was conducted to investigate the effect of feeding liver tonic on growth performance of crossbred dairy calves. Twelve healthy Jersey crossbred calves irrespective of sex of similar age and bodyweight were allocated to two experimental groups, control ( $T_0$ ) and treatment ( $T_1$ ) with six animals in each group. Calves of both groups were fed with a standard basal diet consisted of concentrate, green fodder and paddy straw along with feeding of liver tonic *Rivliv* orally @15 ml daily in the treatment group. The experiment was conducted as a feeding trial for six fortnights and a digestibility trial thereafter for five days in the two experimental groups.

The average initial and final body weight at 6<sup>th</sup> fortnight of the calves were  $88.86 \pm 3.15$  and  $88.86 \pm 2.91$  kg and  $106.67 \pm 3.40$  and  $109.98 \pm 3.24$  kg respectively in  $T_0$  and  $T_1$  groups. Analysis of variance of the data did not reveal any significant difference ( $P > 0.05$ ) of average body weight in control ( $T_0$ ) and treatment ( $T_1$ ) groups.

The overall mean daily body weight gain of  $0.25 \pm 0.01$  kg in  $T_1$  was significantly ( $P < 0.01$ ) higher than the weight gain of  $0.19 \pm 0.00$  kg in  $T_0$  group of calves. In respect of different fortnights, ADG was significantly ( $P < 0.01$ ) higher from 2<sup>nd</sup> to 6<sup>th</sup> fortnight. Similarly, the overall fortnightly body weight gain was significantly higher ( $P < 0.01$ ) in  $T_1$  ( $3.55 \pm 0.09$  kg) than the  $T_0$  ( $2.64 \pm 0.05$  kg) group of calves. The mean body weight gain was higher ( $P < 0.01$ ) in  $T_1$  group than the  $T_0$  group from 2<sup>nd</sup> to 6<sup>th</sup> fortnight.

The overall mean values of the conformation traits (cm) in  $T_0$  and  $T_1$  groups respectively were:  $93.62 \pm 0.56$  and  $94.22 \pm 0.56$  cm for body length;  $104.12 \pm 0.65$  and  $104.52 \pm 0.51$  cm for chest girth as well as  $90.08 \pm 0.77$  and  $90.70 \pm 0.72$  cm for height at wither. All the conformation traits revealed a highly positive correlation with body weight and increased with increase in body weight in both the groups from 1<sup>st</sup> to 6<sup>th</sup> fortnight with advancement of age. Analysis of data on conformation traits showed no significant ( $P > 0.05$ ) difference in all the 3 traits between control ( $T_0$ ) and treatment ( $T_1$ ) groups respectively.

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The overall average daily DM intake was  $2.62 \pm 0.04$  kg in control ( $T_0$ ) and  $2.69 \pm 0.04$  kg in treatment ( $T_1$ ) group. Feeding of the liver tonic *Rivliv* had positive effect on DM intake in the treatment group and it was higher than the control group in all fortnights. However, analysis of variance results revealed no significant ( $P > 0.05$ ) difference between the average values of DM intake between control ( $T_0$ ) and treatment ( $T_1$ ) groups.

The overall mean values of the feed eating time were  $245.71 \pm 2.13$  min. in control ( $T_0$ ) and  $243.01 \pm 1.93$  min. in treatment ( $T_1$ ) group. Analysis of variance revealed that there was no significant ( $P > 0.05$ ) difference between overall average feed eating time in the control ( $T_0$ ) and treatment ( $T_1$ ) groups. However, the feed eating time was less in  $T_1$  group due to feeding of the liver tonic.

The average FCR values were  $14.58 \pm 1.10$  and  $12.80 \pm 0.41$  at 1<sup>st</sup> fortnight and  $13.84 \pm 1.13$  and  $9.64 \pm 0.25$  at 6<sup>th</sup> fortnight in control ( $T_0$ ) and treatment ( $T_1$ ) groups respectively. On overall basis, FCR values were  $14.10 \pm 0.40$  and  $10.78 \pm 0.21$  in control ( $T_0$ ) and treatment ( $T_1$ ) groups. Analysis of variance results revealed that there was highly significant ( $P < 0.01$ ) effect of supplementation of liver tonic on feed conversion ratio of the experimental animals. Further, the C.D. test revealed that FCR in treatment ( $T_1$ ) group was significantly higher from 2<sup>nd</sup> fortnight to 6<sup>th</sup> fortnight compared to control ( $T_0$ ) group.

The overall mean values of the physiological parameters in  $T_0$  and  $T_1$  groups respectively were as: respiration rate,  $26.74 \pm 0.28$  and  $26.53 \pm 0.17$  breath per minute; pulse rate,  $72.94 \pm 0.20$  and  $72.79 \pm 0.27$  beats per minute and rectal temperature,  $101.43 \pm 0.06$  and  $101.40 \pm 0.06$  ( $^{\circ}\text{F}$ ). Analysis of variance of the data revealed no significant ( $P > 0.05$ ) difference in respect of the three parameters between control ( $T_0$ ) and treatment ( $T_1$ ) groups.

The mean SGOT (IU/L) estimates in the  $T_0$  and  $T_1$  groups were  $77.23 \pm 2.87$  (IU/L) and  $77.45 \pm 2.94$  (IU/L) at initial and  $77.17 \pm 2.70$  (IU/L) and  $76.03 \pm 1.40$  (IU/L) at 6<sup>th</sup> fortnight respectively. The mean SGPT (IU/L) estimates in the groups  $T_0$  and  $T_1$  were  $18.30 \pm 0.75$  (IU/L) and  $18.15 \pm 0.72$  (IU/L) at initial and  $18.70 \pm 0.56$  (IU/L) and  $18.00 \pm 0.43$  (IU/L) at 6<sup>th</sup> fortnight respectively. Statistical analysis revealed that there was no significant ( $P > 0.05$ ) difference between control ( $T_0$ ) and treatment ( $T_1$ ) in respect of both initial and final estimates of SGOT (IU/L) and SGPT (IU/L) levels. However, liver tonic had a corrective effect on liver cells as revealed by lower final SGOT and SGPT levels in the treatment group.

The average digestibility coefficient (%) in  $T_0$  and  $T_1$  groups respectively were:  $67.17 \pm 1.03$  and  $72.17 \pm 0.75$  for dry matter (DM);  $70.19 \pm 1.55$  and  $75.16 \pm 0.55$  for organic matter (OM);  $64.48 \pm 0.83$  and  $70.55 \pm 0.87$  for crude protein (CP);  $66.13 \pm 1.04$  and  $72.14 \pm 0.67$  for ether extract (EE);  $63.43 \pm 1.227$  and  $71.39 \pm 1$  for crude fibre (CF) and  $76.58 \pm 1.52$  and  $82.07 \pm 0.85$  for nitrogen free extract (NFE). Analysis of the data revealed significantly ( $P < 0.05$ ) higher digestibility of the organic nutrients in herbal liver tonic fed treatment ( $T_1$ ) group than control ( $T_0$ ) group.

The economic analysis of cost of feeding the experimental calves revealed the following: (i) average daily cost of feed consumption (on DM basis) per calf were Rs. 37.02 and Rs. 40.30, (ii) average net cost of feed consumption (on DM basis) per calf were Rs. 3109.28 and Rs. 3385.6, (iii) cost of feeding per kg body weight gain was Rs. 196.54 and Rs. 159.02 in control ( $T_0$ ) and treatment ( $T_1$ ) respectively. From the results, it was observed that the total cost of feeding was little higher in  $T_1$  than the  $T_0$  group. However, the total body weight gain was higher in the  $T_1$  than the  $T_0$  group which resulted in lower cost of feeding per kg weight gain in the treatment than the control group.

## **Productive Performance of Sahiwal Cows Subjected to Different Levels of Herbal Supplements**

*Manmi Kalita*

A study was conducted to investigate the effect of different levels of herbal supplements on productive performance of Sahiwal cows. Fifteen healthy Sahiwal cows of similar age and body weight were allocated to three experimental groups namely T0, T1 and T2 with five animals in each group. T0 was fed with balance ration (concentrate mixture, para grass and paddy straw) as per requirement, T1 group was supplemented with 25 gms of fenugreek seed (*Trigonella foenum graecum*) along with balance ration and T2 was fed with 50gms of fenugreek seeds along with balance ration. It was observed that overall mean daily dry matter intake (kg/day) in T0, T1 and T2 were  $10.01 \pm 0.02$ ,  $10.24 \pm 0.03$  and  $10.22 \pm 0.08$  respectively. Analysis of data on dry matter intake showed no significant difference ( $p > 0.05$ ) between control and treatment groups respectively. Furthermore, non-significant differences was found in DMI/100kg body weight between the control and treatment groups. The average digestibility coefficient (%) of DM in T0, T1 and T2 groups was:  $71.12 \pm 0.27$ ,  $73.58 \pm 0.26$  and  $74.72 \pm 0.22$ ;  $72.97 \pm 0.08$ ,  $73.78 \pm 0.06$  and  $75.34 \pm 0.09$  for organic matter (OM);  $67.89 \pm 0.11$ ,  $65.54 \pm 0.05$  and  $68.48 \pm 0.07$  for crude protein (CP);  $70.70 \pm 0.05$ ,  $70.98 \pm 0.09$  and  $72.06 \pm 0.08$  for ether extract (EE);  $48.80 \pm 0.37$ ,  $50.04 \pm 0.29$  and  $56.24 \pm 0.28$  for crude fibre (CF) and  $77.14 \pm 0.15$ ,  $77.35 \pm 0.04$  and  $78.13 \pm 0.09$  for nitrogen free extract (NFE) respectively. Analysis of the data revealed significantly ( $P < 0.01$ ) higher digestibility of the nutrients in herbal supplement (fenugreek seeds) fed treatment groups than control group. The overall mean for milk yield (kg) in the experimental cows were  $7.00 \pm 0.05$ ,  $7.56 \pm 0.08$  and  $7.99 \pm 0.10$  respectively in T0(control), T1 and T2 groups. Feeding of fenugreek found to have positive effect in the treatment groups. Highly significant differences in milk yield was found ( $p < 0.01$ ) between treatment groups. Also, Milk efficiency was significantly higher ( $p < 0.01$ ) in treatment groups compared to control. However, there was no significant effect of fenugreek seeds in the duration of peak milk and lactational milk yield of the experimental cows. Milk composition like total fat(%), solid-not-fat(%), lactose(%), protein(%), ash(%), specific gravity was within the normal

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range. However highly significant difference ( $p < 0.01$ ) was observed in fat, SNF, lactose, protein and ash content. The blood constituents like blood glucose and total serum protein were within the normal value among the treatment groups and showed no significant differences ( $p > 0.05$ ) between the treatment groups.

Daily cost of feeding per cow per day were Rs. 182.20, Rs. 192.20 and Rs. 195 in T0(control), T1 and T2 respectively. Cost of feeding per kg milk yield was Rs. 26.02, Rs. 25.15 and Rs. 24.40 in T0, T1 and T2 respectively. The benefit cost ratio was found to be higher in treatment groups than in control group. Based on the results of the present study it could be concluded that feeding of fenugreek seed at the level of 50gms daily along with the normal diet increased performance in terms of milk yield, milk composition and digestibility of nutrients. However, there was no significant effect in duration of peak milk yield, lactational milk yield and blood constituents.

## **Effect of Weaning Age on the Growth Performance of Crossbred Calves**

*Minder Teron*

An investigation was carried out to study the effect of weaning age on growth performance, feed intake and feed conversion ratio (FCR), cost of feeding and certain blood biochemical parameters of crossbred calves. For the study, total 18 numbers of crossbred calves were selected from the private dairy farm and were randomly divided into 3 groups keeping similar sex ratio (50:50) and same parity of their dam. The three groups were weaned at different age *viz.* weaning on 30<sup>th</sup> (G1), 60<sup>th</sup> (G2) and 90<sup>th</sup> (G3). The experimental calves in all the groups were reared under standard housing and management conditions. All the calves were manually fed milk from a nipple bottle @ 1/10<sup>th</sup> of body weight twice daily after colostrum feeding till the weaning age. The calf starter ration (CP-25% & TDN-82.2%) were provided *ad libitum* from 15 days of age along with the mixer of green and dry fodder (Oats, Para and Napier) as basal diet up to 90 days. Thereafter, standard concentrate feed (CP-21% & TDN-80.30%) was provided instead of the starter ration. Deworming and vaccination against most prevalent diseases (HS, BQ and FMD) were done at par the recommended schedule. Clean wholesome drinking water was provided free of choice. The calves were reared up to 12<sup>th</sup> fortnight to study the growth performance, DM intake, FCR and cost of feeding.

There was non-significant effect of age at weaning and highly significant ( $p < 0.01$ ) effect of fortnight on the body weight and body weight gain of crossbred calves at different fortnight. The average body weight of crossbred calves in G1, G2 and G3 groups at 0<sup>th</sup> fortnight (birth) was 30.83±1.41, 30.67±1.62 and 30.50±1.83 kg, respectively. The corresponding value at 2<sup>nd</sup>, 6<sup>th</sup> and 12<sup>th</sup> fortnight was 37.50±1.15, 37.67±1.17 & 37.37±1.85 kg; 59.00±0.68, 58.67±2.26 & 62.83±0.40 kg and 98.67±1.52, 98.33±0.76 & 95.56±0.80 kg in G1, G2 and G3 groups, respectively. The average daily body weight gain at 12<sup>th</sup> fortnight was 0.422±0.044, 0.411±0.077 and 0.411±0.075 kg in G1, G2 and G3 groups, respectively and the average total body weight gain at 12<sup>th</sup> fortnight was 6.33±0.66, 6.16±1.16 and 6.17±1.13 kg in G1, G2 and G3 groups, respectively. The total body weight gain during the entire period (0<sup>th</sup> to 12<sup>th</sup>

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fortnight) was 67.84, 67.66 & 65.06 kg and daily body weight gain was 0.377, 0.376 and 0.361 kg, respectively.

There was non-significant effect of weaning age and highly significant effect of fortnight on the body measurements such as height at withers, body length and heart girth at different fortnight. The average height at withers, body length and heart girth at 12<sup>th</sup> fortnight was 89.75±1.81, 89.41±0.61 & 86.00±2.14 cm; 83.66±2.02, 83.83±2.37 & 83.33±0.84 cm and 95.33±2.91, 95.16±1.35 & 94.83±2.32 cm in G1, G2 and G3 groups, respectively.

There was highly significant ( $p<0.01$ ) effect of fortnight and weaning age on the DM intake and FCR of crossbred calves. The average daily DM intake at 12<sup>th</sup> fortnight was 5.25±0.36, 5.40±0.21 and 5.45±0.18 kg in G1, G2 and G3 groups, respectively. The FCR of G3 group was significantly higher than G1 and G2 groups during 7<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> fortnight

There was highly significant ( $p<0.01$ ) effect of weaning and fortnight on TP, globulin and SOD, where as the effect of weaning age was significant ( $p<0.05$ ) and fortnight was highly significant ( $p<0.01$ ) on albumin. The average TP in G3 was significantly higher than the G1 group, but did not differ from G2 at 6<sup>th</sup> fortnight. The average albumin was significantly lowest in G1, G2 and G3 groups at 2<sup>nd</sup>, 4<sup>th</sup> and 6<sup>th</sup> fortnight, respectively.

There was highly significant ( $p<0.01$ ) effect of weaning age on cost of feeding (total, daily & per kg gain) during 0<sup>th</sup> -6<sup>th</sup> fortnight and 0<sup>th</sup> -12<sup>th</sup> fortnight period; but the effect of weaning age on this parameter was non-significant ( $p>0.05$ ) during 6<sup>th</sup> -12<sup>th</sup> fortnight.

Early weaning of the calves of G1 and G2 groups did not affect their body weight, but rather improved their DM intake and FCR. The cost of feeding also significantly decreased due to early weaning and 30-60 days milk was also saved for sale. Therefore, dairy farmers may follow early weaning on 30<sup>th</sup> to 60<sup>th</sup> day of age instead of 90<sup>th</sup> day for maximising the profit margin of dairy farm business.

## **Effect of Dietary Supplementation of Satomul (*Asparagus racemosus*) on Certain Production Performances of Crossbred Dairy Cows**

*Parteek Kumar Khera*

An experiment of dietary supplementation of Satomul (*Asparagus racemosus*) powder in crossbred dairy cows was carried out to study its effect on their DM intake, feed eating time, milk yield and its composition, sensory evaluation of curd (dahi) and paneer, cost and return of milk production, body weight and body condition. There were two groups, Control (T0) and Treatment (T1) with 6 cows in each group. Cows of both the groups were fed standard diet consisted of concentrate, green fodder and paddy straw with supplementation of satomul @ 100 gm daily in the treatment group. The feeding trial was conducted for 6 weeks time. The overall daily DM intake were  $9.11 \pm 0.12$  kg in control and  $9.68 \pm 0.17$  kg in treatment group (Table 4.1). The result revealed that the Satomul fed treatment group, on average, consumed significantly higher ( $p < 0.01$ ) dry matter than the non-supplemented control group. The DM intake of the cows of the Satomul supplemented increased gradually from Day-1 onward and were higher than the corresponding DM intake value in each week with significant difference ( $p < 0.01$ ) from Day-14 to Day-42 (Table 4.2). The overall values of feed eating time (Table 4.3) were  $260.26 \pm 0.79$  minutes in control and  $257.64 \pm 0.89$  minutes in the treatment group daily. Analysis of variance (Table 4.4) revealed that cows of the Satomul fed treatment group consumed the feeds in significantly ( $p < 0.01$ ) less time than the control group. The cows of the Satomul fed treatment group produced significantly ( $p < 0.01$ ) higher average milk (Table 4.5) with  $8.74 \pm 0.16$  litres than with  $7.72 \pm 0.11$  litres in the control group. The average per day milk yield of cows in the Satomul fed treatment group was significantly higher ( $p < 0.01$ ) (Table 4.6) than the control group from day-1 till end of experiment at day-42. The different compositions of milk (Table 4.7) in the control and treatment groups respectively on overall basis were as: fat  $4.32 \pm 0.11\%$  and  $4.99 \pm 0.09\%$ , solids-not fat (SNF)  $8.89 \pm 0.06\%$  and  $8.93 \pm 0.07\%$ , protein  $3.41 \pm 0.03\%$  and  $3.54 \pm 0.05\%$ , lactose  $4.67 \pm 0.04\%$  and  $4.68 \pm 0.05\%$  and total solids (TS)  $13.21 \pm 0.14\%$  and  $13.92 \pm 0.12\%$ . Results of analysis of variance (Table 4.8)

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revealed that treatment had significant effect ( $p < 0.01$ ) on fat % ( $p < 0.01$ ), protein% ( $p < 0.05$ ) and total solids % while SNF, lactose and acidity percentages were not affected significantly. The average sensory scores of the different organoleptic evaluations of curd (dahi) and paneer samples have been presented in Table 4.9. The results revealed that the average values of curd samples were slightly higher in respect of all attributes e.g., appearance, colour, body and texture, flavor, taste and overall acceptability in treatment group as compared to control group. In the case of paneer also, similar higher values of the sensory attributes were observed in the treatment group in respect of appearance, colour, body and texture, and overall acceptability while values in respect of flavor and taste did not change in both the groups. The result of average feed cost and return from milk production (Table 4.10) revealed that the average daily feed cost in the control group was Rs. 111.03 while it was found to be Rs. 123.31 feed cost plus cost of Rs. 30 for 100 gm. Satomul supplement totaling to Rs. 153.31 in the treatment group. The feed cost per litre of milk (feed cost  $\div$  average milk yield) were Rs. 14.38 and Rs. 17.54 in control and treatment group respectively. The daily money receipt per cow from sale of milk @ Rs. 50/litre (milk yield  $\times$  sale price of milk) were Rs. 386.00 and 437.00 in control and treatment group respectively generating a gross return of Rs. 51/- over the control while corresponding income after deduction of their feed costs were found to be Rs. 274.99 and Rs. 283.70. The margin receipt in the treatment group over the control were Rs. 8.71 with 3.17% increment in margin receipt over control. The results shown in the table 4.11 revealed the body weight of the cows in control and treatment group respectively were  $301.65 \pm 11.71$  kg and  $301.72 \pm 12.38$  kg at day-1,  $302.14 \pm 11.99$  kg and  $303.97 \pm 12.08$  kg at day-14,  $302.85 \pm 11.94$  kg and  $304.45 \pm 11.92$  kg at day-28 and finally  $303.21 \pm 11.89$  kg and  $306.89 \pm 11.42$  kg at day-42. Analysis of variance test (Table 4.12) revealed that treatment with dietary supplementation of Satomul had no significant effect on average body weight of the cows. However, body weight increased linearly with the days in the treatment group. The overall body condition scores were  $3.41 \pm 0.05$  and  $3.51 \pm 0.07$  in the control and treatment group (Table 4.13) respectively and analysis of variance result (Table 4.14) revealed that dietary supplementation of Satomul had significant effect ( $p < 0.05$ ) on average body condition score of the experimental cows.

## **Performance of Hampshire Piglets Reared on Hot Water Treated Floor**

*Phanidhar Mili*

A study was carried out to see the performance of Hampshire piglets reared on hot water treated floor. A total number of 36 newborn Hampshire piglets were selected from six different litters. The piglets were then grouped into 2 each of 18 piglets *viz.*, floor without any treatment (Group I) and hot water treated floor (Group II) and maintained in conventional system of housing and both the groups were randomly allotted to different treatment floor. The final body weight at 8<sup>th</sup> week for the Group I and Group II piglets were  $7.73 \pm 0.20$  kg and  $7.91 \pm 0.15$  kg respectively and the value being non-significant ( $P < 0.05$ ) in both the group but apparently higher body weight in Group II.

The total body weights gain for group I and group II piglets figured as  $6.47 \pm 0.02$  kg and  $6.64 \pm 0.02$  kg respectively. The average daily gain (ADG) for group I and group II piglets appeared as  $0.116 \text{ kg} \pm 0.0004$  and  $0.119 \pm 0.0004$  kg respectively. The total and daily body weight gains appeared to be non-significant ( $P < 0.05$ ). This revealed that hot water treated floor had a positive effect on the body weight gains of the piglets.

The total feed intake per piglet during the whole experimental period was  $9.289 \pm 0.401$  kg and  $9.363 \pm 0.403$  kg for Group I and Group II respectively. The weekly average feed intake in Group I and Group II was  $1.548 \pm 0.401$  kg and  $1.561 \pm 0.403$  kg respectively whereas the daily average intake was  $0.221 \pm 0.010$  kg and  $0.223 \pm 0.010$  kg respectively. Feed intake was slightly influenced by hot water treatment. The average feed conversion ratios of group I and group II were recorded as  $1.85 \pm 0.445$  and  $1.79 \pm 0.433$  respectively. Average feed conversion ratio was found to be apparently better in piglets kept on floor with hot water treatment (Group II). This revealed that feed was more efficiently utilized for growth by the piglets reared on hot water treated floor (Group II).

The diarrhoea incidence rate was recorded as  $13.11 \pm 5.81$  in Group I which was higher than that of Group II piglets with a value of  $6.39 \pm 2.75$ . The data expresses that the overall diarrhoea incidence rate was higher in Group I piglets than Group II. The mortality was 11.11 percent in group I and no mortality was observed in group II and this is suggestive of better effect of hot water on floors.

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## **Effect of Challenge Feeding on the Production Performance of Crossbred Cows**

*Poonam Das*

An experiment of challenge feeding was conducted on two groups of crossbred cows, control and treatment with 6 cows in each group through feeding of high concentrate ration for a period of 16 weeks. The concentrate was fed as per the experimental feeding schedule while roughage was allowed *ad. libitum*. The objectives of the study were to study the effect of challenge feeding on their production performances of colostrum yield, milk yield, milk composition; peri-parturient health problems; blood parameters of Ca, P, Hb, total protein, glucose and cortisol; cost of challenge feeding and growth performance of the calves born

The overall average weekly feed intake were  $90.526 \pm 2.293$  kg and  $95.587 \pm 1.64$  kg in control and treatment groups respectively and was significantly higher ( $p < 0.01$ ) in the treatment group. Analysis of variance revealed significant effect of both treatment and week on feed intake of the experimental cows while their interaction revealed no significant effect.

The overall colostrum yield were  $3.467 \pm 0.093$  kg and  $3.900 \pm 0.111$  kg and the overall milk yield were  $76.375 \pm 2.925$  and  $93.083 \pm 3.931$  kg in control and treatment group respectively. The cows of treatment group produced significantly ( $p < 0.01$ ) higher average colostrums and milk yield than the control group. Analysis of variance table revealed significant effect of group and period on colostrum and milk yield while group  $\times$  period interaction did not have any significant effect.

The overall values of the different milk composition(%) in control and treatment groups were as: fat,  $4.515 \pm 0.376$  and  $4.546 \pm 0.275$ ; protein,  $3.508 \pm 0.094$  and  $3.590 \pm 0.118$ ; lactose,  $5.419 \pm 0.149$  and  $5.365 \pm 0.106$  as well as solids-not-fat (SNF),  $9.277 \pm 0.152$  and  $9.479 \pm 0.244$  respectively. Analysis of variance of the data revealed non-significant effect of challenge feeding on fat, protein, lactose and SNF percentage of milk.

The overall values of blood calcium (mg/dl) during pre and post partum period in control and treatment group were  $10.536 \pm 0.236$  and  $10.592 \pm 0.173$  respectively. The corresponding average values of blood phosphorus (mg/dl) were  $5.268 \pm 0.276$  and

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5.681±0.229 in control and treatment groups respectively. On Statistical analysis non significant difference between groups was observed. But both calcium and phosphorus levels in blood differed significantly ( $p<0.01$ ) during prepartum and postpartum in both control and treatment group.

The overall average values of haematological parameters during pre and postpartum period in control and treatment group respectively were as: Hb (g/dl), 10.917 ±0.412 and 11.192±0.359; total protein (g/dl), 6.809±0.293 and 6.5±0.293 and glucose(mg/dl), 77.734 ± 4.084 and 63.567±8.971 .Result of analysis of variance indicated non significant effect of challenge feeding on Hb, total protein and glucose in blood .

The average of cortisol (nmol/L) during prepartum and postpartum in control and treatment group were 26.653 ±0.704 and 21.021±0.626 respectively. .Result of analysis of variance revealed that the level of cortisol differed significantly and was significantly ( $p<0.01$ ) low in the treatment group than the control group.

There was no any incidence of pre partum nor post partum disease observed in the cows of the control and treatment groups during the entire period of the experiment.

Total post partum feed cost (Rs.) were 23538.08 and 24557.18 in control and treatment group respectively with Rs. 1248.52 extra cost of feed during pre partum in treatment group. The average daily feed cost (Rs.) were 420.32 and 460.81; average daily milk yield (kg) were 10.91 and 13.29; daily return from milk (Rs.) were 600.05 and 730.95; feed cost per kg of milk production (Rs.) were 38.53 and 34.67. There was an additional daily income of (Rs.) 51.30.

The overall average body weight (kg) of the calves during the experimental period were recorded as 35.181±2.106 and 41.290±1.493 for control and treatment group respectively and revealed highly significant effect ( $p<0.01$ ) of challenge feeding on body weight of the calves.

## **Performance of Assam Hill Goat Reared on Periodically Disinfected Floor**

*Santana Das*

A study was carried out to see the performance of Assam Hill Goat reared on disinfected floors. A total number of 18 Assam Hill Goats (9 males and 9 females) were selected and divided into 3 groups; each consists of 6 goats of an equal number of males and females which were intensively housed. The 3 groups were randomly assigned to the following treatments, viz. floor without any disinfectant treatment (T<sub>1</sub>), floor treated with sodium hypochlorite (T<sub>2</sub>) and floor treated with calcium oxide i.e. quicklime (T<sub>3</sub>).

The fortnightly average initial body weight of the selected goats of T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> groups were  $6.01 \pm 0.16$ ,  $6.23 \pm 0.16$  and  $6.21 \pm 0.17$  kg respectively and the corresponding value for the same groups at 6<sup>th</sup> fortnight were  $10.45 \pm 0.17$ ,  $11.93 \pm 0.23$  and  $11.38 \pm 0.22$  kg respectively. Statistical analysis of the data exhibited significant differences among the groups from the 4<sup>th</sup> to 6<sup>th</sup> fortnight ( $P < 0.05$ ). Goats reared on a floor treated with sodium hypochlorite showed higher body weight followed by calcium oxide treated floor during the entire experimental period, however, the difference appeared to be non-significant up to 3<sup>rd</sup> fortnight. The critical difference test reveals that there was a significant difference between T<sub>1</sub> and T<sub>2</sub> groups but no significant difference could be observed between T<sub>1</sub> and T<sub>3</sub> as well as T<sub>2</sub> and T<sub>3</sub> groups.

The body weight gains of goats for T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> groups in the 1<sup>st</sup> fortnight figured as  $0.52 \pm 0.09$ ,  $0.60 \pm 0.08$  and  $0.57 \pm 0.08$  kg and the corresponding values for the same 3 groups in the 6<sup>th</sup> fortnight were recorded as  $1.14 \pm 0.11$ ,  $1.54 \pm 0.10$ , and  $1.37 \pm 0.10$  kg respectively. The average daily body weight gain of goats for T<sub>1</sub> was  $0.035 \pm 0.005$  kg, T<sub>2</sub> was  $0.040 \pm 0.006$  kg and T<sub>3</sub> was  $0.038 \pm 0.005$  kg in the 1<sup>st</sup> fortnight and the corresponding values for the same groups in the 6<sup>th</sup> fortnight were recorded as  $0.076 \pm 0.007$  kg,  $0.100 \pm 0.006$  kg, and  $0.091 \pm 0.006$  kg respectively. The fortnightly body weight gain and daily body weight gain manifested a significant difference ( $P < 0.05$ ) statistically in 6<sup>th</sup> fortnight. The critical difference test reveals that there was a significant difference between T<sub>1</sub> and T<sub>2</sub> groups but found no significant difference between T<sub>1</sub> and T<sub>3</sub> as well as T<sub>2</sub> and T<sub>3</sub> groups.

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The average dry matter intake of goats in T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> were  $4.05 \pm 0.113$ ,  $4.48 \pm 0.120$  and  $4.37 \pm 0.117$  kg in the 1<sup>st</sup> fortnight respectively and the corresponding values for the same 3 groups in the 6<sup>th</sup> fortnight were recorded as  $6.59 \pm 0.101$ ,  $7.51 \pm 0.174$ , and  $7.34 \pm 0.163$  kg respectively. There was a statistically significant difference ( $P < 0.05$ ) from 4<sup>th</sup> to 6<sup>th</sup> fortnight and the critical difference test revealed a significant difference between T<sub>1</sub> and T<sub>2</sub> groups but could not exhibit any significant difference between T<sub>1</sub> and T<sub>3</sub> as well as T<sub>2</sub> and T<sub>3</sub> groups.

The feed conversion ratios for T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> goats in the 1<sup>st</sup> fortnight figured as  $7.80 \pm 0.18$ ,  $7.38 \pm 0.17$  and  $7.65 \pm 0.18$  and the corresponding values for the same 3 groups in the 6<sup>th</sup> fortnight were  $5.80 \pm 0.12$ ,  $4.88 \pm 0.10$ , and  $5.36 \pm 0.11$  respectively. The feed conversion ratio was found to be highly significant ( $P < 0.01$ ) from 4<sup>th</sup> to 6<sup>th</sup> fortnight. This revealed that feed was more efficiently utilized for growth by the goats reared on sodium hypochlorite treated floor (T<sub>2</sub>). The critical difference test reveals that there was a significant difference between T<sub>1</sub> and T<sub>2</sub> groups in 4<sup>th</sup> fortnight but no such differences could be seen between T<sub>1</sub> and T<sub>3</sub> as well as T<sub>2</sub> and T<sub>3</sub> groups. But from 5<sup>th</sup> fortnight onwards there was a significant difference among all the three groups.

The incidence rate of diarrhea of goats was recorded as 40% for T<sub>1</sub>, 18% for T<sub>2</sub> and 40% for T<sub>3</sub> in the 1<sup>st</sup> fortnight. No incidence of diarrhea was observed from 4<sup>th</sup> fortnight onwards in all the groups. The data expressed that the overall diarrhea incidence rate was higher in T<sub>1</sub> goats intermediate in T<sub>3</sub> and lowest in T<sub>2</sub>.

The parasitic infestation of goats was recorded as 83% in T<sub>1</sub>, 66% in T<sub>2</sub> and 83% in T<sub>3</sub> groups in the 1<sup>st</sup> fortnight. The data further reveals that the overall parasitic infestation of goats was found to be lowest in T<sub>2</sub> goats followed by T<sub>3</sub> and T<sub>1</sub>.

## **Growth and Carcass Characteristics of Indigenous Sheep of Assam Reared Under Different Feeding Systems**

*Sakil Ahmed*

Eighteen healthy indigenous weaned male lambs of Assam of similar age and body weight were allocated to three experimental groups of T<sub>1</sub> T<sub>2</sub> and T<sub>3</sub> with 6 lambs in each group and were reared for a period of 8 fortnights(112 days) under three different feeding systems of i) Grazing(T<sub>1</sub>),ii) Grazing and concentrate supplementation(T<sub>2</sub>) and iii)Stall feeding of green grass and concentrate supplementation(T<sub>3</sub>). The concentrate supplement contained 16% CP and 75%TDN and was fed @ 1% of the body weight of the lambs daily during the experimental period.

The average initial and final body weight at 8<sup>th</sup> fortnight of the lambs were 5.38±0.25 and 8.87±0.28 kg, 5.34±0.27 and 5.38±0.27 kg and 10.92±0.31 and 5.38±0.27 kg and 12.57±0.13 kg respectively in T<sub>1</sub>,T<sub>2</sub>and T<sub>3</sub> groups. The corresponding average body weight gains of the experimental lambs were 0.44±0.01,0.70±0.02 and 0.88±0.02 kg in T<sub>1</sub>,T<sub>2</sub>and T<sub>3</sub> groups. Analysis of variance revealed that both the fortnightly body weight and body weight gain differed significantly (P<0.01) among themselves.

The overall mean values of the linear body measurements (cm) in T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub> groups respectively were: 34.94±0.60; 37.54±0.76 and 38.71±0.80 cm. for body length; 37.34±0.49; 37.73±0.63 and 38.76±0.72 cm for height at wither; 46.33±0.59; 46.73±0.79 and 48.39±0.84 cm for chest girth; 14.00±0.25; 14.43±0.42 and 15.57±0.52 cm for neck girth; 10.79±0.20; 10.85±0.26 and 11.11±0.26 cm for tail length; 11.39±0.15; 11.03±0.19 and 11.29±0.19cm for head length; 7.18±0.07; 7.13±0.09 and 7.52±0.15 cm. for head breadth; 6.84±0.09; 7.14±0.13 and 7.66±0.18 cm for ear length and 2.87±0.13, 2.88 ±0.09 and 2.91±0.31cm for horn length. All the conformation traits increased linearly from 1<sup>st</sup> to 8<sup>th</sup> fortnight with advancement of age. Correlation analysis revealed body length, height at wither and chest girth to significantly and positively increase with corresponding increase in body weight in all the three treatments. Analysis

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of variance of the data revealed significant ( $P<0.01$ ) effect of treatment on the conformation traits.

The average physiological parameters of the experimental lambs in  $T_1$ ,  $T_2$  and  $T_3$  groups respectively were as: respiration rate,  $19.04\pm 0.08$ ,  $19.10\pm 0.08$  and  $18.78\pm 0.09$  breaths per minute; pulse rate,  $75.07\pm 0.14$ ,  $75.28\pm 0.13$  and  $74.73\pm 0.14$  beats per minute and rectal temperature,  $101.56\pm 0.02$ ,  $101.57\pm 0.01$ ,  $101.55\pm 0.0$ °F. Analysis of variance revealed significant effect of treatment on respiration rate ( $P<0.05$ ) and pulse rate ( $P<0.01$ ) but did not have significant effect on rectal temperature of the experimental lambs. In respect of respiration and pulse rate, the stall fed group ( $T_3$ ) lambs showed significantly lower respiration and pulse rate than the lambs of  $T_1$  and  $T_2$  groups

The average values of carcass parameters were as: pre-slaughter weight (kg),  $8.87\pm 0.28$ ,  $10.92\pm 0.31$  and  $12.57\pm 0.13$ ; slaughter weight (kg),  $8.19\pm 0.25$ ,  $10.08\pm 0.28$  and  $11.53\pm 0.12$ ; carcass weight (kg),  $4.14\pm 0.14$ ,  $5.30\pm 0.15$  and  $6.33\pm 0.06$  and dressing percentage (%),  $46.67\pm 0.19$ ,  $48.53\pm 0.25$  and  $50.36\pm 0.26$ ; carcass length (cm),  $49.32\pm 0.29$ ,  $50.98\pm 0.33$  and  $52.30\pm 0.29$ ; back fat thickness (mm),  $1.25\pm 0.03$ ,  $1.38\pm 0.04$  and  $1.56\pm 0.06$  and Loin eye area (cm<sup>2</sup>),  $5.09\pm 0.17$ ,  $6.08\pm 0.21$  and  $7.09\pm 0.13$  in  $T_1$ ,  $T_2$  and  $T_3$  respectively. In respect of yield of whole sale cuts, neck and shoulder (kg),  $0.91\pm 0.12$ ,  $1.31\pm 0.04$  and  $1.54\pm 0.01$ ; breast and fore shank (kg),  $0.63\pm 0.02$ ,  $0.81\pm 0.02$  and  $0.97\pm 0.01$ ; rack (kg),  $0.61\pm 0.02$ ,  $0.77\pm 0.02$  and  $0.93\pm 0.0$ ; loin and flank (kg),  $0.55\pm 0.02$ ,  $0.70\pm 0.02$  and  $0.84\pm 0.01$  and Legs (kg),  $1.33\pm 0.04$ ,  $1.70\pm 0.05$  and  $2.03\pm 0.02$  with a total weight (kg) of whole sale cuts,  $4.13\pm 0.14$  (46.56%),  $5.29\pm 0.05$  (48.44%) and  $6.31\pm 0.05$  (50.20%) in  $T_1$ ,  $T_2$  and  $T_3$  respectively. Different by-products yield in the treatment groups were as: blood (lit.),  $0.68\pm 0.03$ ,  $0.85\pm 0.02$  and  $1.04\pm 0.01$ ; head (kg),  $0.57\pm 0.02$ ,  $0.70\pm 0.02$  and  $0.81\pm 0.01$ ; skin,  $0.82\pm 0.03$ ,  $1.02\pm 0.03$  and  $1.29\pm 0.02$ ; empty GIT (kg),  $0.74\pm 0.02$ ,  $0.74\pm 0.02$  and  $1.06\pm 0.01$ ; lungs and trachea (kg),  $0.19\pm 0.00$ ,  $0.23\pm 0.01$  and  $0.27\pm 0.01$ ; pancreas (kg),  $0.02\pm 0.00$ ,  $0.03\pm 0.00$  and  $0.03\pm 0.00$ ; spleen (kg),  $0.03\pm 0.00$ ,  $0.04\pm 0.00$  and  $0.04\pm 0.00$ ; kidneys (kg),  $0.05\pm 0.00$ ,  $0.06\pm 0.00$  and  $0.07\pm 0.00$ ; liver (kg),  $0.18\pm 0.00$ ,  $0.23\pm 0.00$  and  $0.27\pm 0.00$ ; heart (kg),  $0.09\pm 0.00$ ,  $0.11\pm 0.00$  and  $0.13\pm 0.00$ ; testis (kg),  $0.08\pm 0.00$ ,  $0.09\pm 0.00$  and  $0.17\pm 0.11$  in  $T_1$ ,  $T_2$  and  $T_3$  respectively. The total byproducts yield and their respective percentages shown in the parentheses were  $3.44\pm 0.11$  (38.78%),  $4.26\pm 0.12$  (39.01%) and  $5.11\pm 0.06$  (40.65%) respectively in  $T_1$ ,  $T_2$  and  $T_3$  groups. The average percent values of proximate composition (%) were as moisture,  $76.41\pm 0.08$ ,  $75.44\pm 0.09$  and  $73.34\pm 0.08$ ; protein,  $17.44\pm 0.08$ ,  $18.37\pm 0.08$  and  $19.57\pm 0.06$ ; fat,  $3.83\pm 0.15$ ,  $4.41\pm 0.09$  and  $6.31\pm 0.08$  and total ash,  $0.90\pm 0.05$ ,  $1.00\pm 0.00$  and  $1.01\pm 0.00$  in  $T_1$ ,  $T_2$  and  $T_3$  groups respectively. Analysis of variance revealed significant ( $P<0.01$ ) effect of treatment on the carcass characteristics parameters. .

The economic analysis of feeding the lambs revealed that the cost of concentrate per lamb during the experimental period was nil in  $T_1$  while it was Rs. 221.39 and 279.97 in  $T_2$  and  $T_3$  groups respectively. The total body weight gain and total yield of mutton and byproducts were highest in  $T_3$  followed by  $T_2$  and  $T_1$  groups. The corresponding values were, body weight gain, 7.068, 5.606 and 3.481 kg; mutton,



6.325, 5.300 and 4.141 kg and gible, 0.473, 0.398 and 0.320 kg in T<sub>3</sub>, T<sub>2</sub> and T<sub>1</sub> groups respectively. Sale price of mutton was Rs.600/kg and for heart, liver and kidneys together were Rs. 650/kg. Head, empty GIT and skin were sold on lump sum amount of Rs. 175.00 . In this way, total money (Rs) received was highest in T<sub>3</sub> group (4277.45) followed by T<sub>2</sub> (3613.70) and T<sub>1</sub> (2867.60) group. There were an increased receipt of (Rs.) 1409.85 and 746.10 respectively in T<sub>3</sub> and T<sub>2</sub> groups over T<sub>1</sub> group. The corresponding money(minus feed cost) received in these two groups were (Rs.) 1129.88 and 524.71 in T<sub>3</sub> and T<sub>2</sub> groups of lamb respectively indicating stall feeding (T<sub>3</sub>) of the lambs to be more economic and remunerative than grazing with supplementation (T<sub>2</sub>) and only grazing of the lambs (T<sub>1</sub>).

# **Growth Performance of Crossbred Calves Fed Molasses and Probiotics Supplemented Diet**

*Sanidur Ahmed*

The present experiment was conducted to investigate the effect of feeding molasses and probiotics on the growth performance of crossbred dairy calves. Twelve healthy crossbred calves of both sexes of similar age and body weight were allocated to two experimental groups, control (T0) and treatment (T1) with six animals in each group. Calves of both groups were fed with a standard basal diet consisting of concentrate, green fodder, and paddy straw along with Molasses @ 3% of DM requirement and multi-strain probiotics @10 gm/animal/day daily in the treatment group. The experiment was conducted as a feeding trial for six fortnights and a digestibility trial thereafter for five days in the two experimental groups.

The average initial and final body weight in the 6th fortnight of the calves were 89.500±7.843 and 89.500±8.290 kg and 110.667±7.932 and 119.500±7.178 kg respectively in T0 and T1 groups. Analysis of variance of the data did not reveal any significant difference ( $P>0.05$ ) in average body weight in the control (T0) and treatment (T1) groups.

The overall mean daily body weight gain is 0.357±0.019 kg in the treatment group (T1) which was significantly ( $P<0.01$ ) higher than the control group which is 0.252 ± 0.013 kg. In respect of different fortnights, the Average daily gain was significantly ( $P<0.01$ ) higher from the 4th to 6th fortnight. Similarly, the overall fortnightly body weight gain was significantly higher ( $P<0.01$ ) in the treatment group (5.000 ± 0.270 kg) than in the control group (3.556 ± 0.171 kg) of calves. The fortnightly body weight gain was higher ( $P<0.01$ ) in the treatment group than in the control group from the 2nd to 6th fortnight.

The overall mean values of the conformation traits (cm) in the control group (T0) and treatment group (T1) groups respectively were: 97.17± 1.21 and 99.08 ±1.15 cm for body length; 111.69 ±1.12 and 112.64± 1.06 cm for chest girth as well as 100.23± 0.90 and 100.85 ±0.86 cm for height at wither. All the conformation traits revealed a highly positive correlation with body weight. Analysis of variance of

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conformation traits showed no significant ( $P>0.05$ ) difference between control (T0) and treatment (T1) groups respectively.

The overall average daily DM intake was  $2.76 \pm 0.09$  kg in the control group (T0) and  $2.84 \pm 0.09$  kg in the treatment group (T1). Feeding of Molasses and multistrain probiotics had a positive effect on dry matter intake in the treatment group and it was higher than the control group in all fortnights. However, analysis of variance results revealed no significant ( $P>0.05$ ) difference between the average values of DM intake between control (T0) and treatment (T1) groups.

The overall mean values of the feed-eating time were  $243.21 \pm 0.58$  min. in the control (T0) and  $240.42 \pm 0.54$  min. in the treatment (T1) group. Analysis of variance revealed that there was a significant ( $P<0.05$ ) difference between overall average feed-eating time in the control (T0) and treatment (T1) groups. The feed-eating time was reduced significantly ( $P<0.05$ ) in the treatment group (T1) from the 2nd to 6th fortnight.

The average FCR values were  $11.77 \pm 0.79$  and  $10.89 \pm 1.00$  in 1st fortnight and  $10.74 \pm 0.39$  and  $6.39 \pm 0.68$  in the 6th fortnight in control (T0) and treatment (T1) groups respectively. On an overall basis, FCR values were  $10.89 \pm 0.24$  and  $8.35 \pm 0.40$  in the control (T0) and treatment (T1) groups. Analysis of variance revealed that there was a highly significant ( $P<0.01$ ) effect of supplementation of Molasses and probiotics on the feed conversion ratio (FCR) of the experimental animals. Further, the C.D. test revealed that the FCR in the treatment (T1) group was significantly reduced from the 3rd fortnight to the 6th fortnight compared to the control (T0) group. The overall mean values of the physiological parameters in the T0 and T1 groups respectively were as: respiration rate,  $26.17 \pm 0.09$  and  $26.45 \pm 0.11$  breath per minute; pulse rate,  $72.04 \pm 0.13$  and  $72.00 \pm 0.12$  beats per minute and rectal temperature,  $101.07 \pm 0.11$  and  $100.95 \pm 0.11$  (oF). Analysis of the variance of the data revealed no significant ( $P>0.05$ ) difference in respect of the three parameters between the control (T0) and treatment (T1) groups. The blood biochemical and hematological parameters like serum glucose, serum total protein, and hemoglobin were within the normal range for crossbred calves in both the control and treatment groups and the data did not reveal any significant difference ( $P>0.05$ ). The average digestibility coefficient (%) in T0 and T1 groups respectively were:  $67.47 \pm 0.26$  and  $73.33 \pm 0.44$  for dry matter (DM);  $70.37 \pm 1.55$  and  $76.17 \pm 0.44$  for organic matter (OM);  $66.67 \pm 0.73$  and  $71.67 \pm 0.44$  for crude protein (CP);  $66.40 \pm 0.49$  and  $72.63 \pm 0.27$  for ether extract (EE);  $63.97 \pm 0.27$  and  $72.37 \pm 0.18$  for crude fibre (CF) and  $73.40 \pm 1.06$  and  $79.26 \pm 0.73$  for nitrogen-free extract (NFE). Analysis of the data revealed significantly ( $P<0.01$ ) higher digestibility of the organic nutrients in molasses and probiotics fed treatment (T1) group than control (T0) group.

The economic analysis of the cost of feeding the experimental calves revealed the following: (i) average daily cost of feed consumption (on DM basis) per calf was Rs. 42.53 and Rs. 49.06, (ii) average net cost of feed consumption (on DM basis) per calf were Rs. 3572.81 and Rs. 4121.04, (iii) cost of feeding per kg body weight gain was Rs. 167.50 and Rs. 137.37 in control (T0) and treatment (T1) respectively. From the results, it was observed that the total cost of feeding was a little higher in the treatment group

than in the control group. However, the total body weight gain was higher in the treatment group (T1) than in the control group (T0) which resulted in a lower cost of feeding per kg weight gain in the treatment than in the control group.

# **Study on the Indigenous Knowledge System on Pig Rearing Adopted by the Rabha Community of Assam**

*Sayashree Rabha*

A study on the indigenous knowledge system on pig rearing adopted by the Rabha community of Assam was conducted for which farmers from two districts namely Kamrup and Goalpara were selected having atleast 2 pigs. The study was carried out to know the socio-economic status of the pig farmers, managerial practices adopted by them and the use value of pig in the socio-cultural life of the Rabha farmers. Majority of the farmers involved in pig rearing were females (58.67 %), 67.00 % belonged to the middle age group (29-52 years), 60.00 % had high school level of education, 83.33 % of the pig farmers had medium family size (3-5 members) and majority (65.33 %) were agri-farmers. About 71.33 % of the farmers had medium land holding (0.90-4.00 acres) and 91.00 % reared 2-6 numbers of pigs. The average total annual income of the pig farmers was Rs.103700.00±3180.84 and average annual income from piggery was Rs.49670.00±2484.26 Share of piggery to the total income of farmer was 47.89 %. Extensive system of rearing (78.33 %) along with tethering (52.67 %) was predominant and pigs were fed Indigenous or locally available feedstuff (92.67 %). Majority of the pig farmers reared cross breed pigs (85.00 %), followed by non-descript pigs (14.00 %) for fattening purpose (86.66 %). Natural service (87.33 %) was mostly practiced for breeding with average litter size at birth 10.3±0.38 and at weaning 9.13±0.35. About 41.33 % farmers did not take any disease preventive and treatment measures, only 77.33 % of the farmers did castration of piglets, 7.67 % took special care of pregnant and farrowing sows, 46.33 % carried out deworming and 15.33 % vaccinated their pigs. Only 15.00 % of the farmers acquired piggery management training. Majority of the pig farmers (74.33 %) sold their pigs directly to agent or wholesaler at the age of 6 months and above (73.00 %) and 51.00 % bought their piglets from local markets, 58.00 % of the farmers sold pigs due to urgency of money. The average age of pigs at the time of marketing was 234.98±4.7 days, average sale price of piglet was Rs.3560.33 ± 14.50, pig was Rs.13834.00 ± 326.00 and pork per kg was

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Rs.313.53±1.22. Major constraint faced by the farmers was lack of finances for purchasing of new animals, feed, building pig sty or farm etc. (39.33 %). Majority of the farmers reared pigs as financial security during emergency (70.33 %). About 38.00 % reared pigs for social occasions, 14.00 % reared for the Baikho festival and 3.33 % reared for wedding rituals. It was also found that only 37.67 % of the farmers thought that piggery could be taken up as a primary occupation.

## **Effects of Dietary Protein Level during Transition Period of Crossbred Heifers**

*Shams Uz Zaman*

In the present experiment was conducted to study the effect of dietary protein level on the performance of crossbred heifers during the transition period. The trial was done in the Instructional Livestock Farm (Cattle) under the Department of Livestock Production and Management, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati-781022. Twelve (12) pregnant crossbred heifers were selected in the advance stage of pregnancy from the above farm on the basis of available records. All the twelve (12) animals were divided into two groups 21 days prior to calving viz. Treatment No.1 (T1) and Treatment No. 2 (T2) consisting six (6) animals in each group. The T1 group was provided concentrate ration having 18 per cent CP and 70 per cent TDN and the T2 group was provided concentrate ration having 22 per cent CP and 70 per cent TDN during the transition period (ICAR, 2013). During prepartum, both the groups were fed concentrate ration @ 1.5 kg/day/animal in two divided doses and forage was given *ad libitum* and during postpartum, both the group was provided concentrate ration @ 1.5 kg/day/animal plus 1 kg concentrate per 2.5 kg of milk production in two divided doses and *ad libitum* feeding of forage was practiced.

The overall average daily DM intake during prepartum and postpartum was  $6.76 \pm 0.24$  and  $10.39 \pm 0.35$  kg in T1 and  $6.93 \pm 0.21$  and  $11.45 \pm 0.38$  kg in T2 groups. The overall average DM intake during postpartum period differed significantly between T1 and T2 groups, which may be due to increased palatability of feed in T2 than T1 group. The overall DM intake during postpartum was significantly more than prepartum period. The overall average body weight during prepartum and postpartum was  $331.62 \pm 2.20$  and  $312.95 \pm 1.46$  kg in T1 and  $348.54 \pm 2.40$  and  $322.54 \pm 1.47$  kg in T2 groups, respectively. There was highly significant ( $P < 0.01$ ) difference of average body weight between T1 and T2 groups. The overall body weight during postpartum was significantly less than the prepartum which was due to loss of body weight at calving and loss for milk production. The overall average BCS during prepartum was  $3.42 \pm 0.04$  and  $3.47 \pm 0.03$  and during postpartum was  $2.88 \pm 0.05$  and  $3.28 \pm 0.04$  in T1 and T2

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groups, respectively. The average BCS was significantly decreased during postpartum than the prepartum due to calving and lactation in both the group.

The overall average daily respiration rate was  $27.24 \pm 0.29$  and  $27.02 \pm 0.23$  per minute in T1 group and  $27.92 \pm 0.80$  and  $27.84 \pm 0.43$  per minute in T2 group during prepartum and postpartum period, respectively. The afternoon respiration rate was significantly ( $P < 0.01$ ) higher than the morning respiration rate both in prepartum and postpartum period. The overall average daily pulse rate was  $75.23 \pm 0.71$  and  $72.63 \pm 1.13$  per minute in T1 group and  $75.98 \pm 0.18$  and  $73.32 \pm 0.23$  per minute in T2 group during prepartum and postpartum periods, respectively. The overall pulse rate during prepartum ( $75.61 \pm 0.37$  per minute) was significantly higher than the postpartum ( $72.98 \pm 0.69$  per minute), which was due to increased maternal pulse rate at late gestation. In the present study, the afternoon pulse rate was significantly ( $P < 0.01$ ) higher than the morning pulse rate. The overall average rectal temperature during prepartum and postpartum periods were  $101.50 \pm 0.05$  and  $101.72 \pm 0.03$  °F, respectively. The afternoon rectal temperature was significantly ( $P < 0.01$ ) higher than the morning.

The haemoglobin concentration during prepartum and postpartum was  $11.87 \pm 0.26$  and  $10.43 \pm 0.49$  g/dl in T1 group and  $12.18 \pm 0.23$  and  $10.78 \pm 0.37$  g/dl in T2 group, respectively (Table 4.14). The overall average haemoglobin concentration during prepartum  $12.03 \pm 0.17$  g/dl was significantly higher than postpartum  $10.61 \pm 0.29$  g/dl. The average total blood protein concentration during prepartum and postpartum was  $6.85 \pm 0.14$  and  $7.40 \pm 0.12$  g/dl in T1 group and  $6.85 \pm 0.17$  and  $7.55 \pm 0.10$  g/dl in T2 group, respectively.

The overall average total blood protein concentration during postpartum  $7.48 \pm 0.08$  g/dl was significantly higher than the prepartum  $6.85 \pm 0.11$  g/dl. The overall average blood glucose concentration was significantly higher in T2 ( $45.89 \pm 2.04$  mg/dl) group than the T1 ( $43.12 \pm 1.46$  mg/dl) group. The overall average blood glucose concentration during prepartum ( $50.22 \pm 0.79$  mg/dl) was significantly higher than the postpartum ( $38.79 \pm 0.30$  mg/dl) period. The blood calcium concentration during prepartum and postpartum was  $7.67 \pm 0.23$  and  $7.24 \pm 0.21$  mg/dl in T1 group and  $8.04 \pm 0.29$  and  $7.31 \pm 0.23$  mg/dl in T2 group, respectively. The overall average blood calcium concentration during prepartum ( $7.86 \pm 0.19$  mg/dl) was significantly higher than postpartum ( $7.28 \pm 0.15$  mg/dl) period. The overall average blood phosphorus concentration between T1 ( $6.37 \pm 0.16$  mg/dl) and T2 ( $6.50 \pm 0.16$  mg/dl) groups did not differ significantly. The overall average blood cortisol concentration was significantly higher in T2 ( $26.87 \pm 0.64$  nmol/L) than T1 ( $25.41 \pm 0.40$  nmol/L) group. The overall average blood cortisol concentration during prepartum ( $26.48 \pm 0.49$  nmol/L) was significantly higher than the postpartum ( $24.81 \pm 0.32$  nmol/L) period. The overall average urine pH during prepartum and postpartum was  $7.50 \pm 0.02$  and  $7.52 \pm 0.03$  in T1 group and  $7.55 \pm 0.02$  and  $7.55 \pm 0.02$  in T2 group, respectively. There was no significant difference due to treatment and period.



The average birth weight of calves was found to be  $21.00 \pm 1.92$  kg and  $24.33 \pm 1.20$  kg in T1 and T2 groups, respectively; which did not differ significantly. The overall average daily colostrum yield was  $5.67 \pm 0.34$  and  $6.17 \pm 0.38$  kg in T1 and T2 groups, respectively. The overall average daily colostrum yield increased significantly from 1st day to 4th day. The average daily milk yield was significantly higher in T2 ( $12.43 \pm 0.47$  kg) than T1 group ( $10.95 \pm 0.43$  kg). The overall average daily milk yield increased significantly from 1st week to 3rd week.

## Shelf Life of Raw Cow Milk in Different Temperatures

*Subarna Sarkar*

An experiment was conducted to investigate the shelf life of raw cow milk of organised and unorganised farms of Khanapara, Guwahati during summer and winter seasons. A total of 24 milk samples were collected aseptically from pooled milk of the unit after thorough mixing of all the milk with sterile plunger produced in the unit and brought to the laboratory for analysis maintaining the cold chain.

The milk samples were subjected to qualitative and physio-chemical assessment and microbiological assessment.

The milk samples of the organized farm had significantly higher overall average percentage of fat ( $4.03 \pm 0.13$  and  $3.56 \pm 0.18$ ), SNF ( $9.37 \pm 0.05$  and  $8.65 \pm 0.18$ ), protein ( $3.60 \pm 0.02$  and  $3.38 \pm 0.08$ ), lactose ( $5.38 \pm 0.04$  and  $4.99 \pm 0.10$ ), and ash ( $0.77 \pm 0.01$  and  $0.69 \pm 0.01$ ) content in organised farm than in unorganized farm. It was observed that fat, protein, lactose were higher in winter than in summer season.

Specific gravity was higher in organised farm than in unorganised farm ( $1.0331 \pm 0.0026$  and  $1.0311 \pm 0.0062$ ) while season had no effects. Freezing point depression is non-significant in respect of both farms ( $0.64 \pm 0.00$  and  $0.58 \pm 0.02$ ) and seasons ( $0.59 \pm 0.01$  in summer and  $0.62 \pm 0.01$  in winter). Rapid platform tests namely (i) organoleptic evaluation (colour, taste, smell) were found to be *normal* both in organised and unorganised farms in both the seasons, (ii) COB, Alcohol test were *negative* both in respect of farms and seasons and (iii) Resazurin test results of milk were more *superior and acceptable* in unorganised and winter season compare to organised farm and summer season. Physio-chemical parameters e.g. pH ( $6.90 \pm 0.05$  and  $6.73 \pm 0.06$ ) and titratable acidity ( $0.17 \pm 0.01\%$  and  $0.16 \pm 0.00\%$ ) was nonsignificant in respect of farms, while pH ( $6.66 \pm 0.03$  in summer and  $6.97 \pm 0.04$  in winter) and titratable acidity ( $0.18 \pm 0.01$  in summer and  $0.16 \pm 0.01$  in winter) were significantly ( $P < 0.01$ ) lower and higher respectively in summer that indicating higher microbial load in summer. The MBRT results of milk was graded as *excellent* in winter and *good* in summer season in both organised and unorganised farm. TVC and coliform count in milk was significantly

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( $P < 0.01$ ) higher in organised farm and in summer season in different periods compared to unorganised farm and winter season.

The results revealed that the milk collected from organised farm in both the seasons contained higher SNF, fat, protein, lactose and ash but the microbiological quality of milk of unorganised farm was superior to that of organised farm.

## Performance of Crossbred Cows under Farm Conditions

*Venus Das*

The present study was carried out to evaluate the performance of crossbred cows under organized farm condition. Total 260 numbers of complete lactation record, 115 records of age at first calving and 577 cases incidence of disease was collected from Instructional Livestock Farm (cattle) of College of Veterinary Science, Khanapara, Guwahati-781022 during the period from 2007-2017. The data were classified according to genetic group *viz.* Jersey crossbred (G1) and Holstein-Friesian (G2) crossbred cows; seasons *viz.* Pre monsoon (S1), Monsoon (S2), Post monsoon (S3) and Winter (S4) and periods *viz.* period one (P1) (2007-2012) and period two (P2) (2012-2017). Overall mean lactation length, drying period, calving interval, service period, age at first calving of Jersey cross was found to be 299.99±2.13, 99.15±1.72, 399.14±2.22, 120.81±2.39 and 1079.53±23.33 days, respectively and lactation milk yield was 2589.57±51.73 liters. The effect of genetic group was highly significant on all the traits except dry period. The mean lactation length, dry period, calving interval, service period and age at first calving was found to be 294.95, 98.38, 394.75, 115.4 and 1017.50 days, respectively and lactation milk yield was 2316.36 liters in Jersey crossbred cows. The corresponding mean for Holstein-Frisian crossbred cows was 305.88, 99.80, 404.26, 127.03 and 1127.24 days and 2908.31 liters, respectively. The effect of season of calving was highly significant on lactation length, lactation milk yield, calving interval and service period and non- significant on dry period. Mean lactation milk yield was 2798.24±98.96, 2474.04±115.78, 2451.96±117.76 and 2505.86±82.32 liters; lactation length was 281.82 ± 4.25, 299.23 ± 3.52, 314.51 ± 3.68 and 291.51 ± 4.95; dry period was 90.95±3.82, 101.12±2.98, 101.95±3.17 and 98.38±4.02; calving interval was 372.77±4.05, 400.36±3.89, 416.46±3.54 and 389.89±4.67; service period was 88.93±4.17, 122.32±4.43, 140.94±3.47 and 111.08±4.80 and age at first calving was 912.12±26.24, 1200.53±39.20, 1270.85±43.71 and 917.30±32.65 days, during S1, S2, S3 and S4, respectively in crossbred cows. The effect of season of birth was highly significant on age at first calving. The effect of period was observed to be significant for lactation length and calving interval while it was non- significant for lactation milk yield, dry period, service period and age at first calving. Out of total 577 incidence of

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diseases there was 10.22, 11.26, 11.95, 12.99, 4.5, 17.5, 13.69, 7.62 and 10.22 per cent of respiratory diseases, reproductive diseases, GIT infection, non specific fever & diseases, abscess, lameness & wounds, parasitic infestation, metabolic disease and mastitis, respectively in crossbred cows during the study period. Incidence of disease was found to be apparently less in Jersey crossbred compared to Holstein-Friesian crossbred cows. Chi-square test revealed that there was significantly highest incidence of diseases during monsoon season than other seasons. In regards to period higher incidence of diseases was observed during the first period.

The performance of Jersey crossbred cows was better in respect of reproductive traits with less incidence of diseases, where as the performance of Holstein-Friesian crossbred cows was better in respect of production traits. The overall performance of crossbred cows was better during pre-monsoon (S1) season in the present study.

## **Effect of Supplementing Garlic Powder on the Performance of the Sahiwal Calves**

*Zara Kaku Sorang*

The present experiment was conducted to investigate the effect of supplementing garlic powder on the performance of Sahiwal calves. Twelve healthy Sahiwal calves of both sexes of similar age and body weight were allocated to two experimental groups, control (T0) and treatment (T1) with six animals in each group. Calves of both groups were fed with a standard basal diet consisting of concentrate, green fodder, and paddy straw. While in the treatment group, garlic powder was supplemented @ 250 mg/kg body weight along with concentrate feed. The experiment was conducted as a feeding trial for eight fortnights and a digestibility trial thereafter for five days in the two experimental groups.

The average initial and final body weights in the 8th fortnight of the calves were  $81.81 \pm 0.34$  and  $81.46 \pm 0.35$  kg and  $148.75 \pm 0.40$  and  $153.84 \pm 0.38$  kg respectively in T0 and T1 groups. Analysis of the variance of the data revealed a highly significant difference ( $P < 0.01$ ) in average body weight in the control (T0) and treatment (T1) groups.

The overall fortnightly body weight gain was significantly higher ( $P < 0.01$ ) in the treatment group ( $603 \pm 17.00$  g) than in the control group ( $558 \pm 17.00$  g) of calves. The fortnightly body weight gain was higher ( $P < 0.01$ ) in the treatment group than in the control group from the 1st to 8th fortnight.

The overall average daily DM intake was  $2.98 \pm 0.06$  kg in the control group (T0) and  $2.97 \pm 0.07$  kg in the treatment group (T1). Feeding of garlic powder in treatment (T1) had no significant effect on dry matter intake all fortnights. Also, analysis of variance results revealed no significant ( $P > 0.05$ ) difference between the average values of DM intake between control (T0) and treatment (T1) groups.

The average FCR values were  $6.10 \pm 0.07$  and  $5.26 \pm 0.08$  in 1st fortnight  $4.88 \pm 0.05$  and  $4.73 \pm 0.06$  in the 8th fortnight in control (T0) and treatment (T1) groups respectively. On an overall basis, FCR values were  $5.42 \pm 0.06$  and  $4.96 \pm 0.04$  respectively in the control (T0) and treatment (T1) groups. Analysis of variance revealed that there was a highly significant ( $P < 0.01$ ) effect of supplementation of garlic powder

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on the feed conversion ratio (FCR) of the experimental animals. Further, the C.D. test revealed that the FCR in the treatment (T1) group was significantly reduced from the 2nd fortnight to the 8th fortnight compared to the control (T0) group.

The overall mean values of the conformation traits in the control group (T0) and treatment group (T1) groups respectively were: 74.53±2.12 and 79.31±2.41 cm for body length; 86.40±1.74 and 90.80±1.91 cm for chest girth as well as 78.22±2.00 and 82.18±2.10 cm for height at wither. All the conformation traits revealed a highly positive correlation with body weight. Analysis of variance of conformation traits showed highly significant ( $P<0.01$ ) difference between the control (T0) and treatment (T1) groups respectively.

The overall mean values of the physiological parameters in the T0 and T1 groups respectively were as: respiration rate, 28.61±0.21 and 28.79±0.14 breath per minute; pulse rate, 72.20±0.07 and 72.20±0.07 beats per minute and rectal temperature, 101.36±0.04 and 101.30±0.03 °F. Analysis of the variance of the data revealed no significant ( $P>0.05$ ) difference in respect of the three parameters between the control (T0) and treatment (T1) groups.

The blood biochemical and hematological parameters like. serum glucose, serum total protein, RBC and hemoglobin were within the normal range for Sahiwal calves in both the control and treatment groups. Serum glucose data did not reveal any significant difference ( $P>0.05$ ). while serum total protein, RBC and Hemoglobin showed highly significant ( $P<0.01$ ) difference between control and treatment group. The average digestibility coefficient (%) in T0 and T1 groups respectively were: 67.73±0.12 and 73.41±0.14 for dry matter (DM); 71.08±0.2 and 76.28±0.14 for organic matter (OM); 66.73±0.25 and 71.76±0.14 for crude protein (CP); 66.50±0.17 and 72.69±0.08 for ether extract (EE); 63.97±0.27 and 72.37±0.18 for crude fibre (CF) and 73.40 ±1.06 and 79.26±0.73 for nitrogen-free extract (NFE). Analysis of the data revealed significantly ( $P<0.01$ ) higher digestibility of the organic nutrients in garlic powder supplemented treatment (T1) group than control (T0) group. The economic analysis of the cost of feeding the experimental calves revealed the following: total DM consumption per calf was 357.19 and 356.02 kg, cost of per kg feed (DM) was Rs. 15.42 and 15.42, and the cost of feed per group was Rs. 5532.87 and 5489.90, the total cost of garlic powder Rs. 0.00 and Rs. 300, the net cost of feed per day per calf was Rs. 5532.87 and Rs. 5789.90, net feed cost per day per calf Rs. 46.12 and 48.25, weight gain per calf was 30.00 and 32.65 kg, and finally cost of feeding per kg gain was Rs. 184.42 and 177.33 in control (T0) and treatment (T1) respectively. From the results, it was observed that the total cost of feeding was a little higher in the treatment group than in the control group. However, the total body weight gain was higher in the treatment group (T1) than in the control group (T0) which resulted in a lower cost of feeding per kg weight gain in the treatment than in the control group. The present study revealed that the supplementation of garlic powder at dosage of 250 mg/kg body weight in the Sahiwal calf ration is beneficial in terms of body weight gain, feed conversion ratio,

body confirmation traits, hematological parameters, blood biochemicals , digestibility coefficient (%) and economic of feeding.



## **Effects of Split-Weaning on the Performance and Behavioural Traits of Hampshire Piglets**

*Arunima Kalita*

An investigation was carried out under the Department of Livestock Production and Management, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati-22 during the period from September 2018 to February 2019.

Forty eight piglets of Hampshire pig of three weaning age groups from six sows, considering an average litter size of 8 were selected for the experiment and each group consisted with sixteen numbers of piglets. Two groups (Group I and II) were split weaned at 28<sup>th</sup> and 35<sup>th</sup> days of age where 50 per cent of higher body weight piglets of the litter were separated and rest 50 per cent were kept with mother up to 56 days of conventional weaning. Another litter was weaned as conventional weaning age, 56 days (Group III). After weaning, the piglets were reared up to 75 days for studying of post weaning effect. Common conventional feed was provided to all the groups as per NRC (1998).

The average split weaning body weight gain and total body weight of piglets weaned at 35 days of age (Group II) was found significantly higher followed by the piglets weaned at 56 days of age (Group III) and lower in piglets weaned at 28 days of age (Group I) while, the corresponding results also observed in the three experimental groups of piglets from birth to post weaning period till 75 days in respect to the average daily, total and final body weight gain. In regards to the average total feed consumption, feed consumption by per piglet, feed consumption by per piglet per day and total feed consumed till end of the experiment period was more or less equal; however the feed conversion efficiency was found to be comparatively higher in Group II than Group I and III.

From the study, the effect of behavioural traits *i.e.* playing, feeding, water intake, sleeping, huddling and suckling in the three split weaning groups found to be Group II was performed well in time spending on playing, water intake, sleeping and suckling except feeding and huddling, whereas Group I was showed maximum time spent for feeding and huddling and Group II showed in between the two groups.

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Overall, it might be opined from the present investigation that split weaning could be carried out at 35 days old pigs for better performances and better behaviour after weaning.

## **Performance of Pre-Weaning Hampshire Piglets Reared on Rubber Mat Floor**

*Ibasani Sawian*

An investigation was conducted to see the performance of pre-weaning Hampshire piglets reared on rubber mat floor. Thirty six newborn piglets were divided into two groups of eighteen each and were randomly assigned to two floor treatments viz. concrete (Group I) and rubber mat (Group II). The final body weight at 8<sup>th</sup> week for the piglets on rubber mat and concrete floor was  $9.97 \pm 0.06$  kg and  $9.53 \pm 0.20$  kg respectively and the value being significantly ( $P < 0.05$ ) higher in Group II.

The average weekly gain at 8<sup>th</sup> week in Group II was  $1.56 \pm 0.01$  kg which was significantly ( $P < 0.01$ ) higher than Group I piglets which showed an average weekly gain value of  $1.40 \pm 0.01$  kg. The total body weight gains recorded for Group I and Group II piglets were  $8.36 \pm 0.16$  kg and  $8.78 \pm 0.06$  kg respectively. Average daily gains (ADG) were recorded as  $0.149 \pm 0.003$  kg and  $0.157 \pm 0.001$  kg for Group I and Group II respectively. The total and daily body weight gains appeared to be significantly ( $P < 0.05$ ) higher in piglets housed on rubber mat floor. This puts forward that rubber mat floors had a positive influence on the body weight gains of the piglets.

The total feed intake by the piglets of Group I and Group II were recorded as 87.43 kg and 87.95 kg respectively, the weekly average feed intake for Group I and Group II was 14.57 kg and 14.66 kg respectively whereas the daily average intake was 2.08 kg and 2.09 kg respectively. Feed intake of the piglets did not exhibit any variation in respect to the floor type. The diarrhoea incidence rate was recorded as 9.79% in Group I which was higher than that of Group II piglets with a value of 5.88%.

The overall prevalence of sole bruising, sole erosion, limb abrasion, foot and limb swelling in Group I piglets was 23.61%, 28.47%, 29.17%, and 5.56% respectively. The corresponding values for Group II piglets were 21.53%, 11.81%, 8.33%, and 0.69% respectively. The piglets of Group II had lower severity and prevalence of foot and limb injuries that those of Group I piglets. The prevalence of alopecia was 67.37% and 80.55% in Group I and Group II respectively. Piglets exhibiting limb abrasion will not show alopecia in the same location and the abrasive nature of the concrete floor will

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rapidly replace alopecia into abrasion. Hence alopecia was observed more in piglets kept on rubber mat than those on concrete floor. No coronary band injuries and piglet mortality could be observed during the experimental period in both the groups.

# **Physicochemical and Microbiological Quality of Drinking Water for Livestock Under Organized and Unorganized Sectors in the Brahmaputra Valley of Assam**

*Jiaur Rahman*

A study was conducted to identify the sources, assess the physicochemical and microbiological quality of drinking water for livestock under organized and unorganized sectors in the Brahmaputra valley of Assam. Five different agro-climatic zones of the valley were selected and one district was selected from each zone on the basis of livestock population. The study was carried out during the period of November 2018 and February 2019. A total of 60 samples were collected both from organized and unorganized sectors (farms). The sources were identified as well, tube well, bore well, pond and river in both the sectors. The physical as well as chemical parameters were studied using JalTara water testing kits and pH and turbidity were measured with the help of digital pH meter and digital turbidity meter respectively. The most widely used drinking water source in the study area was bore well. The physical parameters viz., colour, temperature and turbidity were within the IS 10500: 2004 and WHO (2011) permissible limit. The temperature of the water samples ranged from 16.15 to 18.88 °C. The chemical parameters viz., pH, TDS, total hardness, sulfate, arsenic, fluoride, chloride and nitrate were below the permissible limit except iron which was above the permissible limit (0.3mg/l). The iron content in Kamrup (R) and Nagaon ranged from 0.85 to 0.90 mg/l and 0.95 to 0.90 mg/l respectively and were highest among all the selected districts. The lowest iron content was found in Karbi Anglong district with a value of 0.33-0.41 mg/l. Out of sixty samples, seven samples from pond, river and bore well sources were found positive for coliform organism both in organized and unorganized farms.

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## **Effect of Dietary Supplementation of Satomul (*Asparagus racemosus*) on Certain Production Performances of Crossbred Dairy Cows**

*Parteek Kumar Khera*

An experiment of dietary supplementation of Satomul (*Asparagus racemosus*) powder in crossbred dairy cows was carried out to study its effect on their DM intake, feed eating time, milk yield and its composition, sensory evaluation of curd (dahi) and paneer, cost and return of milk production, body weight and body condition. There were two groups, Control (T0) and Treatment (T1) with 6 cows in each group. Cows of both the groups were fed standard diet consisted of concentrate, green fodder and paddy straw with supplementation of satomul @ 100 gm daily in the treatment group. The feeding trial was conducted for 6 weeks time. The overall daily DM intake were  $9.11 \pm 0.12$  kg in control and  $9.68 \pm 0.17$  kg in treatment group (Table 4.1). The result revealed that the Satomul fed treatment group, on average, consumed significantly higher ( $p < 0.01$ ) dry matter than the non-supplemented control group. The DM intake of the cows of the Satomul supplemented increased gradually from Day-1 onward and were higher than the corresponding DM intake value in each week with significant difference ( $p < 0.01$ ) from Day-14 to Day-42 (Table 4.2). The overall values of feed eating time (Table 4.3) were  $260.26 \pm 0.79$  minutes in control and  $257.64 \pm 0.89$  minutes in the treatment group daily. Analysis of variance (Table 4.4) revealed that cows of the Satomul fed treatment group consumed the feeds in significantly ( $p < 0.01$ ) less time than the control group. The cows of the Satomul fed treatment group produced significantly ( $p < 0.01$ ) higher average milk (Table 4.5) with  $8.74 \pm 0.16$  litres than with  $7.72 \pm 0.11$  litres in the control group. The average per day milk yield of cows in the Satomul fed treatment group was significantly higher ( $p < 0.01$ ) (Table 4.6) than the control group from day-1 till end of experiment at day-42. The different compositions of milk (Table 4.7) in the control and treatment groups respectively on overall basis were as: fat  $4.32 \pm 0.11\%$  and  $4.99 \pm 0.09\%$ , solids-not fat (SNF)  $8.89 \pm 0.06\%$  and  $8.93 \pm 0.07\%$ , protein  $3.41 \pm 0.03\%$  and  $3.54 \pm 0.05\%$ , lactose  $4.67 \pm 0.04\%$  and  $4.68 \pm 0.05\%$  and total solids (TS)

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13.21±0.14% and 13.92±0.12% . Results of analysis of variance (Table 4.8) revealed that treatment had significant effect ( $p < 0.01$ ) on fat % ( $p < 0.01$ ), protein% ( $p < 0.05$ ) and total solids % while SNF, lactose and acidity percentages were not affected significantly. The average sensory scores of the different organoleptic evaluations of curd (dahi) and paneer samples have been presented in Table 4.9. The results revealed that the average values of curd samples were slightly higher in respect of all attributes e.g., appearance, colour, body and texture, flavor, taste and overall acceptability in treatment group as compared to control group. In the case of paneer also, similar higher values of the sensory attributes were observed in the treatment group in respect of appearance, colour, body and texture, and overall acceptability while values in respect of flavor and taste did not change in both the groups. The result of average feed cost and return from milk production (Table 4.10) revealed that the average daily feed cost in the control group was Rs. 111.03 while it was found to be Rs. 123.31 feed cost plus cost of Rs. 30 for 100 gm. Satomul supplement totaling to Rs. 153.31 in the treatment group. The feed cost per litre of milk (feed cost ÷ average milk yield) were Rs. 14.38 and Rs. 17.54 in control and treatment group respectively. The daily money receipt per cow from sale of milk @ Rs. 50/litre (milk yield x sale price of milk) were Rs. 386.00 and 437.00 in control and treatment group respectively generating a gross return of Rs. 51/- over the control while corresponding income after deduction of their feed costs were found to be Rs. 274.99 and Rs. 283.70. The margin receipt in the treatment group over the control were Rs. 8.71 with 3.17% increment in margin receipt over control. The results shown in the table 4.11 revealed the body weight of the cows in control and treatment group respectively were 301.65±11.71 kg and 301.72±12.38 kg at day-1, 302.14±11.99 kg and 303.97±12.08 kg at day-14, 302.85±11.94 kg and 304.45±11.92 kg at day-28 and finally 303.21±11.89 kg and 306.89±11.42 kg at day-42. Analysis of variance test (Table 4.12) revealed that treatment with dietary supplementation of Satomul had no significant effect on average body weight of the cows. However, body weight increased linearly with the days in the treatment group. The overall body condition scores were 3.41±0.05 and 3.51±0.07 in the control and treatment group (Table 4.13) respectively and analysis of variance result (Table 4.14) revealed that dietary supplementation of Satomul had significant effect ( $p < 0.05$ ) on average body condition score of the experimental cows.

## Performance of Crossbred Cows under Farm Conditions

*Venus Das*

The present study was carried out to evaluate the performance of crossbred cows under organized farm condition. Total 260 numbers of complete lactation record, 115 records of age at first calving and 577 cases incidence of disease was collected from Instructional Livestock Farm (cattle) of College of Veterinary Science, Khanapara, Guwahati-781022 during the period from 2007-2017. The data were classified according to genetic group *viz.* Jersey crossbred (G1) and Holstein-Friesian (G2) crossbred cows; seasons *viz.* Pre monsoon (S1), Monsoon (S2), Post monsoon (S3) and Winter (S4) and periods *viz.* period one (P1) (2007-2012) and period two (P2) (2012-2017). Overall mean lactation length, drying period, calving interval, service period, age at first calving of Jersey cross was found to be  $299.99 \pm 2.13$ ,  $99.15 \pm 1.72$ ,  $399.14 \pm 2.22$ ,  $120.81 \pm 2.39$  and  $1079.53 \pm 23.33$  days, respectively and lactation milk yield was  $2589.57 \pm 51.73$  liters. The effect of genetic group was highly significant on all the traits except dry period. The mean lactation length, dry period, calving interval, service period and age at first calving was found to be 294.95, 98.38, 394.75, 115.4 and 1017.50 days, respectively and lactation milk yield was 2316.36 liters in Jersey crossbred cows. The corresponding mean for Holstein-Friesian crossbred cows was 305.88, 99.80, 404.26, 127.03 and 1127.24 days and 2908.31 liters, respectively. The effect of season of calving was highly significant on lactation length, lactation milk yield, calving interval and service period and non- significant on dry period. Mean lactation milk yield was  $2798.24 \pm 98.96$ ,  $2474.04 \pm 115.78$ ,  $2451.96 \pm 117.76$  and  $2505.86 \pm 82.32$  liters; lactation length was  $281.82 \pm 4.25$ ,  $299.23 \pm 3.52$ ,  $314.51 \pm 3.68$  and  $291.51 \pm 4.95$ ; dry period was  $90.95 \pm 3.82$ ,  $101.12 \pm 2.98$ ,  $101.95 \pm 3.17$  and  $98.38 \pm 4.02$ ; calving interval was  $372.77 \pm 4.05$ ,  $400.36 \pm 3.89$ ,  $416.46 \pm 3.54$  and  $389.89 \pm 4.67$ ; service period was  $88.93 \pm 4.17$ ,  $122.32 \pm 4.43$ ,  $140.94 \pm 3.47$  and  $111.08 \pm 4.80$  and age at first calving was  $912.12 \pm 26.24$ ,  $1200.53 \pm 39.20$ ,  $1270.85 \pm 43.71$  and  $917.30 \pm 32.65$  days, during S1, S2, S3 and S4, respectively in crossbred cows. The effect of season of birth was highly significant on age at first calving. The effect of period was observed to be significant for

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lactation length and calving interval while it was non- significant for lactation milk yield, dry period, service period and age at first calving. Out of total 577 incidence of diseases there was 10.22, 11.26, 11.95, 12.99, 4.5, 17.5, 13.69,7.62 and 10.22 per cent of respiratory diseases, reproductive diseases, GIT infection, non specific fever & diseases, abscess, lameness & wounds, parasitic infestation, metabolic disease and mastitis, respectively in crossbred cows during the study period. Incidence of disease was found to be apparently less in Jersey crossbred compared to Holstein-Friesian crossbred cows. Chi-square test revealed that there was significantly highest incidence of diseases during monsoon season than other seasons. In regards to period higher incidence of diseases was observed during the first period.

The performance of Jersey crossbred cows was better in respect of reproductive traits with less incidence of diseases, where as the performance of Holstein-Friesian crossbred cows was better in respect of production traits. The overall performance of crossbred cows was better during pre-monsoon (S1) season in the present study.

## **Carcass and Meat Quality Characteristics of *Kamrupa* Chicken**

*Jameel Ahmad*

Kamrupa is a new variety of chicken developed after crossing three different types of local strains i.e. Assam local, coloured broiler (PB-2) and Dahlem red in the All India Co-ordinated Research Project on Poultry breeding, C.V.Sc, AAU, Khanapara . The new variety of chicken is becoming popular among the rural people of Assam. Many farmers have adopted this chicken as backyard poultry for their regular livelihood generation. Since 'Kamrupa' is a dual purpose variety, certain information like carcass and meat quality of the chicken are important for the farmers and the consumers as well as the information on these is very scanty. It is imperative to gather data on carcass and meat qualities of the new chicken if commercial venture on production, processing and marketing of meat is chosen.

Keeping in view the above facts, the proposed study was undertaken to generate data on various parameters related to carcass and meat qualities of Kamrupa chicken. It was also envisaged in the study to gather information on generation of different by-products after slaughter of the birds and shelf life of the meat at chilling temperature.

Under carcass traits, pre-slaughter body weight, carcass weight, dressing percentage, meat bone ratio, wholesale cuts and yield of by-products were taken into consideration while under meat quality traits physico-chemical qualities, muscle fibre diameter, shear force value, textural qualities, colour analysis, microbial quality, sensory properties and shelf life of meat of two age groups (12 and 54 weeks) and both the sexes (total 20 no of birds) were covered in this study. The carcass of 54 weeks of Kamrupa chicken had shown comparatively better results for most of the carcass traits when comparison was made with the carcasses of 12 weeks of age. With respect to yield of wholesale cuts the breast cut was found to be heaviest and the neck cut was the lightest. Body weight and carcass weight influenced the yield of both the edible (giblet) and inedible by-products and thus, birds of 54 weeks age group gave higher yields.

Physico-chemical qualities of meat samples indicated inconsistent and conflicting results. Meat from 54 weeks of age had shown a higher shear force value and larger

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muscle fibre diameter but not much variation between the two age groups and sexes were observed in other traits like pH, WHC and ERV. Lipolysis was seen to be very quick as TBARS values exceeded the acceptable limit on 5<sup>th</sup> day of storage. Muscles of higher age group revealed higher crude protein, fat and ash content, while moisture content, drip losses and cooking losses were found to be lower in this group. All textural characteristics exhibited higher values in 54 weeks of birds in both the sexes. Colour analysis of muscle revealed a lighter colour in male birds of 12 weeks age group while redness and yellowness were seen to be brighter in 54 weeks of birds. Sensory qualities of the meat of both the age groups and sexes were found to be similar as no significant differences were observed.

High initial microbial loads were recorded for mesophilic, psychrophilic, yeast and mould counts and Coliform counts. Speedy growth was observed for all the microorganisms during the storage period. Shelf life of the stored meat samples at  $4\pm 1^{\circ}\text{C}$  was less than 5 days. Considering overall quality performances, chicken of 54 weeks age group may be considered better than 12 weeks of age group.

## **Effects of Starter Culture and Types of Bamboo on Quality Attributes of *Banhor Chunga Doi***

*Sumi Roy*

A study was undertaken to elucidate the effects of starter culture and bamboo types on quality attributes of *Banhor Chunga Doi*. The study was carried out in the Department of Livestock Products Technology and the All India Coordinated Research Project on Post Harvest Engineering and Technology, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati -781022 during the period from August, 2018 to February, 2019.

Yoghurt culture NCDC 144 obtained from the National Dairy Research Institute, Karnal was used @ 1.5% (v/v) in the study.

pH and lactic acid content, proximate composition, microbiological and sensory qualities and shelf-life of the product at room temperature were analysed to ascertain the effects of starter culture and bamboo types on the quality attributes of *Banhor Chunga Doi*.

Amongst the 4 treatment groups, the samples of B (JB) i.e., *Banhor Chunga Doi* prepared from boiled and cooled buffalo milk and stored in tubes of *Jati* bamboo at room temperature for 5d showed the highest pH value of  $4.01 \pm 0.011$  with a corresponding least lactic acid content of  $1.21 \pm 0.005\%$ .

The *Banhor Chunga Doi* of the treatment group B (JB) was found to contain highest fat of  $4.50\% \pm 0.883$ . The samples of C (JMB) contained the highest quantity of protein at  $5.914\% \pm 0.52$  while the sample of the *Banhor Chunga Doi* of the starter culture added treatment group SC (JB) was found to contain highest moisture and the least total solids and total ash contents.

Amongst the 2 control and 4 treatment groups, the highest mean TVC of  $8.69 \log_{10} \text{cfu/g} \pm 0.001$  was enumerated in the samples of SC (JB) which might be due to the addition of the starter culture at the dose level of approximately  $6.86 \log_{10} \text{cfu/g}$  in the beginning of the production process. The starter culture added samples [SC (JB) and SC (JMB)] showed an increasing TVC up to 3<sup>rd</sup> day of storage. Thereafter, the TVC of

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these samples decreased on 5<sup>th</sup> day. The lowest mean TVC of  $4.38 \pm 0.003 \log_{10} \text{cfu/g}$  was noted in the samples of B (JMB) which is due to the thermal destruction of the contaminating microbes during boiling of the milk sample. The samples of the buffalo milk *Banhor Chunga Doi* that were not inoculated with the starter culture exhibited an increasing TVC from 1<sup>st</sup> to the 5<sup>th</sup> d of storage at room temperature. Over the storage period, none of the *Banhor Chunga Doi* samples either from the control or the treatment groups were found to possess coliform organisms, *Escherichia coli*, *Salmonella*, *Shigella*, *Staphylococcus aureus*, yeast and moulds and anaerobic spores.

Yield of the *Banhor Chunga Doi*, calculated as the weight of the curd after draining out the whey over the total volume of buffalo milk poured into the bamboo tubes, was found to be highest in samples of the treatment group SC (JB) at 96.94% while the lowest yield of 94.64% was recorded in samples of B (JB).

Amongst the treatment groups, *Banhor Chunga Doi* of the treatment group SC (JB) enjoyed the highest panel ratings for appearance, colour, body and texture, flavour, taste and overall acceptability.

The results of the present study lead us to draw the following conclusions:

1. Good quality buffalo milk curd can be prepared by using tubes of *Jati* and *Jatie makal* bamboos.
2. The ITK on use of both *Jati* and *Jatie makal* bamboo tubes in preparation of *Banhor Chunga Doi* is validated. Boiling and cooling of the buffalo milk and addition of starter culture @1.5% (v/v) prior to filling in bamboo tubes add value to the finished product in terms of superior physico-chemical, microbiological and sensory properties.
3. Buffalo milk *Banhor Chunga Doi* had a shelf-life of 5d at room temperature.
4. *Jati* bamboo tubes are found to be better than the *Jatie makal* bamboo tubes in terms of sensory properties and per cent yield of buffalo milk *Banhor Chunga Doi*.
5. *Jati* bamboo tubes are found to be better than the *Jatie makal* bamboo tubes in terms of sensory properties and per cent yield of buffalo milk *Banhor Chunga Doi*. Cost of production of buffalo milk *Banhor Chunga Doi* using *Jati* bamboo tube is less by Rs. 7.00 as compared to *Jatie makal* Bamboo tubes.

Suggestion:

Since non-availability of suitable commercial yoghurt culture in the region is a hindrance in transfer of the technology to the traditional producers of *Banhor Chunga Doi*, development of a repository of dairy starter cultures and commercial production of suitable yoghurt cultures in the region may be a boon to the traditional producers in production of uniform quality *Banhor Chunga Doi* with superior sensory, microbiological and safety indices.

# **Empowerment of Women Through Milk Cooperative Societies in Selected Districts of Assam**

*Banani Das*

Taking into consideration the issues of success and failure of milk cooperatives in the state of Assam and the ever debatable topic of women empowerment the present study on “Empowerment of Women through Milk Cooperative Societies in Selected Districts of Assam” was undertaken. Two districts of Assam i.e., Darrang and Barpeta were purposively selected for the study with the objectives to explore a) The socio-economic status of women involved in dairy cooperatives of two selected districts of Assam, b) To find out the extent of involvement of women in different activities of dairy cooperatives, c) To assess the areas of empowerment through milk cooperatives, d) To find out the constraints related to dairy cooperatives as perceived by the respondents. From the two selected districts two blocks, Pathorighat and Bajali, were selected and from these blocks two milk cooperative societies were considered for the current research work. From both the cooperatives 60 women dairy farmers were selected by random sampling making the total sample size 120. A pretested, reliable and valid interview schedule was used for data collection. The data collected were analysed using standard statistical methods. Majority of the women dairy farmers i.e. 57.50 per cent were in middle age category and the average age was found to be 36.8 years. 95.83 per cent of respondents were married while only 4.16 per cent were widow. Further, in Darrang district 83.33 per cent respondents and 51.66 per cent respondents in Barpeta district belonged to general caste. It was observed that 80.33 per cent women dairy farmers resided as nuclear family while 19.16 per cent as joint family. Majority of respondents in Darrang district i.e. 83.33 per cent had medium family size with 3-6 numbers of family members while in Barpeta 75.00 per cent had medium family size 3-6 numbers. It was found that in Darrang district 56.66 per cent respondents had medium level of educational qualification and in Barpeta district educational qualification of respondents was found to be 61.66 per cent which is of medium level. Majority of the respondents in both the districts Darrang and Barpeta had medium herd size i.e. 80.00

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per cent and 71.66 per cent, respectively. It was observed from the study that 51.66 per cent of respondents in Darrang district and 63.33 per cent in Barpeta district had medium social participation. Maximum number of respondent i.e., 56.66 per cent in Darrang district and in Barpeta district 45.00 per cent had medium extension contact. A fairly large number of respondents i.e., 68.33 per cent of both Darrang and Barpeta district had medium level of mass media exposure. In case of Darrang district 86.66 per cent of respondent had medium level of daily milk contribution to the cooperative with 15-64 litres while in Barpeta the corresponding figure was 58.33 litres. It was observed that in Darrang district majority i.e., 78.33 per cent had medium land holding and in Barpeta district 70.00 per cent of respondent had medium land holding. 100.00 per cent respondents in Darrang district had medium annual income from dairying and in Barpeta district 55.00 per cent had medium income. It was found that in Darrang district 68.33 per cent of respondent had medium annual income from other sources while 51.66 per cent of respondents had medium income. The study depicted that in Darrang district 100 per cent respondents had medium total annual income of while in Barpeta district 56.66 per cent of respondent had medium level of total annual income. In Darrang district maximum number of respondents i.e., 71.66 per cent were in the medium category while 28.33 per cent were in high category of extent of involvement of women in different activities of dairy cooperatives. In case of Barpeta district majority of respondents i.e., 66.66 per cent were in medium level and 33.33 per cent in low level of involvement in dairying activity. The mean difference of the two districts was found to be highly significant ( $t=13.505^{**}$ ,  $p<0.01$ ). Majority of respondents in Darrang district i.e., 58.33 per cent had medium level of empowerment while 41.66 per cent had high level of empowerment. The mean value was 239.20 with standard deviation 10.79 and range 213-256. Among the respondents in Barpeta district majority of respondents i.e., 63.33 per cent had medium level of empowerment while 36.66 per cent had high level of empowerment. The mean difference of the two districts was found to be highly significant ( $t=10.658^{**}$ ,  $p<0.01$ ). In correlational analysis 3 independent variables *viz.* educational qualification land holding and annual income from other sources had positive and highly significant correlation with extent of involvement of women in different activities of dairy cooperatives and milk yield had negative and significant correlation in Darrang district. In Barpeta district educational qualification and land holding had negative and significant correlation with the dependent variable. Independent variables like age, land holding and annual income from other sources had positive and highly significant correlation with areas of empowerment through milk cooperatives while mass media exposure had negative and significant correlation and herd size had negative and highly significant correlation with areas of empowerment through milk cooperatives in Darrang district while none of the independent variable had significant correlation with the dependent variable in Barpeta district. In multiple regression analysis the co-efficient of multiple determination ( $R^2$ ) with 12 independent variables under study could explain 61.20 and 25.1 per cent variation in extent of

involvement of women in different activities of dairy cooperatives in districts of Darrang and Barpeta. The co-efficient of multiple determination ( $R^2$ ) revealed that the 12 independent variables under study could elucidate 47.70 per cent variation in areas of empowerment through milk cooperatives in Darrang district. It was found that as per the preferential ranking of constraint based upon Mean Rank Based Quotient (R.B.Q) "Lack of land for fodder cultivation" was ranked first among all the constraints faced by the women dairy farmers of Pathorighat Dugdha Utpadak Samiti followed by "High feed cost", "Lack of emergency health services". The rank correlation coefficient in Darrang district was found to be 0.731 which was highly significant at 0.01% level of significance. It was observed that as per the preferential ranking of constraint based upon Mean Rank Based Quotient (R.B.Q) "Lack of land for fodder cultivation" was ranked the most important constraint followed by "Lack of technical knowledge for management", "Lack of training in dairy". The rank correlation coefficient of respondents in Barpeta district was found to be 0.864 which was highly significant.



## **Empowerment of Women of Selected Tribes in Tripura Through Livestock Enterprises**

*Keshab Jamatia*

An investigation was undertaken to study the empowerment of women of selected tribes in Tripura through livestock enterprises. Two major tribes namely Deb Barma and Jamatia were selected from among the nineteen tribes that inhabit in Tripura and from each of the two tribes 100 respondents were selected by snow ball sampling technique from the purposively selected two districts namely Sepahijala and Gomati to make the sample size 200. The sole criterion of the respondent was that she should have atleast two pigs or two goats or ten poultry or one cattle. The data were collected by the researcher personally by using a pre-tested valid and reliable interview schedule which consisted of five parts:- first part dealt with socio-personal, economic and psychological traits of the respondents, second part assessed the gender participation of tribal people in livestock enterprises, third part was meant for measuring the empowerment level, fourth part was used to find out the constraints perceived by respondents in livestock enterprises and the last part was made in identifying and documenting the indigenous technical knowledge practised by the tribal people of Tripura in livestock enterprises. The data thus collected were subjected to statistical analysis like percentage, frequency, mean, SD, t-test, correlation and regression. The research study revealed that in pooled data majority (64.00 per cent) of the respondents from both the tribes belonged to middle (29-47 yrs.) age category and had nuclear families (68.50 per cent) with family size ranging from 3-6 members. Majority of the respondents had read upto high school level (33.00 per cent) with medium level in the traits like social participation (48.00 per cent), land holding (0.98-2.81 acre), herd size (0.195-2.864 nos.), experience in livestock farming (4-22 yrs.), mass media exposure (84.50 per cent), extension contact (79.00 per cent), entrepreneurship behaviour (75.00 per cent) and liking of information source (83.50 per cent). On the other hand, most of the respondents had neutral attitude towards improved livestock farming (77.50 per cent) with medium level of participation in livestock enterprises (74.50 per cent) and spent an average time of 1.94 hours daily in livestock enterprises. In respect of their occupation majority of the respondents were

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involved in agriculture along with animal husbandry and self-employment (28.00 per cent) with an average annual earning of Rs. 31,993.50 from livestock and poultry, Rs.1, 56,507.00 from sources other than livestock and poultry and average of Rs.1, 88,684.50 from all the sources. Most of the respondents performed alone in livestock related activities like collection of eggs, preparation of feed for animals, feeding and watering of birds, feeding and watering of animals, cleaning of animal shed, maintenance of bird shed, care of sick animals, care of new born animals, care of health condition of animals, bathing of animals and milking of animals. They also performed jointly the activities like selling of animal at market age, maintenance of animal shed, collection of fodder and grazing of animals and had medium level of participation in livestock enterprises (74.50 per cent). Majority of the respondents had medium level of perceived overall empowerment and in this regard their appeared no significant difference between the two tribes. Out of sixteen independent variables only five showed highly significant positive relationship with overall empowerment level. Similarly, out of seventeen variables only five variables had significant contributing effect on variation of empowerment level and the coefficient of determination was 4.66 which indicated that only 46.60 per cent variation could be explained by these variables. The significant F value (9.968) indicated that these five variables were good predictors of empowerment level. While assessing the constraints as many as 12 constraints were identified through R.B.Q. technique, where the perceived constraints “non-availability of grazing land due to rubber plantation” was ranked 1st by Deb Barma respondents and “feed and feed related problems like less availability of feed and improper growth even after proper feeding” was ranked 1st by Jamatia respondents. In respect of indigenous technical knowledge practised by the tribal people in Tripura a total of 24 medicinal plants (14 herbs, 5 shrubs and 5 trees) used in treating and feeding animals and 3 mixtures were identified and documented properly with the help of local healers and some respondents.

# **Prevalence of Newcastle Disease Virus in Backyard and Commercial Poultry in Assam**

*Pubaleem Deka*

Newcastle disease (ND) is a highly contagious and economically important viral disease of poultry. This study was undertaken to have a detailed study of the prevalence of ND and to characterize the circulating Newcastle disease virus (NDV) alongwith some epidemiological studies. A seroprevalence study was conducted in 18 districts of Assam, where a total of 925 sera samples from 231 unvaccinated backyard poultry flocks were collected and subjected to haemagglutination test (HI) test to determine the level of antibodies against NDV. An overall seroprevalence was recorded to be 23.89%. Agewise seroprevalence revealed that the adult birds >12 months of age had higher antibody titre. A total of 274 tissue samples and 158 cloacal swabs were collected and subjected to HI and RT-PCR targeting *F* gene. NDV could be detected in 61.68% tissue samples. Subsequently, NDV was also detected from 22.15% cloacal swabs from clinically affected vaccinated birds providing evidence of shedding of the virus despite of vaccination. Representative samples were sequenced and subjected to phylogenetic analysis. A phylogenetic tree was constructed which revealed that the sequences clustered with Genotype XIII in Class II. Molecular pathotyping which comprised of F protein cleavage site analysis revealed that all the seven isolates had amino acid sequences of 112RRKQRF117 revealing them to be of virulent type. Restriction mapping revealed the presence of cleavage site for *HhaI* restriction enzyme in the sequence confirming the sequences to be of mesogenic pathotype. Further, mean death time (MDT) of the present NDV isolates were between 76.0±2.69 to 87.6±1.00hours confirming them to be of mesogenic strain. A questionnaire survey was conducted to evaluate the risk factors for ND occurrence. The analysis showed that the factors like close proximity of nearby poultry farms (OR=30, 95% CI: 10.38-86.68, p<0.0001), frequent contact with wild birds (OR=16.92, 95% CI: 6.57-43.59, p<0.0001), floor space of the poultry house (OR=4.33, 95% CI: 1.96-9.59, p=0.003), usage of non-chlorinated drinking water (OR=10.68, 95% CI: 4.43- 25.70, p=<0.0001), seperation of diseased birds (OR= 2.64,

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CI: 1.13-6.17,  $p= 0.024$ ), awareness of biosecurity procedures (OR= 14.80, CI: 5.40-40.55,  $p= <0.0001$ ) and frequent entry of visitors (OR= 28.88, CI: 6.41- 130.11,  $p= <0.0001$ ) etc had significant association and higher risk of ND outbreak. The present study reveals that the ND is endemic in Assam state and the presently circulating genotype of NDV falls under genotype XIII. Further, risk factors related to biosecurity and farm practices appear to have a significant role in the occurrence of ND outbreaks.

# **Immune Response of Pigs Vaccinated with Classical Swine Fever (CSF) Diva Based Vaccine and Cell Culture Adapted Lapinized Vaccine**

*Nouluongunuo Suokhrie*

Classical swine fever is a highly contagious, haemorrhagic, and multisystemic viral disease affecting domestic pigs, wild hogs and pygmy hogs. It is an economically devastating disease and therefore control of the disease is of utmost importance. In endemic country like India including north Eastern States, vaccination is the best way to prevent and control the disease. Although live attenuated vaccines are available, protective immunity is obtained only after booster vaccination. Therefore, immune response can be enhanced with use of oil adjuvanted vaccines. A great disadvantage of live attenuated vaccine is its inability to differentiate infected with that of vaccinated populations. Therefore, CSF-DIVA based vaccine with a reliable companion diagnostic assay is highly desirable for successful implementation of control programme against CSF. In the present study, two groups of CSFV free pigs were immunized with Baculovirus expressed Erns-deleted CSF virus like particle (VLP) as vaccine as well as PK-15 cell culture adapted whole CSFV vaccine, both adjuvanted with montanide oil adjuvant. Potency of Erns deleted classical swine fever VLP-DIVA vaccine was first carried out with aluminium hydroxide as the adjuvant. Immune response was assayed by indirect ELISA and neutralizing assay. Vaccinated pigs elicited early antibody by 7<sup>th</sup> dpv ( $2.86 \pm 0.09$ ;  $2.10 \pm 0.15$ ) with peak antibody titre on 30th dpv ( $3.86 \pm 0.07$ ;  $3.51 \pm 0.10$ ) and maintained high antibody titre upto 180th dpv ( $2.91 \pm 0.06$ ;  $2.45 \pm 0.20$ ). Single montanide oil adjuvanted whole CSFV vaccine effectively stimulated neutralizing antibody with 90-95% inhibition titre. However, montanide oil adjuvanted CSF-VLP vaccinated group failed to elicit neutralizing antibody.

To develop DIVA based companion ELISA, CSFV Erns protein was expressed in PK-15 cell line. Cell lysate used as the coating antigen was optimized with the concentration of 5 µg/well and blocking buffer standardized with 5%LAH and 2% goat serum. The Erns ELISA could distinctly differentiate CSF-VLP-DIVA vaccinated

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animals from naturally infected CSFV as well as whole CSFV vaccinated animals. The present study highlights that oil adjuvanted whole CSFV vaccines was safe and elicited high neutralizing antibody titre with single vaccination till marketable age of pigs. Although oil adjuvanted CSF-VLP-DIVA vaccine elicited high ELISA titre, it failed to develop neutralizing antibody. Therefore, factors related to the development of neutralizing antibody in oil adjuvanted CSF-VLP-DIVA vaccine in pigs need to be explored further in details. As companion DIVA based ELISA, Erns coated protein could distinctly differentiate CSF-VLP-DIVA vaccinated animals from naturally infected CSFV as well as whole CSFV vaccinated pigs.

# **Isolation of Foot-and-Mouth Disease Virus Type ‘O’ of Bovine and Porcine Origin in Different Cell Lines and Molecular Characterization of the Adapted Virus**

*Ray Kayaga*

The aim of this study was to isolate Foot-and-mouth-disease virus type O from bovine and porcine origin in different cell lines and molecular characterization of the adapted virus after passaging. The study showed that, the virus clustered in a different group with a confident bootstrap value of 99%. The strains appeared to branch out as a topologically distinct group among the different topotypes, along with two other isolates from India and neighbouring countries. The strains when aligned with other Indian isolates showed distinct point mutations. Furthermore, the FMD strains showed 68 bootstrap confidences among themselves emphasizing on difference among isolates from different host. Following isolation and adaptation in different cell lines, the study reveals that BHK-21 cells are the most suitable cells for supporting maximum infectivity titer of FMD virus serotype ‘O’ followed by MDBK and PK-15 cell lines. Findings in the second objective of molecular characterization of the adapted virus showed that the sequence of VP1 gene remains the same in as many as five adapted virus in different cell lines. However, in this study there were single nucleotide point mutations observed among the adapted strains when compared with the parental strain. Furthermore, these point mutations did not cause any change in the amino acid pattern except for one change from tryptophan to isoleucine at amino acid residue number 74 in the bovine origin strain adapted in BHK21 cells after at 10th passages level. Such change from nonpolar to hydrophobic amino acids might result in conformational changes in the protein structure affecting its functionality. The study confirmed that the VP1 gene of FMD isolates were quite stable on cell adaptation.

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# **Attenuation and Molecular Characterization of Vero Cell Line Adapted Goatpox Virus Isolate From Assam**

*Shyama Prasad Panda*

Goatpox and Sheeppox are highly contagious, trans-boundary viral diseases of sheep and goats, clinically characterized by pyrexia, lacrimation, secondary bronchopneumonia with nasal discharges and generalized pox lesions with lymphadenopathy causing high mortality and morbidity. Diseases caused by CaPVs are economically important as they cause significant production losses due to high morbidity, reduced milk yield, decrease in weight gain, increase abortion and damage to wool and hides. Control of the disease can only be effective by mass vaccination of all susceptible sheep and goats by single vaccine through intradermal or subcutaneous route with OIE recommended safe dose of GTPV vaccine (102.5 TCID<sub>50</sub>). A variety of live and inactivated goatpox vaccines are being produced commercially. However, inactivated vaccines produce only short-term immunity. Live attenuated vaccine is the better choice for long term immunity against CaPVs. Therefore, in the present study one indigenous strain of goatpox virus was adapted and attenuated in Vero cell line and characterized molecularly. In the present study total nine local GTPV isolates, maintained in the Department of Microbiology, C.V.Sc, AAU, were revived in Vero cell line. Identity of the isolates were confirmed by virus specific cytopathic effects and molecularly by realtime PCR and PCR-RFLP. Among all the isolate GTPV/AsKa/14 was selected for attenuation, based on the degree of characteristic CPE and TCID<sub>50</sub> evaluated virus titer at passage 15 (i.e. 105.75TCID<sub>50</sub>) in Vero cells. Selected isolate was propagated up to passage 50 with confirmation of presence of virus at different passage level by partial length amplification of P32 gene of goatpox virus. Gradual increase in the infectivity titer of the virus isolate was observed and found to be 106TCID<sub>50</sub> at passage 50. Required titer of virus was calculated and adjusted to single recommended vaccine dose 103TCID<sub>50</sub> and 50 vaccine dose 104.7TCID<sub>50</sub> for preparation of inoculum. Sterility test of the prepared virus inoculum was performed to

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confirm the absence of any contamination. After 14 days of incubation prepared inoculum was found to be sterile. Total 18 no. of goats under 3 groups were used for safety test of the attenuated virus isolate. Group 1 animals were immunized with 1 single recommended vaccine dose of the isolate where group 2 animals were immunized with 50 recommended vaccine doses subcutaneously and group 3 animals, injected with 1ml of normal saline were kept as control. Animals were found apparently healthy without any adverse reaction or any thermal reaction even after 28 days post immunization showing the safety of the attenuated virus isolate. Antibody response was also calculated by indirect ELISA and SNT. Initially on 7th day ELISA titer (Log10) was  $30 \pm 4.9$  while on 28th day it was  $426.67 \pm 78.3$ . Similarly, in SNT 50% neutralization titer (Log10) was  $24 \pm 1.66$  and on 28th day it was found to be highest  $150 \pm 15.4$ . Molecular characterization and sequence analysis of P32 gene of goatpox virus isolate under the present study revealed that the attenuated GTPV isolate shared identity to some extent with other GTPV isolate from different parts of world and with the commercial vaccine strain. At nucleotide and amino acid level the attenuated virus isolate shared 99.6% sequence identity and 0.4% deviation from the original virus isolate. Though, there was no significant difference in amino acid sequence level.

# **Characterization of Methicillin Resistant *Staphylococcus aureus* Isolated From Raw Meat**

*Leons Mathew Abraham*

*Staphylococcus aureus* is an opportunistic pathogen capable of causing multiple diseases of varying severity. Among *S. aureus*, Methicillin-resistant (MRSA) strains have gained particular attention during recent years due to its multi drug resistance property and ability to affect the various systems of the body. The frequent use of antimicrobials at farm is discussed as a risk factor for the wide dissemination of MRSA in livestock production chains including meat and meat products. The present study was taken up primarily with an intention to isolate and characterise methicillin-resistant *S. aureus* from meat sold at the retail outlets in Guwahati city of Assam. The study also included analysis of antimicrobial susceptibility pattern of the isolates and detection of important virulence-associated genes by PCR .

For the study, a total of 309 meat samples were collected. *Staphylococcus* species could be isolated from 166 (53.72%) samples while only 65 (21.03%) were found to be coagulase-positive comprising of 35, 14, 11 and 5 isolates respectively from chicken, pork, chevon and beef samples. On the basis of biochemical tests and PCR detection of *aro A* gene, 61 (93.84%) out of the 65 coagulase positive isolates were confirmed as *Staphylococcus aureus*, of which 33 (94.28%) were from chicken, 12 (85.71%) from pork, 11 (100%) from chevon and 5 (100%) from beef samples. The antibiogram of the 61 *S. aureus* isolates was determined by the Disk diffusion method employing 12 antimicrobial agents. The highest resistance was observed against Penicillin (85.24%) followed by Oxytetracycline(63.93%), Enrofloxacin (62.29%), Amoxicillin/ Clavulanic acid (44.26%), Oxacillin (36.06%), Neomycin (36.06%), Cefuroxime (34.42%), Gentamicin (31.14%), Cefoxitin (29.50%), Streptomycin (26.22%), Piperacillin/Tazobactam (26.22%) and Teicoplanin (6.55%). Out of the 61 isolates, 50 (81.96 %) showed resistance against 3 or more antibiotics while six (9.83%) isolates were resistant to ten out of the twelve drugs tested. All the isolates were

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resistant to atleast one antibiotic but none showed resistance against all the 12 antibiotics.

Cefoxitin and Oxacillin based disc diffusion test was employed for phenotypical detection of Methicillin resistance. A total of 18 (29.50%) *S. aureus* isolates were resistant to Cefoxitin while 22 (36.06 %) isolates were resistant to Oxacillin. Growth characteristics on MeReSa agar and Epsilometric test using Cefoxitin yielded similar results to that of the disk diffusion test using Cefoxitin. For confirmation, the 18 phenotypically positive MRSA isolates were subjected to PCR for the detection of the *mecA* gene, and all the 18 (100%) were found to be positive. Considering the total number of samples collected (n=309), MRSA could be isolated from only 18 (5.82%) samples. It was observed that 11 (7.63%) out of the total 144 chicken samples, 3 (4.16%) out of 72 pork, 3 (5.17%) out of 58 chevon and 1 (2.85%) out of 35 beef samples were MRSA. Furthermore, the PCR amplification of the isolates targeting the thermonuclease, *nuc* gene showed that all the 61 *S. aureus* isolates were positive. This study also evaluated the presence of the enterotoxin A, *sea* gene in meat as *S. aureus* is a major pathogen when it comes to food-borne illnesses. Interestingly, only 2 (3.27%) out of the 61 isolates were found carrying the *sea* gene.

## **Trematode Parasites of Asian Elephant (*Elephas maximus*) with Special Reference of Liver Fluke**

*Bandanpreet Kour Raisim*

A prevalence study of intestinal trematode parasites in Asian elephant (*Elephas maximus*) was conducted on faecal samples received from 5 different protected areas of Assam including the Assam State Zoo-cum-Botanical Garden from the month of March 2019 to June 2019. Out of total 85 samples examined, 50.00 (58.82%) sample was found positive for trematode parasitic infection. Samples received from Pobitora Wildlife Sanctuary had highest rate of infection (81.81%) followed by samples from Manas National Park, Laokhowa Wildlife Sanctuary and Assam State Zoo-cum-Botanical Garden which had lowest (33.33%) rate of infection. Amongst positive samples the rate of infection for *Fasciola jacksoni*, amphistomes and mixed infection of *F. jacksoni* and amphistomes was found in 21 (42.00%), 43(86.00%) 35 (70.00) samples, respectively. Four different trematode parasites could be recovered from the samples. Morphologically the parasites could be identified as *Pseudodiscus collinsi* (Cobbold, 1875), *Gastrodiscus secundus* (Looss, 1907), *Pfenderius birmanicus* (Bhalerao, 1935) and *Pfenderius pappilatus* (Cobbold, 1882). Surface morphology of *G. secundus* was studied using SEM. Molecular characterization of *P. collinsi* and *G. secundus* was done amplifying ITS2 rDNA gene with conventional PCR method. The query sequence showed 99.16% similarity with *G. hominis* and 98.88% similarity with *Homalogaster paloniae*. The distance matrix of *P. collinsi* showed a maximum similarity of 93.36% with *Watsonius watsoni*. Comparative morphological studies between liver fluke of Asian elephant and *Fasciola* species of cattle, buffalo and goat showed that the elephant liver fluke was *Fasciola jacksoni* (Cobbold, 1869) and the *Fasciola* species of cattle, buffalo and goat was *Fasciola gigantica* (Cobbold, 1885). Morphologically the *F. jacksoni* differed substantially from the latter species. Ultrastructural studies conducted with SEM on *F. jacksoni* revealed significant surface features. A phylogenetic analysis conducted for *F.jacksoni* of Asian elephant and *F. gigantica* of cattle, buffalo and goat targeting ITS1, ITS2 and *nad1* gene by conventional

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PCR showed that *F. jacksoni* was a distant outlier to *F. gigantica* of cattle, buffalo and goat. Phylogenetically *F. jacksoni* (Assam isolate) was similar to Sri-Lankan isolate of *F. jacksoni* and *Fascioloides magna*. A comparative gross and histopathological study was conducted on the liver of Asian elephant affected with *F. jacksoni* and *F. gigantica* in cattle, buffalo and goat. There were both gross and histopathological differences between the affections caused by *F. jacksoni* in elephant and *F. gigantica* in the three ruminant hosts. Moreover, the lesions in elephant liver produced by *F. jacksoni* when compared with that of lesions produced by *Fascioloides magna* from published literature revealed similarities.

# **Clinico Pathological Studies of Canine Parvoviral Infection**

*Ginah Maria Binny*

Present study was investigated for a period of one year from March 2018 to February 2019. A total of 138 diarrheic dogs were suspected for Canine Parvovirus (CPV) infection and were examined. CPV was confirmed on the basis of rapid diagnostic kit. 62 dogs showed positive in the rapid diagnostic kit. 62 fecal samples from each dog showing positive in the rapid kit test were subjected for polymerase chain reaction (PCR) and haemagglutination (HA). In the current study 54 (87.10%) fecal samples were found positive by PCR and 41 (66.13%) were positive by HA. Dogs of the age group above 3 to 6 months were found to be most susceptible (37.09 %). Season wise highest occurrence of CPV was found in the monsoon (40.03 %). The unvaccinated dogs showed higher occurrence of CPV (45.16 %) in comparison to the partially vaccinated dogs (30.64 %) and the vaccinated dogs (24.19 %). It was observed that occurrence of CPV had no significant effect on either of the sex. Haematological studies revealed significant decrease in Hb, PCV, TEC, MCV, MCH and MCHC in CPV affected dogs along with significant increase in eosinophils. There was significant thrombocytopenia and lymphocytopenia. A non-significant increase in WBC, neutrophils and monocytes were also recorded. Biochemical estimation revealed significant increase in ALT, AST and BUN levels with significant decrease in Na and K level of CPV affected dogs. A non-significant decrease in glucose, creatinine and chloride level was also recorded.

Cytological studies were done in 12 live dogs affected by CPV and 19 dogs that died due to clinically confirmed CPV. Among the total 31 dogs, tongue smears from 22 dogs showed the presence of intracytoplasmic basophilic inclusion bodies both in the Diff quick and Giemsa stain.

The prominent clinical signs observed in the affected dogs were anorexia, dehydration, depression, lethargy, emaciation and fever. Foul smelling diarrhea was the most common finding. The conjunctival mucous membrane and the gums were pale due to anemic condition of the dog. Severely affected dog when presented showed

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prolonged capillary refill time, poor pulse rate, tachycardia and hypothermia. Gross examination revealed congested gastric mucosa, hemorrhagic enteritis and hepatomegaly. Hemorrhage was observed in the medulla of kidney in some of the CPV affected dogs. Cerebrum congestion of the capillaries. Erosive hemorrhagic ulcers were frequently seen in the tongue.

The histopathological examination revealed the presence of intracytoplasmic and intranuclear inclusion bodies in the brain, tongue, lungs and intestine. Endothelial cell proliferation was observed in most of the organs. Brain showed congestion, neuronophagia and satellitosis. Tongue revealed sloughing of the villi and congestion of blood vessel in the sub epithelial layer. Hyperplasia of the basal cell layer was also observed in the tongue of some cases. Heart showed degeneration of the myocardial fibers, congestion and focal infiltration of mononuclear cells. Interstitial and serous pneumonia associated with hyperplasia of bronchial epithelium were recorded in the lungs of the affected dogs. Liver sections revealed congestion and hemorrhage in the sinusoidal space and proliferation of biliary epithelial cells. Intestine revealed necrosis and sloughing of the epithelium, flattening of the villi associated with congestion and hemorrhage in the mucosal and muscular layer. Necrosis of the Peyer's patches with depletion of the lymphocytes were also recorded. Shrinkage of the glomerular tuft with associated cystic glomeruli was observed in the renal parenchyma. Interstitial nephritis, congestion and hemorrhage were the common findings. Changes in the lymphoid organs such as spleen, thymus and lymph node consisted of hemorrhage, congestion and depletion of lymphocytes from lymphoid follicle.

PCR was found to be more sensitive in the diagnosis of CPV in comparison to the HA test. HA test showed that although CPV can agglutinate both swine and chicken RBCs, the characteristic agglutination was observed when the swine RBCs were used. PCR confirmed CPV isolates by molecular detection of CPV-VP2 gene at 160 bp. The phylogenetic analysis revealed that the isolates recorded in the present study were CPVtype 2b and was in the same cluster as other CPV-VP2 isolates from Hissar (EU2743041.1), India, Anand (JN625224.1) and India, Tamilnadu (MH536199.1).

## ***In vitro* Evaluation and Molecular Mechanism of Parthenin as Anti-Cancer Agent**

*Monoshree Sarma*

Parthenin, a sesquiterpene lactone was evaluated for its anti-cancer potential. Looking at the prevalence of head and neck cancer and triple negative breast cancer in North-Eastern India, parthenin was screened against FaDu (Human pharyngeal cancer) cells and MDA-MB-231 (triple negative breast cancer) cells. For studying the cytotoxicity of parthenin against FaDu cells and MDA-MB- 231 cells, MTT assay was used. Cytotoxicity was observed against FaDu and MDA-MB- 231 cells. The IC<sub>50</sub> of parthenin against FaDu and MDA-MB-231 are 5.11 $\mu$ M and 5.65 $\mu$ M respectively. The cytotoxicity of parthenin against FaDu cells is at par with that of the standard drug hydroxychlorquine. However, the standard drug hydroxychlorquine is more potent against MDA-MB-231 cells as compared to that of parthenin. The nuclear and cellular morphologies of parthenin treated FaDu were studied using Hoechst 33258 dye that revealed that parthenin induces nuclear fragmentation and damage in two doses PAR-1 (1.23 $\mu$ M) and PAR-2 (5.11  $\mu$ M). The nucleus of parthenin treated FaDu cells assumed the shape of horse-shoe indicating the potential of parthenin to bring about apoptosis.

Mitochondrial membrane potential (MMP) of parthenin treated FaDu cells were studied using JC-1 dye. For this study, two doses were considered: PAR-1 (1.23  $\mu$ M) and PAR-2 (5.11  $\mu$ M). The study revealed that parthenin causes disruption of mitochondrial membrane potential and integrity which was higher in PAR-2 dose. This illustrates that parthenin might activates the intrinsic pathway of apoptosis. Parthenin treated FaDu cell exhibited up regulation of pro-apoptotic factor BAX and down regulation of anti-apoptotic factor BCL-2. This result confirms the activation of intrinsic pathway by parthenin in FaDu cells. Other factors like Caspase-9 and Caspase-3 which are involved in intrinsic pathway of apoptosis were also up regulated by parthenin in FaDu cells. Also, there was up regulation of p53, a gene which is involved in tumour suppression and generally found inactivated in malignant tumours. Parthenin also causes down regulation of PARP 1 and NF $\kappa$ B in FaDu cells, two factors involved in cell

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signalling, cell proliferation and repairment of DNA damage. Parthenin brings about cell death of FaDu cells by activating and inhibiting pro-apoptotic and anti-apoptotic pathways respectively. Parthenin enhances the expression of BAX and decreases the expression of BCL-2 of MDA-MB-231 cells. Not only this, in MDA-MB-231 cells, parthenin also up regulates the expressions of various pro-apoptotic factors involved in intrinsic way of apoptosis like Caspase-9 and Caspase-3. The expression of p53, a tumour suppressor gene, which is inactivated in most of the malignant tumours is up regulated in parthenin treated MDA-MB-231 cells. In MDA-MB-231 cells, parthenin also causes down regulation of PARP 1 and NFκB, two factors involved in cell signalling, cell proliferation and repairment of DNA damage. Parthenin causes death of MDA-MB-231 cells by activating and inhibiting pro-apoptotic and anti-apoptotic pathways respectively.

## **Physio-Biochemical Studies of Adult Pati Ducks Reared Under Semi-Intensive System**

*Tenzing Lopsang Lachenpa*

The Pati duck is the only recognized duck breed of India and is indigenous to Assam. It has remained a largely popular duck variety among the locals due to its ability to grow with low inputs and easy management, greater resistance to diseases and hot and humid weather conditions which is prevalent across most parts of the state. The present experiment was carried out to study some hematological and biochemical parameters of adult Pati ducks reared under semi-intensive system for summer (July-August) and winter (December-January) seasons. A total of 24 ducks comprising 12 males and 12 females aged 10 weeks and above were considered for the experiment. The ducks were maintained in the duck farm adjacent to a pond and were housed during the night on concrete floor with deep litter and let loose during day time. The experimental ducks were subjected to blood collection at 7-day intervals during both the seasons and analyzed for total erythrocyte count, hemoglobin content, hematocrit, differential leukocyte count, and total leukocyte count for hematological study and superoxide dismutase (SOD), lactate dehydrogenase (LDH), total protein, alkaline phosphatase (ALP), HSP90 and cortisol for blood biochemical study. The hematological parameters were almost similar between male and female Pati ducks within the same season. However, the monocyte count was significantly higher ( $P<.01$ ) in male Pati ducks and the lymphocyte and eosinophil counts were significantly higher ( $P<.01$ ) in female Pati ducks during winter season. The hemoglobin content (Hb), and the total leukocyte count (TLC) were significantly higher ( $P<.01$ ) for both male and female Pati ducks during summer season whereas the total erythrocyte count (TEC), and hematocrit (PCV) were significantly higher ( $P<.01$ ) during winter season for both the sexes. Similarly, the biochemical parameters were also almost similar between male and female Pati ducks within the same season. However, alkaline phosphatase (ALP) and HSP90 levels were significantly higher ( $P<.01$ ) during summer season in both male and female Pati ducks while lactate dehydrogenase (LDH) activity, total protein

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concentration, superoxide dismutase (SOD), and cortisol levels were significantly higher ( $P<.01$ ) during winter season. Thus, from the experimental findings we can conclude that LDH, SOD, and cortisol could be considered good indicators of cold stress whereas HSP90 could be considered a good indicator for heat stress.

# **Sero-Prevalence and Risk Factor Analysis of Leptospirosis Among Cattle Population in West District of Tripura State**

*Banitya Mohan Tripura*

Leptospirosis is a re-emerging zoonotic, occupational and water-borne bacterial disease. The disease is endemic in our country since 20th century. The current study was investigated to know the seroprevalence of this particular zoonosis among cattle population in West District of Tripura. The research was carried out from March 2018 to February 2019. A total of 255 blood samples were collected from 3 (three) subdivisions of West Tripura both from clinically ill and apparently healthy cattle randomly irrespective of their age, breed and sex. The presence of anti-Leptospiral antibody is screened by Enzyme Linked Immunosorbent Assay (ELISA) and detection of serovars by Microscopic Agglutination Test (MAT).

Out of the 255 serum samples screened, the overall seroprevalence was recorded to be 24/255 (9.41%) and 17/255 (6.66%) by ELISA and MAT respectively. Also the following serovars were encountered *viz.* Autumnalis (29.41%) followed by Bataviae (23.52%), Ballum, Australis, Grippytyphosa, Hebdomadis and Javanica. A comparative study was made out for the sensitivity and specificity of ELISA and MAT with 100% and 70.83% respectively and concordance (97.25%). From the study it was observed that ELISA is superior than MAT based on its sensitivity, easy and rapid to detect circulating antibody.

Out of the three subdivisions studied, the seroprevalence was recorded highest in Mohanpur (15.29%) followed by Sadar (9.41%) and lowest in Jirania (3.52%). Statistical analysis by Chi-Square test showed that there was significant association of *Leptospira* seropositivity with the risk factors *viz.* health status, farm hygiene, rodent infestation, feeding quality, water source, herd size and season (P-value<0.05). Average temperature and rainfall were also recorded highest in monsoon. Seropositivity among cattle was recorded more with clinically ill cattle (21.43%) than apparently healthy cattle. Farm with poor hygiene was recorded highest (18.05%) with *Leptospira*

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infection. Farm with history of rodent infestation was recorded higher with leptospirosis (32.3%). In consideration to feeding quality more cases of leptospirosis was recorded in cattle fed with cultivating grasses (13.63%). The recorded leptospirosis associated with stored water as risk factor was 15.18%. Farm with herd size >5 of animals was recorded with *Leptospira* infection (15.45%). Based on season highest *Leptospira* infection was recorded in monsoon (20.75%) and lowest in winter (3.38%). Whereas, there was no significant association with the risk factors viz. breed, sex, age, farm location, grazing pattern and contact with other animals.

Therefore, the current study will give a baseline seroprevalence of leptospirosis among cattle population in West District of Tripura.

# Prevalence of Cysticercosis in Jorhat District of Assam

*Mrinmoyee Sarma*

A study on prevalence and seroprevalence of porcine cysticercosis and its associated risk factors and a retrospective study of NCC in man were conducted for a period of one year from July'18 to June '19 in Jorhat district of Assam. A total of 104 numbers of carcasses were examined in different market places from 5 different locations, out of which 1 carcass was found positive for *Cysticercus cellulosae* infection with the prevalence rate of 0.96%. A single positive carcass (1.85%) was reported between the age group of 7-12 months. Number of positive cases in male and female was 1(1.53%) and 0 (0%) respectively. The prevalence rate in non-descript and crossbred pigs was 0 (0%) and 1(1.26%) respectively. To validate the results of meat inspection, DNA sample of the cyst were examined by PCR with TBR primer and Cox-1 primer. The PCR product with molecular size of 286 bp and 984 bp were amplified targeting large subunit rRNA Gene and cytochrome oxidase sub unit 1 gene respectively. On characterization of cystic fluid protein profile of porcine larval cestode by SDS-PAGE, two highly antigenic bands and one moderately antigenic band was observed.

A total of 140 number of serum samples were collected from 20 farms from 5 locations of Jorhat district. All the serum samples were analyzed by using RIDASCREEN *Taenia solium* IgG kit (R- Biopharm AG, Germany) to detect the presence of circulating antibody against *C. cellulosae*. Out of 140 samples examined, 13 were found to be positive for antibody against porcine cysticercosis with the prevalence rate of 9.2%. The highest numbers of cases were recorded from Madhupur (17.85%). The highest seroprevalence (12.06%) was recorded in the age group of 7 to 12 months and lowest (5.4%) in the 1-6 months. Sex-wise seroprevalence in female and male was 9 (10.22%) and 4 (7.69%) respectively. The proportional distribution of infection in female and male was 57% and 43% respectively. The seroprevalence rate in non-descript and crossbred pigs was 3 (7.69%) and 10 (9.9%) respectively. The proportional distribution between non-descript and crossbred pigs was 44% and 56% respectively.

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A total of 20 household associated with pig husbandry practices from 5 different locations and 50 consumers from different markets of Jorhat district were interviewed with the help of two suitable questionnaires to collect the baseline information to assess the risk factors associated with cysticercosis. Risk factors associated with cysticercosis were absence of latrines, defecation in open, poor personal hygiene, awareness to the disease, food habit, system of pig rearing, lack of meat inspection, lack of vaccination in pigs against cysticercosis, lack of periodic deworming of pigs as well as of human beings.

A total of 20 patients from Jorhat district were registered in Jorhat Medical College and Hospital for treatment of Neurocysticercosis (NCC) from July'17 to June'19. A backward study of patients (using retrospective and current data) was carried out with the help of a suitable questionnaire to determine the factors influencing the prevalence of NCC in the study area. Risk factors associated with the prevalence of NCC among the patients were gender of the patient, source of water supply, poor personal hygiene, consumption of raw salad and lack of periodic deworming.

## **Intraoperative Assessment of Intestinal Viability in Rabbits**

*Evakordor Hynniewta*

Intraoperative assessment of bowel of questionable viability remained a challenge to surgeons. In this study, a rabbit experimental model was used to compare the accuracy of standard clinical criteria (SCC), pulse oximetry technique (POX) and fluorescein dye technique (FDT) in the determination of intestinal viability. Viability end point of each segment was established by histopathological studies and results were compared with results obtained from SCC, POX and FDT. Twelve ischemic intestinal segments were created experimentally by ligation of a branch of superior mesenteric artery along with the clamping of the loop supplied by the ligated artery. Viability assessment was then carried out after 4 hours in Group I and 8 hours in Group II of ischemic intervals. Standard clinical criteria included judging the bowel based on the color, pulsations and peristalsis. Pulse oximetry readings were made by placing the probe of the pulse oximeter on the anti-mesenteric border of the intestine. Fluorescein dye technique was carried out by injection of fluorescein sodium intravenously @75mg/kg body weight and fluorescence pattern was judged following 2 to 3 minutes of administration under ultraviolet illumination using Wood's lamp in a dark room. The overall accuracy of FDT was found to be 100%, while SCC and POX had 83.33% each. Fluorescein dye technique was found to be 100% accurate in making correct predictions of bowel of questionable viability. Standard clinical criteria and pulse oximetry were equally effective in predicting the non-viable loops with 100% sensitivity. However, this was at the cost of 83.33% positive predictive value. Fluorescein dye technique was found to have 100% sensitivity and specificity. Therefore, fluorescein dye technique in combination with standard clinical criteria can be recommended for intraoperative viability assessment of ischemic intestine. Blood and peritoneal fluid were collected at zero hour and after 4 hours in Group I and 8 hours in Group II. Estimation of serum alkaline phosphatase (U/L), alanine aminotransferase (U/L), cholesterol (mg/dl), creatinine (mg/dl) and phosphorus (mg/dl) was carried out in both the groups. Peritoneal fluid evaluation of alkaline phosphatase (U/L) and lactate dehydrogenase (U/L) was also done. A significant increase in the biochemical parameters of blood was seen following

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8 hours of ischemia. However, creatinine, did not reveal any significant changes after 8 hours of ischemia. A significant increase could be seen following 8 hours of ischemia in peritoneal fluid alkaline phosphatase and lactate dehydrogenase. Creatinine was not a good indicator of ischemia as it did not reveal any significant change at both the ischemic intervals. The significant increase seen in these biochemical markers of blood and peritoneal fluid marked the severity of the ischemia following 8 hours of ischemic insult. Thus, it can be concluded that these biochemical markers cannot reveal the fate of an ischemic bowel but can help in the diagnosis of ischemia.

## **Tiletamine-Zolazepam Anaesthesia in Cat**

*Monalisa Ahmed*

In this study, ten clinically healthy cases of domestic cat (*Felis catus*), requiring surgical intervention for various conditions were considered. The cats were of either sex, weighing 3 to 4 kg, and of 2 to 4 years of age. They were randomly divided into 2 (two) equal groups with five animals in each group. The cats of group I received tiletamine - zolazepam (Zoletil 100 vet.) @ 5 mg/kg body weight and the cats of group II were administered the same anaesthetic combination @ 10 mg/kg body weight intramuscularly. The mean induction time of  $2.40 \pm 0.24$  minutes and  $1.60 \pm 0.24$  minutes, duration of anaesthesia of  $24.40 \pm 1.69$  minutes and  $43.60 \pm 5.87$  minutes, and the recovery time of  $34.20 \pm 3.00$  minutes and  $57.00 \pm 4.84$  minutes were recorded in the cats of group I and group II, respectively. Group I and II showed significant difference ( $p < 0.05$ ) in induction time and duration of anaesthesia; and high significant difference ( $p < 0.01$ ) in recovery time between the groups. Animals of both the groups showed initial pawing, unconsciousness, eyes remained open throughout the duration of anaesthesia, mydriasis, presence of corneal and pupillary reflexes, smacking of lips, and protrusion of tongue without salivation. Animals of group I exhibited moderate analgesia and muscle relaxation; but in case of animals of group II, good analgesia as well as muscle relaxation were ascertained. No unwanted effects like salivation, catalepsy, vomiting, urination, or defaecation were observed in any of the groups.

In both the groups, heart rate increased significantly ( $p < 0.01$ ), whereas, nonsignificant ( $p > 0.05$ ) decrease of respiration rate was seen. The rectal temperature and SpO<sub>2</sub> for both the groups showed significant ( $p < 0.01$ ) decrease with time. Moreover, the MAP increased significantly ( $p < 0.01$ ) in both the groups. Haematological parameters like Hb, PCV and TEC revealed significant ( $p < 0.01$ ) decrease in both the groups. In case of biochemical parameters, there was non-significant ( $p > 0.05$ ) increase of GGT, blood glucose and cortisol but non-significant ( $p > 0.05$ ) decrease of total protein and creatinine levels in both the groups. All the changes were transient in nature.

From the above studies, it can be concluded that tiletamine – zolazepam @ 5 mg/kg body weight produced moderate anaesthesia of shorter duration allowing minor

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surgical interventions like castration, removal of external growths, aural haematoma operations, etc., and tiletamine – zolazepam @ 10 mg/kg body weight intramuscularly produced balanced anaesthesia permitting major surgical procedures like spaying, gastrotomy, cystotomy, etc. in domestic cats.

## **Sevoflurane Anaesthesia in Butorphanol- Midazolam Premedicated Dogs Induced with Propofol and Ketamine**

*Sarahna Taufiq*

Twelve clinical cases of female Mongrel dogs of 1-5 years, weighing 10-15 kg were considered for the study. The animals were randomly divided into two groups with the following anaesthetic regime: premedication with butorphanol @ 0.3 mg/kg, IM and midazolam @ 0.3 mg/kg, IM followed by induction of anaesthesia with ketamine @ 7.5 mg/kg, IV (Gr A) and propofol @ 4.0 mg/kg, IV (Gr B) and maintenance of anaesthesia with sevoflurane in oxygen in both the groups.

Time of sedation was recorded  $5.00 \pm 0.29$  mins in Gr A and  $5.17 \pm 0.31$  mins in Gr B. Four (66.67%) animals showed excellent quality of sedation and two animals (33.33%) showed light sedation in both the groups. Time of induction was recorded  $2.43 \pm 0.13$  mins in Gr A and  $2.32 \pm 0.08$  mins in Gr B. Quality of induction was smooth without any adverse signs, although apneustic respiration in two (Gr A) and apnoea in four animals (Gr B) was observed after induction. Intubation score was graded as excellent in four (66.67%) and good in two (33.33%) animals in Gr A whereas excellent in all the animals (100%) in Gr B. Quality of analgesia was found to be excellent in Gr A and good in Gr B. Muscle relaxation was graded as excellent in four (66.67%) and moderate in two (33.33%) animals in Gr A, while all the animals (100%) showed excellent muscle relaxation in Gr B. Time for return of swallowing reflex was shorter in Gr B ( $13.83 \pm 0.60$  mins) than Gr A ( $14.83 \pm 0.48$  mins). The time required for head raise was significantly ( $p < 0.05$ ) shorter in Gr B ( $23.42 \pm 0.52$  mins) than Gr A ( $25.67 \pm 0.84$  mins). The time required for standing was  $33.00 \pm 0.93$  mins in Gr A and  $33.17 \pm 0.70$  mins in Gr B. The time for complete recovery was shorter in Gr B ( $51.50 \pm 1.52$  mins) than Gr A ( $53.50 \pm 1.57$  mins). Quality of recovery was excellent in both the groups however, two animals in Gr A showed signs of shivering, salivation and urination. Also, two animals in Gr B showed slight whimpering, salivation and urination during recovery. Heart rate increased significantly, respiration rate and rectal

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temperature were reduced significantly ( $p < 0.05$ ) in both the groups. Oxygen saturation was well maintained and not less than 88% at various time intervals in both the groups. CRT at various time intervals was less than 2 seconds in all the animals. Hb, PCV, TEC and TLC decreased significantly ( $p < 0.05$ ) and total platelet count decreased non-significantly for both the groups throughout the period of study. Total protein decreased significantly ( $p < 0.05$ ) while total albumin and total globulin decreased non-significantly in both groups. ALP, GGT increased non-significantly in both groups. Creatinine increased in both Gr A ( $p > 0.05$ ) and Gr B ( $p < 0.05$ ). The value of BUN was found to increase in both Gr A ( $p < 0.05$ ) and Gr B ( $p > 0.05$ ). In conclusion, both the anaesthetic combinations were found to produce balanced anaesthesia in dogs and could be recommended for clinical use. However, Gr B was observed to be better among the two groups in terms of smooth induction, ease of intubation, good degree of analgesia, excellent muscle relaxation and an overall smooth recovery.

## **Evaluation of *In-Vitro* Antiviral Effect of Nanocurcumin and Nano Eugenol Against Goat Pox**

*Namitha. A*

Five treatment combinations namely Curcumin, Eugenol, Nanocurcumin, nano eugenol and their combinations were considered, which are known for their medicinal values especially their anti-viral effects against various viruses are screened for their anti-viral effect against Goatpox virus replication in-vitro. Nanocurcumin and Nano eugenol prepared by Evaporative precipitation of nanosuspension (EPN) and ultrasonication method had Z-average particle size of 64.22nm and 7.270nm, respectively which was found to be physically stable without any phase separation. All the treatments viz. Curcumin, Eugenol, Nanocurcumin, Nano eugenol were found to be safe for oral administration up to 2000mg/kg body weight. In-vitro cytotoxicity studies of curcumin, Eugenol, Nanocurcumin, Nano eugenol and their combinations showed their Maximum Non-Toxic Doses to be 39.06µg/ml, 78.12µg/ml, 140.62µg/ml, 156.25µg/ml and 296.875µg/ml, respectively and Cytotoxic Concentration<sub>50</sub> values to be 290.4±1.419µg/ml, 319.7±1.301µg/ml, 1462±1.0620µg/ml, 432.7±1.1656µg/ml, and 1309±1.2887µg/ml, respectively. All the treatments viz. Curcumin, Eugenol, Nanocurcumin, Nano eugenol and their combinations were found to have their viral percentage inhibition of 74.88, 79.43, 97.48, 99.55 and 99.85, respectively which are found to be significant at P<0.05 at their MNTDs. Out of which Nanocurcumin, Nano eugenol and their combinations showed >80% inhibition and their EC<sub>50</sub> values found to be 92.47±1.586µg/ml, 54.93±1.1220µg/ml and 52.48±1.1481µg/ml with their therapeutic indices to be 15.81, 7.877 and 24.94, respectively. One step growth inhibition of goatpox virus by Nanocurcumin showed inhibition up to 0 hour post infection, but Nano eugenol and combination of nanocurcumin and nano eugenol showed inhibition upto 72 hour post infection. The nano-ointment was prepared by the combination of nanocurcumin and nano eugenol and applied on skin lesions of positive goatpox cases which resulted in better and faster healing. Results indicated that combination of nanocurcumin and nano eugenol had the highest antiviral effect with

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greater therapeutic index followed by Nanocurcumin and Nano Eugenol and there was dose dependent increase in percentage of inhibition of goatpox virus with their action being virucidal and also inhibited viral entry and some steps of viral replication in-vitro. Combination of nanocurcumin and nano Eugenol Nano-ointment showed better healing in clinical cases of goatpox.

## **Performance of Assam Hill Goat Reared Under Bamboo and Wooden House**

*Armina Sultana Begum*

The experiment was carried out at Goat Research Station, Assam Agricultural University, Byrnihat, Guwahati, Assam under the supervision of the Department of Livestock Production and Management, College of Veterinary Science, Khanapara, Guwahati-781022 for a period of three months from February to May, 2022 to study the performance of Assam Hill goat reared under different house.

Twelve (6 male and 6 female) healthy Assam Hill goats; approximately two to three months old were randomly divided into two groups ( Group I and Group II) consisting six animals in each group. During the experimental period, the kids were sheltered in group in an elevated (4 ft.) two different types of house *i.e.* elevated bamboo and wooden house of the Goat Research Station, Assam Agricultural University, Byrnihat. All experimental kids were managed intensively under the same feeding managemental care. The feed were offered as 1/3rd concentrate ration on DM basis with 2/3rd roughages in both the groups.

The average initial and final body weight of kids in bamboo and wooden house were  $5.92 \pm 0.15$  and  $9.62 \pm 0.13$  kg and  $5.85 \pm 0.22$  and  $8.55 \pm 0.17$  kg respectively. The overall body weight of kids was found to be  $7.69 \pm 0.20$  and  $7.20 \pm 0.15$  kg respectively. The fortnightly body weight have no significant difference in 1st, 2nd and 3rd fortnight, however in 4th fortnight it was found to be significant difference ( $P < 0.05$ ) between the groups. The body weight in 5th and 6th fortnight was recorded highly significant ( $P < 0.01$ ); on the other hand in overall, it showed insignificant difference between the groups.

The overall fortnightly body weight gain were found to be  $0.617 \pm 0.02$  and  $0.450 \pm 0.01$  kg in group I and group II respectively. The overall daily body weight gain was recorded as  $41.11 \pm 1.17$  and  $30.00 \pm 0.91$  g. The total body weight gain from 1st to 6th fortnight period were  $3.7 \pm 0.04$  and  $2.7 \pm 0.12$  kg in respective group. The body weight gain in every fortnight and daily body weight gain showed insignificant difference in 1st fortnight while in 2nd and 3rd fortnight had significant ( $P < 0.05$ ) differences and in 4th, 5th, 6th and overall were highly significant ( $P < 0.01$ ) among the

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groups. The total body weight gain was found to be highly significant ( $P < 0.01$ ).

The overall average feed intake in Group I and Group II were  $1.84 \pm 0.026$  and  $1.71 \pm 0.018$  kg, respectively. Feed intake was found to be highly significant difference ( $P < 0.01$ ) at every fortnight and overall among the Group I and II.

The overall average feed conversion efficiency in group I and group II were  $7.01 \pm 0.20$  and  $9.12 \pm 0.31$  respectively. There was no significant differences in feed conversion efficiency at 1st, 2nd and 3rd fortnight among the group I and group II while in 4th and 5th fortnight showed the significant ( $P < 0.05$ ) difference. There was highly significant ( $P < 0.01$ ) difference recorded in 6th fortnight and overall in feed conversion efficiency between the groups.

On calculation of production economy, the cost of production per kid was Rs 433.83 and 396.00 in Group I and II, respectively. The cost of feeding per kg of live weight gain recorded as Rs. 117.25 and 146.67, in the respective groups.

# Quality Characteristics of Soy Milk Blended Yoghurt

*Arifa Khatun*

A study was carried out to evaluate the quality characteristics of soy milk blended cow's milk yoghurt. The study was carried out in the laboratories of the Department of Livestock Products Technology, the All India Coordinated Research Project on Post-Harvest Engineering and Technology, the Department of Veterinary Biochemistry, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati-781022 and in the Central Analytical Instrumentation Facility, Guwahati Biotech Park Incubation Centre, Amingaon, Kamrup, Guwahati-781031 during the period from December, 2021 to September, 2022.

Organic whole soybeans procured from the local super markets were used for preparing sprouted and unsprouted soy milk. The NCDC 144 obtained from the National Dairy Research Institute, Karnal was used @ 3% (v/v) as yoghurt starter culture in the study.

The effects of addition of soy milk on the pH, per cent lactic acid content, free fatty acids, flavour and colour profile, proximate composition, microbiological quality, sensory scores and the best before end of the cow's milk yoghurt were studied.

A gradual decrease in the pH values of the Control samples as well as in all the samples of the Treatment groups was noted. Fatty acids and flavour compounds were identified with the help GC-MS. The colour profiling revealed that L, a and b values were the highest in control samples followed by T2 group while the samples of T1 group showed the least values for these colour components.

The samples of T2 group contained the maximum mean values of  $4.23 \pm 0.02$ ,  $19.65 \pm 0.10$  and  $1.26 \pm 0.00\%$  for protein, total solids and ash, respectively, while the Control samples showed the maximum mean value of  $4.37 \pm 0.03$  and  $82.96 \pm 0.12\%$  for fat and moisture, respectively. The protein content of the cow's milk yoghurt incorporated with 25% of soy milk had higher protein content than the cow's milk yoghurt. Addition of sprouted soymilk increased the per cent protein content of the cow's milk yoghurt than those incorporated with unsprouted soymilk.

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**Major Advisor : Dr. (Mrs.) T. Borpuzari**

The highest mean TVC of  $9.13 \pm 0.01$  log<sub>10</sub>cfu/ml was recorded in the samples of the T2 group which might be due to rapid growth of the added starter organisms accelerated by the synergistic effect of the germination metabolites of soybeans. Coliforms, *E. coli*, *Salmonella*, *Shigella*, *Staph. aureus* and yeast and moulds were not detected in any of the samples.

The cow's milk yoghurt prepared with 25% unsprouted soymilk had higher contents of caproic, caprylic, and lauric acids over the control samples. The yoghurt prepared with 25% sprouted soymilk had higher concentrations of margaric, palmitoleic, proprionic, tricosylic, tridecylic and vaccenic acids as compared to the control as well as the unsprouted samples. These free fatty acids might have contributed to the typical flavour of soy blended cow's milk yoghurt.

The cow's milk yoghurt blended with 25% of unsprouted and sprouted soy milk enjoyed identical panel acceptance for the appearance, colour, body and texture, and flavour characteristics indicating that soy milk could be successfully blended with cow's milk up to 25% in yoghurt without affecting its sensory properties. However, the cow's milk yoghurt was more preferred for its taste as compared to the soy milk blended yoghurts. Cow's milk yoghurt blended with 25% soy milk had the 'Best Before End' of 5d at refrigeration temperature.

## **Carcass and Meat Quality Characteristics of *Kamrupa* Chicken**

*Jameel Ahmad*

Kamrupa is a new variety of chicken developed after crossing three different types of local strains i.e. Assam local, coloured broiler (PB-2) and Dahlem red in the All India Co-ordinated Research Project on Poultry breeding, C.V.Sc, AAU, Khanapara . The new variety of chicken is becoming popular among the rural people of Assam. Many farmers have adopted this chicken as backyard poultry for their regular livelihood generation. Since 'Kamrupa' is a dual purpose variety, certain information like carcass and meat quality of the chicken are important for the farmers and the consumers as well as the information on these is very scanty. It is imperative to gather data on carcass and meat qualities of the new chicken if commercial venture on production, processing and marketing of meat is chosen.

Keeping in view the above facts, the proposed study was undertaken to generate data on various parameters related to carcass and meat qualities of Kamrupa chicken. It was also envisaged in the study to gather information on generation of different by-products after slaughter of the birds and shelf life of the meat at chilling temperature.

Under carcass traits, pre-slaughter body weight, carcass weight, dressing percentage, meat bone ratio, wholesale cuts and yield of by-products were taken into consideration while under meat quality traits physico-chemical qualities, muscle fibre diameter, shear force value, textural qualities, colour analysis, microbial quality, sensory properties and shelf life of meat of two age groups (12 and 54 weeks) and both the sexes (total 20 no of birds) were covered in this study. The carcass of 54 weeks of Kamrupa chicken had shown comparatively better results for most of the carcass traits when comparison was made with the carcasses of 12 weeks of age. With respect to yield of wholesale cuts the breast cut was found to be heaviest and the neck cut was the lightest. Body weight and carcass weight influenced the yield of both the edible (giblet) and inedible by-products and thus, birds of 54 weeks age group gave higher yields.

Pysico-chemical qualities of meat samples indicated inconsistent and conflicting results. Meat from 54 weeks of age had shown a higher shear force value and larger

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muscle fibre diameter but not much variation between the two age groups and sexes were observed in other traits like pH, WHC and ERV. Lipolysis was seen to be very quick as TBARS values exceeded the acceptable limit on 5<sup>th</sup> day of storage. Muscles of higher age group revealed higher crude protein, fat and ash content, while moisture content, drip losses and cooking losses were found to be lower in this group. All textural characteristics exhibited higher values in 54 weeks of birds in both the sexes. Colour analysis of muscle revealed a lighter colour in male birds of 12 weeks age group while redness and yellowness were seen to be brighter in 54 weeks of birds. Sensory qualities of the meat of both the age groups and sexes were found to be similar as no significant differences were observed.

High initial microbial loads were recorded for mesophilic, psychrophilic, yeast and mould counts and Coliform counts. Speedy growth was observed for all the microorganisms during the storage period. Shelf life of the stored meat samples at  $4\pm 1^{\circ}\text{C}$  was less than 5 days. Considering overall quality performances, chicken of 54 weeks age group may be considered better than 12 weeks of age group.

## **Development of Duck Meat Sausages Incorporated with Foxtail Millet (*Setaria italica*)**

*Kiran Moye Handique*

The present study was aimed to develop duck meat sausages by incorporating three different levels of roasted foxtail millet flour (*Setaria italica*) (5%, 10% and 15%) and other non-meat ingredients. The best formulation/combination that can be stored reasonably at refrigeration temperature without affecting its physicochemical, sensory and microbiological qualities was estimated. A total of five batches of each formulation were prepared with the following formulations- Control (0% FTMF), T<sub>1</sub> (5% FTMF), T<sub>2</sub> (10% FTMF) and T<sub>3</sub> (15% FTMF). The stuffed raw sausages of each formulation were cooked in a cooking vat maintained at 85°C for 45 minutes. After that, these were packed in food-grade polyethylene bags, stored under refrigeration temperature and evaluated for various quality traits viz., pH, Water Activity (a<sub>w</sub>), Thiobarbituric acid reactive substance (TBARS) value, Water Holding Capacity (WHC), Sensory qualities, Total Viable Count (TVC), Total Viable Psychrophilic Bacterial Count (TVPBC) and Colititre value on 1<sup>st</sup>, 5<sup>th</sup>, 10<sup>th</sup> and 15<sup>th</sup> days of storage. In addition, the Emulsion Stability (ES), Cooking Yield, Proximate Composition, Colour Profile and Texture Profile of the products were estimated on the day of production (1<sup>st</sup> day). Besides the above, the Calorie value and production cost of duck meat sausages were estimated.

The ES revealed highly significant differences (p<0.01) between the control and the treated products. The cooking yield was significantly (p<0.05) higher in formulations treated with FTMF than in control. The results of the present study indicate that the pH of the products differed significantly (p<0.01) between the control and treated formulations during the entire storage period. The a<sub>w</sub> and the TBARS values decreased significantly (p<0.01) from control to T<sub>3</sub>. The results for the WHC showed the highest value for the T<sub>3</sub> sample. During storage at refrigeration temperature (4±1°C), the pH, a<sub>w</sub>, and WHC showed a decreasing trend with the increase in storage period. However, the TBARS values increased significantly (p<0.01) up to 15 days of storage. The sensory scores of the duck meat sausages for all attributes at 5% level of foxtail millet flour incorporation were quite comparable with control. TVC and TVPBC showed a significantly (p<0.01) decreasing trend from control to treated products.

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However, the bacterial load increased during the storage for up to 15 days. No coliform and yeast and mould were detected during the entire storage period. The moisture, crude protein, ether extract and calorific value declined from control to treated products, while the ash content was highest for T<sub>3</sub>. The colour profile revealed no significant ( $p > 0.01$ ) difference in lightness(L\*), redness(a\*) and yellowness(b\*). A highly significant difference ( $p < 0.01$ ) was observed between control and treated products in the springiness of the duck meat sausages. Significant differences ( $p < 0.05$ ) were also observed between control and treated sausages in hardness, chewiness and resilience. However, in cohesiveness, non-significant ( $p > 0.05$ ) differences were observed between the control and the treated products. The cost of production revealed that duck meat sausages prepared with the incorporation of 15% foxtail millet flour (T<sub>3</sub>) were more cost-effective than the control duck meat sausages.

Based on the above findings, it might be concluded that value-added, nutritionally balanced duck meat sausages could be made with the incorporation of 15% FTMF ( T<sub>3</sub>) without adversely affecting its quality and were acceptable for 15 days when stored under aerobic packaging and at refrigeration temperature ( $4 \pm 1^\circ\text{C}$ ). However, among the treated products, duck meat sausages with 5% level of foxtail millet flour (T<sub>1</sub>) was found to be the best one in terms of overall quality parameters.

# **Effect of Spices and Methods of Smoking on Certain Quality Attributes of Chhana Sausage**

*Manash Jyoti Chutia*

The present research work was envisaged to develop a spiced smoked chhana sausage from cow's milk. The investigation was carried out in the laboratories of the Department of Livestock Products Technology and All India Coordinated Research Project on Post-Harvest Engineering and Technology, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati – 781 022.

The effect of spices and smoking methods on physico-chemical characteristics, proximate composition, colour profile, texture analysis, sensory properties and microbiological quality of spiced smoked chhana sausage was investigated.

The pH in all the sausage samples exhibited a decreasing trend with an increase in storage days. Conventional smoked spiced chhana sausage (T2) samples had the lowest pH value amongst the different treatment groups while the control group had the highest pH value on 0, 5<sup>th</sup>, and 10<sup>th</sup> day of storage period, respectively. On the contrary, the % lactic acid showed an increasing trend as the storage period progressed. On 0, 5<sup>th</sup>, and 10<sup>th</sup> days of storage period, conventional smoked spiced chhana sausage (T2) exhibited the highest titratable acidity while the control group had the lowest acidity level.

The water activity ( $a_w$ ) of all the sausage samples ranged between 0.98 to 0.99.

Amongst the different treatment groups, conventional smoked spiced chhana sausage (T2) had the highest value for total solids (TS), protein, fat and ash content, while the liquid smoked spiced chhana sausage (T1) had the lowest value for total solids (TS), protein and fat content, respectively. On the contrary, the control group had the lowest ash content. The liquid smoked spiced chhana sausage (T1) and conventional smoked spiced chhana sausage (T2) samples had the highest and lowest moisture content, respectively.

Liquid smoke spiced chhana sausage (T1) enjoyed superior eating quality characteristics for all the sensory attributes while conventional smoked spiced chhana sausage (T2) enjoyed the maximum score (7.78) for juiciness attribute.

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**Department : Veterinary Livestock Products Technology**

**Major Advisor : Dr. Masuk Raquib**



The maximum mean value for the Texture Profile Analysis (TPA) parameters (springiness, cohesiveness, chewiness, and resilience) were noted in liquid smoked spiced chhana sausage (T1) samples, with the exception of hardness, which was recorded in the conventional smoked spiced chhana sausage (T2) group. In contrast, the lowest TPA value for springiness, chewiness were noted in the control group and cohesiveness in the conventional smoked spiced chhana sausage (T2) samples.

The colour profile of spiced chhana sausage samples revealed that  $b^*$ (yellowness) was highest in the conventional smoked spiced chhana sausage (T2) samples, while  $L^*$ (Lightness) and  $a^*$  (redness) were highest in the control group.

Nil count of TVC (Total Viable Count) of sausage samples packed under aerobic packaging and stored at refrigeration temperature was observed on 0 d. There was a gradually increased in the viable count with an concomitant increase in storage period up to 10 d. Minimum viable count was noted in conventional smoked spiced chhana sausage (T2) samples on 5 d and 10 d of storage periods and maximum count was observed in the control sausage samples during the entire storage period. All the spiced chhana sausage samples had nil counts for yeast and moulds, *E. coli*, coliform, and *Staph. aureus* during the entire storage period.

Based on the proximate composition, sensory attributes and microbiological qualities both the spiced smoked products were superior, however, based on the sensory evaluation as perceived by the taste panel evaluators the technology developed for the liquid smoked spiced chhana sausage is recommended and a suitable protocol for commercial production of spiced smoked chhana sausage has been proposed.

# **Development of Enzyme Based Chromogenic Strips for Detection of Selected Adulterants in Milk**

*Priya Muktan*

The present investigation was carried out to develop an enzyme based chromogenic strip for detection of selected adulterant in milk. The experiment was carried out in the Department of Livestock Products Technology, All India Coordinated Research Project on Post Harvest Engineering and Technology and Department of Veterinary Biochemistry, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati-781022.

An enzyme based chromogenic test strip using Whatman filter paper grade 602 and Whatman filter paper No. 1 was developed for the detection of glucose, starch and urea in milk using glucose oxidase, amyloglucosidase and urease enzyme in the presence of potassium iodide for starch and glucose and phenol red for urea as an indicator. The activity of the test strip was validated in both raw and processed milk spiked with the respective adulterants.

All the enzyme based test strips were able to detect 2mg/ml of glucose, starch and urea with definite ring formation within a specified time period. The response time for the detection of glucose, starch and urea in milk was noted at  $31.22 \pm 0.014$  and  $30.00 \pm 0.05$ ,  $128.3 \pm 0.88$  and  $129 \pm 0.57$  &  $99 \pm 0.57$  and  $109.67 \pm 0.88$  sec, respectively in Whatman filter paper grade 602 and Whatman filter paper No. 1 at a pH of 4.5, 4.5 and 8.0 and a chromogenic substrate concentration of 40, 50 and 1 mg/ml. The optical density of glucose, starch and urea was found to be almost linear. As the concentration of the substrate increase the optical density value tends to increase proportionately.

The test strip was tested for true positive and true negative results. The limit of detection for glucose, starch and urea were found to be 1.0, 2.0 and 0.8 mg/ml, with response time of 1, 4 and 3 min, respectively.

To see the effect of different processing condition on the ability to degrade glucose, starch and urea in milk, all the test strips showed positive response except in

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**Major Advisor : Dr. Masuk Raquib**

household boiling condition wherein the response was delayed by a few min. The enzyme based test strip were 100 percent specific for detection of glucose, starch and urea as presence of similar types of compounds did not interfere with the positivity rate of the strips which was verified with help of confusion matrix.

The shelf life of enzyme based chromogenic glucose, starch and urea test strips were found to be 40 and 30, 34 and 30 & 42 and 34 d, respectively for Whatman filter paper grade 602 and Whatman filter paper No. 1, respectively when stored under refrigerated storage ( $7\pm 1^{\circ}\text{C}$ ) and ambient storage ( $29\text{-}32^{\circ}\text{C}$ ) condition in airtight glass containers.

# **Effects of Soy Protein Isolate and Inulin on Certain Quality Characteristics of Low-Fat Duck Meat Sausages**

*Sushmita Moirangthem*

Low fat duck meat sausages were prepared by replacing the added fat percent in the formulations with soy protein isolate (SPI) and inulin (I) along with other non- meat ingredients to find out the best formulation which can be stored for reasonable time at refrigeration temperature without affecting its physico-chemical, organoleptic and microbiological qualities. The formulations prepared were - Control (0% SPI and I), T<sub>1</sub> (2.5% I), T<sub>2</sub> (2.5% SPI) and T<sub>3</sub> (2.5% SPI + 2.5% I). Total five batches of duck meat sausages of each formulation were prepared. The raw sausages were cooked in water maintained at 80 - 85°C temperature for 45 minutes. Thereafter, the cooked sausages were packed and stored under refrigeration and evaluated for various quality traits viz., Physico-chemical, Proximate Composition, Calorie Value, Organoleptic Qualities, Microbiological Qualities. In addition to these the cost of production/kg was also calculated out.

Emulsion stability (ES) and cooking yield were significantly ( $p < 0.01$ ) higher in treated formulations with SPI and I compared to the control. The pH value differed significantly between the control and treated formulations and also there was significant ( $p < 0.01$ ) increase in pH values during storage up to 15<sup>th</sup> days. The highest water activity ( $a_w$ ) was recorded in T<sub>3</sub> sample and the lowest values in control sample. Irrespective of the control and treated formulations the water activity ( $a_w$ ) decreased significantly ( $p < 0.01$ ) during the storage period. The TBARS values were significantly ( $p < 0.01$ ) lower in the treated formulations as compared to the control. However, TBARS values increased significantly ( $p < 0.01$ ) during the storage period both in control and treated products. The tyrosine values did not differ significantly between the control and treated formulations although there was significant ( $p < 0.01$ ) increase in tyrosine values during the storage period. Proximate composition of the study revealed significant ( $p < 0.01$ ) increase in the moisture content and percent crude protein while ash content showed no significant ( $p > 0.05$ ) difference. On the contrary, the percent ether extract decreased

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significantly ( $p < 0.01$ ) from the control to the treated groups. The study revealed a significant ( $p < 0.01$ ) decrease in the calorie value from the control to the treated groups. The colour profile revealed no significant difference in all the parameters *i.e.* lightness, redness and yellowness. The texture profile analysis revealed non-significant differences in all the parameters *i.e.* springiness, cohesiveness, chewiness and resilience except in hardness scores that revealed significantly ( $p < 0.01$ ) increasing trend from control to the treated formulations. The taste panel evaluation studies showed a significantly ( $p < 0.01$ ) increasing trend in all the eating quality parameters *i.e.* appearance, colour, flavour, texture, juiciness, overall acceptability. The TVC showed a significant decrease in the treated groups however there was a significant increase in the bacterial load during the storage till day 15<sup>th</sup>. The count was within acceptable limit till day 10. The TVPBC showed a significant ( $p < 0.01$ ) increase in bacterial load from day 5 to 15<sup>th</sup> day of storage. Colititre counts were negative for all the product formulations during storage up to 15<sup>th</sup> day. Cost of production was marginally higher in treatment formulations than the control product.

Based on the results obtained in the study, it might be concluded that low fat duck meat sausages could be prepared satisfactorily by replacing fat with of soy protein isolate and inulin at the rate of 2.5% of each, without adversely affecting the quality of the products.

# **Isolation and Characterization of Bacteriophages and Their Lytic Effects on Multidrug Resistant *Escherichia coli* Strains from Pig**

*Adwitiya Das*

The present study was conducted with a view of isolation and characterization of bacteriophages and study their lytic effects on multidrug resistant *Escherichia coli* strains from pig.

Using host bacteria *Escherichia coli* ATCC 43888, 12 (46.15%) bacteriophages were isolated from a total 26 pig shed effluents collected from different sources viz: ICAR-AICRP/MSP on Pig, College of Veterinary Science, Assam Agricultural University, Khanapara (n=15), ICAR National Research Centre on Pig, Rani, (n=07) and unorganized pig farms (n=04). Statistical analysis interpreted that isolation by preliminary methods like turbidity reduction test (50%), streak plate test (30.76%) and spot test (46.15%) were equally efficient. Transmission electron microscopy confirmed the presence of phages. Plaque morphology of these 12 isolated phages varied from small sized pin headed, clear plaques to large sized diffused plaques ranging from 0.1 mm to 3 mm. Phages appear to have dissimilar profiles of the nucleic acid fragments generated by digestion of their DNA with restriction enzymes like NdeI, SspI, EcoRV, EcoRI, TaqI and HindIII. However, digestion pattern was more distinct with HindIII restriction enzyme.

The present study showed that 92 (90.2%) out of 102 rectal swab samples from diarrhetic piglets yielded *E. coli* from different sources like 41 (91.12%) out of 45 samples collected from ICAR AICRP/MSP on Pig, College of Veterinary Science, Assam Agricultural University, Khanapara and 32 (88.89%) out of 36 samples collected from ICAR-National Research Centre on Pig, Rani, Guwahati, Assam while 19 (90.48 %) out of 21 samples collected from different unorganized farms. For pathotyping of the *E. coli* isolates by multiplex Polymerase Chain Reaction (mPCR), a total of 92 strains of *E. coli* were examined for the presence of stx1, est1, elt1 and eaeA gene using standard primers. The study revealed that 25 isolates were positive for stx1 gene (27.17%), 18 for est1 gene (19.56%), 6 for elt1 gene (6.52%), 3 for presence of both genes est1 and elt1 (3.26%) and 12 for eaeA gene (13.04%).

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**Department : Veterinary Microbiology**

**Major Advisor : Dr. Dilip Kumar Sarma**

Determination of antibiotic sensitivity on the *E. coli* (n=92) isolates revealed that the highest percentage (71.74%) of the *E. coli* isolates were resistant to tetracycline and least percentage of the *E. coli* isolates (4.34%) were resistant to imipenem. Study of lytic effects of the 12 phages on the 46 number of Multi Drug Resistant (MDR) *E. coli* isolates revealed that the 12 phages could exhibit lytic effects on 20 number of MDR *E. coli* isolates out of the total 46 MDR *E. coli* isolates tested. The present study showed the presence of *E. coli* specific phages in pig shed effluents; *E. coli* in piglet diarrhoea having different virulent genes and multidrug resistant *E. coli*. The in-vitro lytic effects of phages on virulent MDR *E. coli* isolates from piglet diarrhoea in the present study has opened up future scope on the application of phages in clinical cases of piglet diarrhoea caused primarily by pathogenic MDR *E. coli* and further characterization of the phages isolated from pig shed effluents.

# **Seroprevalence and Molecular Detection of Bovine Brucellosis and Leptospirosis in Assam**

*Bandana Devi*

Brucellosis and leptospirosis are neglected zoonotic disease prevalent throughout the world. Bovine brucellosis is predominantly caused by *Brucella abortus*. Leptospirosis in bovine is mainly caused by *Leptospira* serovars under the serogroup Sejroe. Both the diseases share some common clinical signs and symptoms and cause severe economic losses. The present study was undertaken to estimate the seroprevalence of bovine brucellosis and leptospirosis and diagnose both the diseases by molecular detection of *Brucella* and *Leptospira* organisms in clinically suspected and seropositive cases. The study was carried out in Assam during August 2021 to July, 2022.

In this study, a total of 1013 cattle serum samples were collected from 11 districts of Assam viz. Tinsukia, Lakhimpur, Dhemaji, Sonitpur, Nagaon, Kamrup-M, Barpeta, Udalguri, Kokrajhar, Dhubri and Cachar, and screened for *Brucella* antibody by Rose Bengal Plate Test (RBPT) and Indirect-enzyme Linked Immunosorbent Assay (i-ELISA) to estimate the seroprevalence of the disease. To detect seroprevalence of leptospirosis, a total of 512 cattle serum samples were collected from 7 districts of Assam viz. Dhemaji, Bishwanath, Nagaon, Kamrup-M, Bongaigaon, Kokrajhar and Dhubri, and tested by i-ELISA for *Leptospira* antibody. A total of 41 serum samples were found to be positive for *Brucella* antibody by both the tests with a seroprevalence rate of 4.04% and 19 out of 512 serum samples were found to be positive for *Leptospira* antibody by i-ELISA with a seroprevalence rate of 3.71%. Higher seroprevalence of brucellosis was recorded in female (4.60%) than in male animals (2.16%). Similarly, higher seroprevalence of leptospirosis was recorded in female (4.53%) than in male animals (1.45%). Age wise seroprevalence of brucellosis was found to be highest in animals of 2.1 to 5 years (1st to 3rd lactation) of age (6.32%) followed by animals of 5.1 years and above (4th lactation onwards) age group (2.90%). In case of leptospirosis, animals of 5.1 years and above (4th lactation onwards) age group showed highest seroprevalence (7.47%) followed by animals of 2.1 to 5 years (1st to 3rd lactation) of age (4.14%).

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**Abstract of M.Sc. Thesis**

**Department : Veterinary Microbiology**

**Major Advisor : Dr. G. K. Saikia**



In both brucellosis and leptospirosis, higher seroprevalence rate i.e., 6.54% and 4.33%, respectively was recorded in crossbred than in local cattle (1.07% and 2.97%, respectively). In case of brucellosis, animals reared in organised farms showed higher seroprevalence (8.94%) than the animals reared in semi-organised (3.08%) and backyard farms (1.63%). On the other hand, in case of leptospirosis, animals reared in backyard farms showed higher seroprevalence (7.20%) than the animals reared in semi-organised (2.63%) and organised farms (2.47%). In relation to animal health status, the seroprevalence of both the diseases were found to be highest in clinically ill animals with 40.90% for brucellosis and 8.18% for leptospirosis than apparently healthy animals i.e., 3.22% for brucellosis and 3.06% for leptospirosis. Again, among clinically ill animals, seropositivity for brucellosis was highest in animals with history of abortion (66.66%) followed by animals with retention of placenta (50.0%) and repeat breeding (33.33%). Similarly, in case of leptospirosis, highest seroprevalence was found in animals with history of abortion (33.33%) followed by animals with retention of placenta (25.0%) and repeat breeding (13.33%).

In this study, both *Brucella* and *Leptospira* antibodies could be detected in 5 out of 512 serum samples screened by i-ELISA specific for both the diseases with a seropositivity rate of 0.976%.

For molecular detection of brucellosis, 41 seropositive (32 apparently healthy and 9 clinically ill) and 23 clinically suspected (seronegative) samples (whole blood, aborted foetus, placenta, vaginal swab) were tested by *Brucella* genus specific PCR. Out of these, 9 clinical samples (39.13%) from seronegative cases and 4 samples (9.75%) from seropositive cases were found to be positive for *Brucella* genomic DNA in *Brucella* genus specific *bcs31* PCR. Overall, out of 64 samples examined, *Brucella* genomic DNA could be detected in 13 number of samples with a positivity rate of 20.31%. All 13 *Brucella* DNA were confirmed as *Brucella abortus* by multiplex PCR (AMOS). For molecular detection of leptospirosis, 19 seropositive (15 apparently healthy and 4 clinically ill) and 33 clinically suspected (seronegative) samples (whole blood, aborted foetus, placenta, vaginal swab and urine) were tested by *Leptospira lipL32* gene PCR. Out of 33 clinically suspected (seronegative) samples, *Leptospira* DNA could be detected in 6 number of samples with positivity rate of 18.18%. *Leptospira* DNA could not be detected from seropositive samples. As a whole, out of 52 samples, *Leptospira* DNA could be detected in 6 sample with an overall positivity rate of 11.53%.

# **Neutralization Efficacy of Classical Swine Fever C-Strain Specific Antibody to Different Genotypes Circulating in North Eastern States, India**

*Jayashree Sarma*

Classical swine fever (CSF) or Hog cholera is a highly contagious viral diseases affecting domestic and wild pigs. It has been a big threat to the piggery sector globally, causing negative impact on the economic background. The disease is highly endemic in India including NER. Assam too records highest CSF outbreaks. The recent outbreaks recorded occurrence of genotype 2.2, 2.1 and 1.2 besides wide prevalence of the historical genotypes 1.1. Outbreaks in vaccinated herds and shift in genogroup 1 to 2 globally, has raised the concern over the antigenic variation, protective immune response and neutralizing capacity of C-strain vaccine antibodies. Thus the present study was undertaken to explore the cross- protection efficacy of C-strain vaccine antibodies to the different genotypes or the need for potential vaccine candidate.

Tissue samples and lyophilized isolates were selected for the study from CSFV repository, Department of Veterinary Microbiology. Sandwich ELISA and nested RT-PCR was done to determine the presence of the virus. Out of total 49 samples, overall positivity in SELISA was 36.0% (18) and in nested RT-PCR was 30.0% (15). The recovery rate of tissue samples was lower (35.0%) in comparison to lyophilized isolate 40.0%.

Molecular characterization of the samples found positive in screening test was done based on E2 full length gene. Five isolates representing each state from north-east was successfully amplified at 1119bp for full length amplification of E2 gene. Genogrouping and phylogentic analysis revealed, genogroups 1.1 and 2.2 circulating in NER showing 98% and 84% nucleotide identity, respectively with the reference Alfort/187 strain. Whereas 99% nucleotide identity within the genogroup.

The five isolates with known genogroups were propagated in PK-15 cell line upto 5th passage level and confirmed by S-ELISA and nested RT-PCR. Four isolates were isolated successfully except the isolate from Assam. The OD value at different

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**Abstract of M.Sc. Thesis**

**Department : Veterinary Microbiology**

**Major Advisor : Dr. N. N. Barman**

passage level ranged from 0.589 to 1.763, showing an increase in titre with each subsequent passage. CSFV\_AAU\_Mg01 showed highest OD value at 5th passage. In-situ demonstration of CSFV by IPT revealed reddish brown cytoplasm indicating replication of the virus in the cytoplasm. TCID<sub>50</sub> of the passaged viruses were done by FAT showing comparable titre (4.49-5.16) with that of vaccine strain at 5th passage level. CSFV\_AAU\_Mg01 showing highest log TCID<sub>50</sub> 10 5.16 log TCID<sub>50</sub> per ml.

Hyperimmune sera was raised using purified cell culture adapted lapinised vaccine showing titres of 1:800 and 1:1600 and used for immunological characterization of the isolates by cross neutralization assay. A 50% neutralization titre of the hyperimmune serum ranged from 1/133 to 1/158 when assayed against the different viruses by FAT. Neutralization and cross – neutralization assay with C-strain specific antibody showed 100% neutralization with genotype 1.1, whereas 84% in genotype 2.2.

The study revealed genotypes 1.1 and 2.2 widely circulating in NER with lower neutralization efficacy of vaccine antibodies to heterologous genotypes.

# **Physicochemical Properties of Live Attenuated Duck Plague Vaccine and Evaluation of Stabilizer Efficacy for Lyophilization**

*Jonmoni Barua*

Duck plague (DP) or Duck Viral Enteritis (DVE) is an acute contagious herpesvirus infection of ducks and waterfowl of the family Anatidae of the order Anseriformes. Anatid Herpesvirus-1 (AHV-1) or duck enteritis virus (DEV) of the family Herpesviridae is the responsible agent for DP or DVE which is a member. The disease is known to have a global distribution and is associated with significant economic losses worldwide. The only method for preventing and controlling the disease is vaccination. Also, an active decontamination process for an effective vaccination programme in field conditions is important. So, in the present study emphasis has been laid to understand the physicochemical properties of a DPV vaccine strain along with evaluation of thermostability of freeze-dried vaccine with different combinations of stabilizers.

In the present study, a vaccine strain of DPV available in the DBT-ADMaC Department of Veterinary Microbiology, College of Veterinary Science, AAU, Khanapara was revived in CEF and selected for study on the basis of identity with DPV by observing CPE, PCR and molecular characterization. Characteristic CPE like vacuolation, rounding, syncytium formation and ultimately detachment of cells were observed, in case of PCR band was observed at 1510 bp which proves similar identity with DPV. Molecular characterization revealed homology with DPV isolates from India (Kerala and Assam) and China. Quantitation was done at each step to find out the titre by TCID<sub>50</sub>/ml after every evaluation right from initial titre, loss of titre during lyophilization, loss of titre during the evaluation of physicochemical treatment, stability evaluation of the freeze-dried vaccine vial, as well as reconstituted vials.

The initial titre was found to be  $6.9 \pm 0.17$ . The vaccine virus was found to be sensitive to temperatures exceeding 56°C and above, pH 3 and below, and pH 11 and above. It was also found sensitive to ether and trypsin. On sterility test, no growth was found on the culture. Lyophilization was carried out with 3 combinations of stabilizers

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namely LS, PTI and LHT. On quality evaluation, PTI and LHT showed uniform cake formation along with minimal loss of titre due to lyophilization. To check the thermostability of freeze-dried vaccines and reconstituted vaccines, vials were exposed at different temperatures. Among the freeze-dried vaccine, LHT could keep the highest titre when exposed to different temperatures and sampled at different time intervals. Although, LS and PTI too could keep with the infectivity titre with minimal loss of titre. In case of the reconstituted vaccine, NSS showed better stability at different temperatures than PBS, though the differences were minimum between the two.

Finally, it can be concluded that LHT is one of the better stabilizers for DPV freeze-dried vaccine production. Alternatively, LS and PTI can be used by utilizing a suitable freeze-drying protocol. PBS and NSS both can be used as a diluent for the lyophilized DPV vaccine although in this study NSS was found to be superior. Hence, stabilizer LHT with diluent NSS was found to be superior for the DPV vaccine strain under this study.

# **Characterization of Methicillin Resistant *Staphylococcus aureus* Isolated from Raw Meat**

*Leons Mathew Abraham*

*Staphylococcus aureus* is an opportunistic pathogen capable of causing multiple diseases of varying severity. Among *S. aureus*, Methicillin-resistant (MRSA) strains have gained particular attention during recent years due to its multi drug resistance property and ability to affect the various systems of the body. The frequent use of antimicrobials at farm is discussed as a risk factor for the wide dissemination of MRSA in livestock production chains including meat and meat products. The present study was taken up primarily with an intention to isolate and characterise methicillin-resistant *S. aureus* from meat sold at the retail outlets in Guwahati city of Assam. The study also included analysis of antimicrobial susceptibility pattern of the isolates and detection of important virulence-associated genes by PCR.

For the study, a total of 309 meat samples were collected. *Staphylococcus* species could be isolated from 166 (53.72%) samples while only 65 (21.03%) were found to be coagulase-positive comprising of 35, 14, 11 and 5 isolates respectively from chicken, pork, chevon and beef samples. On the basis of biochemical tests and PCR detection of *aro A* gene, 61 (93.84%) out of the 65 coagulase positive isolates were confirmed as *Staphylococcus aureus*, of which 33 (94.28%) were from chicken, 12 (85.71%) from pork, 11 (100%) from chevon and 5 (100%) from beef samples. The antibiogram of the 61 *S. aureus* isolates was determined by the Disk diffusion method employing 12 antimicrobial agents. The highest resistance was observed against Penicillin (85.24%) followed by Oxytetracycline(63.93%), Enrofloxacin (62.29%), Amoxycillin/ Clavulanic acid (44.26%), Oxacillin (36.06%), Neomycin (36.06%), Cefuroxime (34.42%), Gentamicin (31.14%), Cefoxitin (29.50%), Streptomycin (26.22%), Piperacillin/Tazobactam (26.22%) and Teicoplanin (6.55%). Out of the 61 isolates, 50 (81.96 %) showed resistance against 3 or more antibiotics while six (9.83%) isolates were resistant to ten out of the twelve drugs tested. All the isolates were resistant to atleast one antibiotic but none showed resistance against all the 12 antibiotics.

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Cefoxitin and Oxacillin based disc diffusion test was employed for phenotypical detection of Methicillin resistance. A total of 18 (29.50%) *S. aureus* isolates were resistant to Cefoxitin while 22 (36.06 %) isolates were resistant to Oxacillin. Growth characteristics on MeReSa agar and Epsilometeric test using Cefoxitin yielded similar results to that of the disk diffusion test using Cefoxitin. For confirmation, the 18 phenotypically positive MRSA isolates were subjected to PCR for the detection of the *mecA* gene, and all the 18 (100%) were found to be positive. Considering the total number of samples collected (n=309), MRSA could be isolated from only 18 (5.82%) samples. It was observed that 11 (7.63%) out of the total 144 chicken samples, 3 (4.16%) out of 72 pork, 3 (5.17%) out of 58 chevon and 1 (2.85%) out of 35 beef samples were MRSA. Furthermore, the PCR amplification of the isolates targeting the thermonuclease, *nuc* gene showed that all the 61 *S. aureus* isolates were positive. This study also evaluated the presence of the enterotoxin A, *sea* gene in meat as *S. aureus* is a major pathogen when it comes to food-borne illnesses. Interestingly, only 2 (3.27%) out of the 61 isolates were found carrying the *sea* gene.

# **Adaptation of Mesogenic Newcastle Disease Virus (Genotype XIII) In Vero Cell and Its Immunogenic Potential**

*Lewamangphika Rapthap*

The ever-occurring vaccination failures and outbreaks of Newcastle disease (ND) globally and nationally underscore the need to develop genotype-matched vaccines that can reduce outbreaks and viral shedding. The present study describes the adaptation and attenuation of a mesogenic genotype XIII Newcastle disease virus (NDV). The isolate (As/GP/18/92) was obtained from the repository of Department of Veterinary Microbiology under DBT Twinning project on —An integrated omics approach to characterize circulating Newcastle disease virus and intervention strategies to control Newcastle disease in North-East India, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati-22, Assam. The isolate was adapted in Vero cell line passages up to the 20th passage without addition of any extraneous supplement. Cytopathic effects (CPE) were observed from the 3rd passage onwards which was characterized by grouping, clumping, rounding of the cells at 48 hours post inoculation (hpi) with ultimate detachment of the cell monolayer at 72hpi. At every 5th passage, the growth of the Vero-adapted NDV was confirmed by Haemagglutination assay (HA), virus isolation in 9-to-11-day old Specific Pathogen Free (SPF) embryonated chicken eggs and molecular confirmation by RT-PCR targeting *F* gene (363bp). Sequence analysis of the original (P0) and 20th passage (P20) Vero cell adapted virus revealed no changes in the F-Protein Cleavage Site (FPCS) region. However, nucleotide changes were observed in the M protein region. The TCID<sub>50</sub> values in Log<sub>10</sub>/ml of every 5th passage increased with an increase in passage levels (P5- 10-3.5TCID<sub>50</sub>, P10-10-4.78TCID<sub>50</sub>, P15-10-5.23TCID<sub>50</sub>, P20-10-6.23TCID<sub>50</sub>). At every 10th passage, biological characterization of the Vero-adapted virus revealed that the virulence of the virus decreased with increase in the passage levels. The mean death time (MDT) of passage 1, passage 10 and passage 20 in hpi was recorded as 77.8±1.68, 81.6±0.66 and 84.0±0.57 respectively. Moreover, the intracerebral pathogenicity index (ICPI) of passage 1, passage 10 and passage 20 was recorded as

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1.39, 1.27 and 1.16 respectively. The immunogenic trial of 20th passage Vero cell adapted NDV was conducted on 21- days old broiler birds (n=30). Group I (n=10) immunized with 20th passage Vero cell adapted virus revealed significantly similar Haemagglutination inhibition (HI) and ELISA titre at day 7 (4.50±0.34, 3.88±0.34), day 14 (6.00±0.57, 5.40±0.40), day 21 (7.83±0.40, 8.76±0.36), day 28 (8.33±0.21, 9.72±0.30) and day 35 (8.00±0.25, 9.60±0.51) with group II (n=10) immunized with commercially available R2B vaccine at day 7 (4.66±0.33, 3.75±0.40), day 14 (5.66±0.42, 5.00±0.34), day 21 (8.00±0.36, 8.90±0.32), day 28 (8.17±0.40, 9.52±0.50) and day 35 (8.16±0.30, 9.41±0.57). Group III (n=10) was kept as unvaccinated control. These findings indicate that on the basis of biological characterization, the virulence of the adapted virus decreased with an increase in the passage levels. Moreover, the immunogenic potential of the Vero cell adapted virus (As/GP/18/92) in terms of humoral immune response was found to be significantly similar with commercially available R2B vaccine. Therefore, the isolate (As/GP/18/92) can be considered as a genotype-matched vaccine candidate in the future.

# **Immune Response of Pigs Vaccinated with Classical Swine Fever (CSF) Diva Based Vaccine and Cell Culture Adapted Lapinized Vaccine**

*Nouluongunuo Suokhrie*

Classical swine fever is a highly contagious, haemorrhagic, and multisystemic viral disease affecting domestic pigs, wild hogs and pygmy hogs. It is an economically devastating disease and therefore control of the disease is of utmost importance. In endemic country like India including north Eastern States, vaccination is the best way to prevent and control the disease. Although live attenuated vaccines are available, protective immunity is obtained only after booster vaccination. Therefore, immune response can be enhanced with use of oil adjuvanted vaccines. A great disadvantage of live attenuated vaccine is its inability to differentiate infected with that of vaccinated populations. Therefore, CSF-DIVA based vaccine with a reliable companion diagnostic assay is highly desirable for successful implementation of control programme against CSF. In the present study, two groups of CSFV free pigs were immunized with Baculovirus expressed Erns-deleted CSF virus like particle (VLP) as vaccine as well as PK-15 cell culture adapted whole CSFV vaccine, both adjuvanted with montanide oil adjuvant. Potency of Erns deleted classical swine fever VLP-DIVA vaccine was first carried out with aluminium hydroxide as the adjuvant. Immune response was assayed by indirect ELISA and neutralizing assay. Vaccinated pigs elicited early antibody by 7<sup>th</sup> dpv ( $2.86 \pm 0.09$ ;  $2.10 \pm 0.15$ ) with peak antibody titre on 30th dpv ( $3.86 \pm 0.07$ ;  $3.51 \pm 0.10$ ) and maintained high antibody titre upto 180th dpv ( $2.91 \pm 0.06$ ;  $2.45 \pm 0.20$ ). Single montanide oil adjuvanted whole CSFV vaccine effectively stimulated neutralizing antibody with 90-95% inhibition titre. However, montanide oil adjuvanted CSF-VLP vaccinated group failed to elicit neutralizing antibody.

To develop DIVA based companion ELISA, CSFV Erns protein was expressed in PK-15 cell line. Cell lysate used as the coating antigen was optimized with the concentration of 5 µg/well and blocking buffer standardized with 5% LAH and 2% goat serum. The Erns ELISA could distinctly differentiate CSF-VLP-DIVA vaccinated animals from naturally infected CSFV as well as whole CSFV vaccinated animals. The

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present study highlights that oil adjuvanted whole CSFV vaccines was safe and elicited high neutralizing antibody titre with single vaccination till marketable age of pigs. Although oil adjuvanted CSF-VLP-DIVA vaccine elicited high ELISA titre, it failed to develop neutralizing antibody. Therefore, factors related to the development of neutralizing antibody in oil adjuvanted CSF-VLP-DIVA vaccine in pigs need to be explored further in details. As companion DIVA based ELISA, Erns coated protein could distinctly differentiate CSF-VLP-DIVA vaccinated animals from naturally infected CSFV as well as whole CSFV vaccinated pigs.

# **Isolation of Foot-And-Mouth Disease Virus Type ‘O’ of Bovine and Porcine Origin in Different Cell Lines and Molecular Characterization of the Adapted Virus**

*Ray Kayaga*

The aim of this study was to isolate Foot-and-mouth-disease virus type O from bovine and porcine origin in different cell lines and molecular characterization of the adapted virus after passaging. The study showed that, the virus clustered in a different group with a confident bootstrap value of 99%. The strains appeared to branch out as a topologically distinct group among the different topotypes, along with two other isolates from India and neighbouring countries. The strains when aligned with other Indian isolates showed distinct point mutations. Furthermore, the FMD strains showed 68 bootstrap confidences among themselves emphasizing on difference among isolates from different host. Following isolation and adaptation in different cell lines, the study reveals that BHK-21 cells are the most suitable cells for supporting maximum infectivity titer of FMD virus serotype ‘O’ followed by MDBK and PK-15 cell lines. Findings in the second objective of molecular characterization of the adapted virus showed that the sequence of VP1 gene remains the same in as many as five adapted virus in different cell lines. However, in this study there were single nucleotide point mutations observed among the adapted strains when compared with the parental strain. Furthermore, these point mutations did not cause any change in the amino acid pattern except for one change from tryptophan to isoleucine at amino acid residue number 74 in the bovine origin strain adapted in BHK21 cells after at 10th passages level. Such change from nonpolar to hydrophobic amino acids might result in conformational changes in the protein structure affecting its functionality. The study confirmed that the VP1 gene of FMD isolates were quite stable on cell adaptation.

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**Major Advisor : Dr. Krishna Sharma**

# **Thermoadaptation of a Newcastle Disease Virus Isolate from Duck and Its Immunogenic Potential**

*Sangeeta Das*

Newcastle disease (ND) is a highly infectious and contagious viral disease of poultry having significant economic impact on production due to the soaring morbidity and mortality associated with it. The effective measure to curb the economic menace of ND is by only biosecurity measures and effective vaccination. To date, a number of effective live vaccines are extensively used for ND control. It is important to note here that most, if not all, of these live vaccines are heat labile and require storage at a temperature range of 2-80C at all times to maintain their efficacy, which is challenging under village conditions or remote areas that are often beyond the reach of the cold chain. Addressing the need of thermostable vaccine development, in the present study an attempt was made to thermoadapt a lentogenic ND virus (NDV) isolate from duck (As/Km/19/44) and evaluate its immunogenic potential.

In the present study, the NDV isolate was adapted in Vero cells by supplementing the culture media with exogenous proteases: 10% allantoic fluid and acetylated trypsin (2.5µg/ml). The Vero cell adapted As/Km/19/44 was assessed for thermostability by subjecting the isolate at 250C, 400C and 560C directly for different time intervals. Initially, the isolate retained 50% haemagglutinin (HA) activity and infectivity for 60 and 30 mins at 250C and 400C respectively. However, the isolate lost its HA activity and infectivity at 560C within 5 mins.

In the present study, thermoadaptation of the Vero cell adapted As/Km/19/44 was done by selective heat treatment. For this, the Vero cell adapted NDV isolate was exposed to 10 thermal cycles i.e treatment at 400C for 30 mins followed by 10 passages in Vero cells. After 10 thermal cycles, the Vero cell adapted NDV isolate was able to withstand for a period of 2 hours at 400 C and 15 mins at 560 C. The haemagglutinin neuraminidase (*HN*) gene sequences of the Vero cell adapted NDV (prior thermal exposure), 5th and 10th passage thermoadapted NDV were analysed for assessing the molecular changes, if any, induced during thermoadaptation. In the present study, the 10th passage thermoadapted NDV had nucleotide substitution at position 87(C→T),

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317(C→A) and 512(G→T) with its counterpart untreated Vero cell adapted NDV sequence which resulted in substitution of the amino acid alanine (A) with glutamic acid (E) at position 317(A→E) and glycine (G) with valine (V) at position 512(G→V). However, nucleotide substitution at position 87(C→T) did not lead to any substitution of the amino acid Valine (V). Thus, nucleotide substitution within the *HN* gene might have contributed to thermostability of the isolate.

In the present study, inexpensive chemical stabilizers were used to further thermally stabilize the 10th passage thermoadapted NDV isolate. Following chemical stabilization with a mixture of 10% (W/V) Pullulan, 0.5 M Trehalose and 45mg/ml Inulin, the thermoadapted NDV was able to withstand 50% HA activity and infectivity for up to 5 days at 40°C and 18 hours at 56°C. Moreover, the reconstituted virus sample could tolerate 400C for 120 mins and 15 mins after exposure at 560C. Finally, the 10th passaged thermoadapted and chemically stabilized As/Km/19/44 were administered by intraocular route to experimental chicks with a standard dose of 106 EID50 per chick to evaluate their immunogenic potential and compared with the conventional Lasota vaccine strain. The HI log<sub>2</sub> and I-ELISA log<sub>10</sub> antibody titers in the serum samples of the experimental chicks at different days post immunization revealed that there was no significant difference (P<0.01) between the immune response of thermoadapted As/Km/19/44 and the conventional Lasota vaccine strain.

The present study revealed that the thermoadapted lentogenic NDV isolate was found to be equally immunogenic in eliciting immune response with conventional LaSota vaccine strain and therefore, the thermoadapted lentogenic NDV may be explored further as a potential alternative to the currently available lentogenic NDV vaccine to ensure better effectiveness of ND vaccine in developing countries, especially in remote areas with minimum cold chains.

# **Attenuation and Molecular Characterization of Vero Cell Line Adapted Goatpox Virus Isolate from Assam**

*Shyama Prasad Panda*

Goatpox and Sheeppox are highly contagious, trans-boundary viral diseases of sheep and goats, clinically characterized by pyrexia, lacrimation, secondary bronchopneumonia with nasal discharges and generalized pox lesions with lymphadenopathy causing high mortality and morbidity. Diseases caused by CaPVs are economically important as they cause significant production losses due to high morbidity, reduced milk yield, decrease in weight gain, increase abortion and damage to wool and hides. Control of the disease can only be effective by mass vaccination of all susceptible sheep and goats by single vaccine through intradermal or subcutaneous route with OIE recommended safe dose of GTPV vaccine (102.5 TCID<sub>50</sub>). A variety of live and inactivated goatpox vaccines are being produced commercially. However, inactivated vaccines produce only short-term immunity. Live attenuated vaccine is the better choice for long term immunity against CaPVs. Therefore, in the present study one indigenous strain of goatpox virus was adapted and attenuated in Vero cell line and characterized molecularly. In the present study total nine local GTPV isolates, maintained in the Department of Microbiology, C.V.Sc, AAU, were revived in Vero cell line. Identity of the isolates were confirmed by virus specific cytopathic effects and molecularly by realtime PCR and PCR-RFLP. Among all the isolate GTPV/AsKa/14 was selected for attenuation, based on the degree of characteristic CPE and TCID<sub>50</sub> evaluated virus titer at passage 15 (i.e. 105.75TCID<sub>50</sub>) in Vero cells. Selected isolate was propagated up to passage 50 with confirmation of presence of virus at different passage level by partial length amplification of P32 gene of goatpox virus. Gradual increase in the infectivity titer of the virus isolate was observed and found to be 106TCID<sub>50</sub> at passage 50. Required titer of virus was calculated and adjusted to single recommended vaccine dose 103TCID<sub>50</sub> and 50 vaccine dose 104.7TCID<sub>50</sub> for preparation of inoculum. Sterility test of the prepared virus inoculum was performed to confirm the absence of any contamination. After 14 days of incubation prepared

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inoculum was found to be sterile. Total 18 no. of goats under 3 groups were used for safety test of the attenuated virus isolate. Group 1 animals were immunized with 1 single recommended vaccine dose of the isolate where group 2 animals were immunized with 50 recommended vaccine doses subcutaneously and group 3 animals, injected with 1ml of normal saline were kept as control. Animals were found apparently healthy without any adverse reaction or any thermal reaction even after 28 days post immunization showing the safety of the attenuated virus isolate. Antibody response was also calculated by indirect ELISA and SNT. Initially on 7th day ELISA titer (Log10) was  $30 \pm 4.9$  while on 28th day it was  $426.67 \pm 78.3$ . Similarly, in SNT 50% neutralization titer (Log10) was  $24 \pm 1.66$  and on 28th day it was found to be highest  $150 \pm 15.4$ . Molecular characterization and sequence analysis of P32 gene of goatpox virus isolate under the present study revealed that the attenuated GTPV isolate shared identity to some extent with other GTPV isolate from different parts of world and with the commercial vaccine strain. At nucleotide and amino acid level the attenuated virus isolate shared 99.6% sequence identity and 0.4% deviation from the original virus isolate. Though, there was no significant difference in amino acid sequence level.



# **Molecular Characterization of Avipoxvirus from Domestic Ducks**

*Sumi Chungkrang*

Avipoxvirus (APV) is a slow spreading, highly contagious viral disease causing morbidity and mortality in both domesticated and free ranging birds which results in economic losses in poultry industry. APV in duck is endemic in Assam. A few studies have been conducted on APV in duck. Farmers of Assam rear duck without following much scientific management practice leading to increase the chance of APV infection in duck. Therefore, the present study was undertaken to study the prevalence in Assam, to isolate in suitable system and to characterize the isolated virus by molecular techniques. Out of 60 samples collected from the infected ducks of Assam, 57 were found to be positive for APV. Percent positivity of the samples for Avipoxvirus by PCR were found to be 95% (57/61). According to age group, highest number of positivity was recorded in 0-8 weeks (45/45) followed by 9-20 weeks (12/14). Among different age groups the highest morbidity was recorded at 0-8 weeks (85%) followed by 9-20 weeks (60.9%) and above 20 weeks (11.1%). The total morbidity 71.4% and cause specific mortality 15.0% was recorded in this study. A total of five isolates were selected for isolation in embryonated eggs, CEF/DEF and Vero cell line. Morphological changes such as oedematous thickening, swelling and typical pock lesion on CAM and characteristic CPE in cells including rounding, vacuolation, shrinking and detachment of cells were observed. CPE like rounding and detachment of cells were observed from the 2nd passage and from the 8th passage in CAM adapted isolates and field isolates respectively in Vero cell line. Isolation of APV at each passage level was confirmed by conventional PCR targeting the P4b core gene. Molecular characterization of the isolated APV was done by cloning and sequence analysis revealed the sharing of P4b gene under present study with other APVs reported from different parts of the world at nucleotide level (nt) level.

The present study concluded that APV in duck is common in Assam indicated by high number of positivity. APV could be successfully isolated in embryonated eggs, fibroblast cell and Vero cell line and demonstrated by conventional PCR. Molecular characterization study revealed that APV isolates of Assam were clustered along with other reported APV from India and other parts of the world.

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# **Trematode Parasites of Asian Elephant (*Elephas maximus*) with Special Reference of Liver Fluke**

***Bandanpreet Kour Raisim***

A prevalence study of intestinal trematode parasites in Asian elephant (*Elephas maximus*) was conducted on faecal samples received from 5 different protected areas of Assam including the Assam State Zoo-cum-Botanical Garden from the month of March 2019 to June 2019. Out of total 85 samples examined, 50.00 (58.82%) sample was found positive for trematode parasitic infection. Samples received from Pobitora Wildlife Sanctuary had highest rate of infection (81.81%) followed by samples from Manas National Park, Laokhowa Wildlife Sanctuary and Assam State Zoo-cum-Botanical Garden which had lowest (33.33%) rate of infection. Amongst positive samples the rate of infection for *Fasciola jacksoni*, amphistomes and mixed infection of *F. jacksoni* and amphistomes was found in 21 (42.00%), 43(86.00%) 35 (70.00) samples, respectively. Four different trematode parasites could be recovered from the samples. Morphologically the parasites could be identified as *Pseudodiscus collinsi* (Cobbold, 1875), *Gastrodiscus secundus* (Looss, 1907), *Pfenderius birmanicus* (Bhalerao, 1935) and *Pfenderius pappilatus* (Cobbold, 1882). Surface morphology of *G. secundus* was studied using SEM. Molecular characterization of *P. collinsi* and *G. secundus* was done amplifying ITS2 rDNA gene with conventional PCR method. The query sequence showed 99.16% similarity with *G. hominis* and 98.88% similarity with *Homalogaster paloniae*. The distance matrix of *P. collinsi* showed a maximum similarity of 93.36% with *Watsonius watsoni*. Comparative morphological studies between liver fluke of Asian elephant and *Fasciola* species of cattle, buffalo and goat showed that the elephant liver fluke was *Fasciola jacksoni* (Cobbold, 1869) and the *Fasciola* species of cattle, buffalo and goat was *Fasciola gigantica* (Cobbold, 1885). Morphologically the *F. jacksoni* differed substantially from the latter species. Ultrastructural studies conducted with SEM on *F. jacksoni* revealed significant surface features. A phylogenetic analysis conducted for *F.jacksoni* of Asian elephant and *F. gigantica* of cattle, buffalo and goat targeting ITS1, ITS2 and *nadI* gene by conventional PCR showed that *F. jacksoni* was a distant outlier to *F. gigantica* of cattle, buffalo and

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goat. Phylogenetically *F. jacksoni* (Assam isolate) was similar to Sri-Lankan isolate of *F. jacksoni* and *Fascioloides magna*. A comparative gross and histopathological study was conducted on the liver of Asian elephant affected with *F. jacksoni* and *F. gigantica* in cattle, buffalo and goat. There were both gross and histopathological differences between the affections caused by *F. jacksoni* in elephant and *F. gigantica* in the three ruminant hosts. Moreover, the lesions in elephant liver produced by *F. jacksoni* when compared with that of lesions produced by *Fascioloides magna* from published literature revealed similarities.

# **Ectoparasites of Goat with Special Reference to Mange Mite**

*Debjani Borah*

A study was conducted in and around Guwahati for a period of one year from July 2021 to June 2022 to study the prevalence of different ectoparasites in goats. Different ectoparasites in goat found to be prevalent in this area were ticks (67.32 %), lice (43.02%), flea (68.44%) and mite (14.38%). *Haemaphysalis bispinosa*, *H. hystricis*, *Rhipicephalus (Boophilus) microplus*, *Linognathus africanus*, *Damalinia (Bovicola) caprae*, *Ctenocephalides felis orientis*, *C. canis*, *C. felis felis* and *Sarcoptes scabiei* var. *caprae* were the prevalent species of ectoparasites found throughout the year. In the present study *Linognathus africanus* and *Damalinia (Bovicola) caprae* were reported for the first time in goat in Assam. Seasonal prevalence of the ectoparasites was studied in different climatic conditions of Assam namely temperature, humidity and rainfall. Prevalence of tick was found to be highest in the pre-monsoon season (March, April and May). The highest prevalence of lice, flea and mite was observed in the winter season (December, January and February). A significantly higher prevalence of tick and flea was observed in female goats than the male ones whereas prevalence of lice and mite was not dependent on the gender of the goats examined. Prevalence of ticks and mite was significantly higher in goats aged more than 6 months. Significantly higher prevalence of flea was observed in the goats below 6 months of age. Prevalence of lice was independent of age.

Doramectin (Advanto®) @1ml/50kg b.wt. showed better results in the treatment of goats naturally infested with *Sarcoptes scabiei* var. *caprae* in comparison to Ivermectin (Parid pour-on @1ml/10kg b.wt.) and Castor oil (an indigenous knowledge-based acaricide). The haemoglobin, PCV, TEC and lymphocyte levels in the treated goats were observed to have a highly significant increase ( $p < 0.01$ ) post-treatment (day 48). The TLC, neutrophil and eosinophil levels showed a highly significant decrease ( $p < 0.01$ ) and monocyte per cent were observed to have a significant decrease ( $p < 0.05$ ) after treatment (day 48) with the three acaricides. Oxidative stress parameters revealed that malondialdehyde (MDA) level was seen to be higher and the superoxide dismutase (SOD) and glutathione peroxidase (GPx) activities were seen to be lower in goats

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**Major Advisor : Dr. Ranjeet Neog**

infested with *S. scabiei* var. *caprae* mite in comparison to their normal range of healthy goats kept as control. This implies that the goats infested with *S. scabiei* var. *caprae* were in a state of oxidative stress prior to the treatment(s) and with the progress of the treatment(s), the goats showed a significant decrease in MDA level and increase in SOD and GPx activities indicating a reduction of oxidative stress in the treated goats due to the treatment(s).

# Tick and Mite Infestation in Dog in and Around Guwahati, Assam

*Pratik Bhowmik*

A total of 582 dogs of different breed, age group, sex and categories were examined for presence of ticks and mites in and around Guwahati, Assam for a period of one calendar year from March 2019 to February 2020. The overall prevalence of tick was 58.76 per cent (342/582). The prevalence of *Demodex* sp. was found 19.75 per cent (115/582) and *Sarcoptes scabiei* var. *canis* was 1.89 per cent (11/582), respectively. *Rhipicephalus sanguineus*, was the only tick species found in the study. Morphometric study of *Demodex* revealed highest mean body length in *Demodex injai* followed by *D.canis* and *D.cornei*. Breed-wise prevalence of tick was recorded highest in Mongrels (75.00%). Sex-wise, prevalence in male dogs was higher (70.10%) than the females (47.42%). Age-wise, highest prevalence was recorded in dogs below 1 year (89.38 %). Season-wise, highest prevalence was recorded during monsoon season (70.79%). Category-wise, highest prevalence was recorded in stray dogs (92.77%). *Demodex* sp. and *Sarcoptes scabiei* var. *canis* were recorded highest in Labrador retriever (42.72%) and in German shepherd (7.24%) breeds of dog, respectively. Sex-wise, prevalence of both mite species was more in male (*Demodex* sp. 23.02% and *Sarcoptes scabiei* var. *canis* 2.40%) than the female dogs (*Demodex* sp. 16.49% and *Sarcoptes scabiei* var. *canis* 1.37%). Like-wise, the prevalence of both the mite species was higher in dogs below 1 year age (*Demodex* sp. 32.74% and *Sarcoptes scabiei* var. *canis* 2.65%) than dogs above 1 year age (*Demodex* sp. 11.51% and *Sarcoptes scabiei* var. *canis* 1.40%). Season-wise, prevalence of *Demodex* sp. and *Sarcoptes scabiei* var. *canis* was highest in pre-monsoon (25.30%) and in winter (4.72%), respectively. Category-wise, prevalence of both the mite species was more in stray dogs (*Demodex* sp. 35.54% and *Sarcoptes scabiei* var. *canis* 4.81%). Polymerase Chain Reaction (PCR) analysis confirmed the identification of *Rhipicephalus sanguineus* tick and *Demodex* sp. mite. Histopathologically, formation of pouch-like structures along with aggregation of infiltrating leukocytes were observed in the tick infested skin area. In the skin section infested with mite, large numbers of infiltrating cells in the epidermal areas with cross section of mites in the hair follicle were seen.

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## **Forensic Entomology-Based Post-Mortem Interval Estimation in Animals and Birds**

*Souvik Sarma*

A study was conducted to estimate the Post-Mortem Interval (PMI) of carrions using the techniques for forensic entomology. A total 8 carrions/baits were allowed to attract fly species in the refugia. Larvae were collected from these carrions and allowed to develop up to adult stage in laboratory. Daily larval development in terms of larval length, ambient temperature and relative humidity was recorded. Based on the morphological characteristics of the eggs, larva, pupa and adults, 4 different fly species could be taxonomically identified which were attracted by the carrions/baits, namely, *Sarcophaga pattoni* (Senior-White, 1924), *Chrysomya megacephala* (Fabricius, 1794), *Lucilia sericata* (Meigen) and *Chrysomya rufifacies* (Macquart, 1843). Multiple Linear Regression analysis of Time (day) was done using the data on Daily development in length (mm) of larvae, ambient temperature ( $^{\circ}\text{C}$ ) and relative humidity (RH%). The  $R^2$ ,  $R^2$  adj., RMSE for each species of carrion was examined to check the reliability of estimated models which was found significantly reliable in estimation of PMI for all the carrions/baits under study. Bivariate non-linear regression of Time (day) was calculated on the length of larvae retrieved from the carrions. The  $R^2$  value for each of the carrions showed that the non-linear polynomial regression was reliable and the data from only larval length was sufficient to calculate the PMI for which a nonlinear regression equation was established for each of the species of carrion/bait whose time of death was known. In another set of observation, 4 carrions were collected whose time of death was not known. The carrions had already been frequented with carrion feeding fly species. These flies had laid their eggs on the carrions. Larvae from these carrions were incubated in laboratory under ambient temperature and relative humidity till they were adult. The daily larval development, ambient temperature and relative humidity were recorded. Two fly species i.e. *Sarcophaga pattoni* and *Chrysomya rufifacies* was found in these carrions. The regression equations which were developed in the first set of observation in which the time of death was known were used to estimate the PMI of these four carrions. The replicates were selected on the basis of similar or nearest meteorological parameters and the species of fly larva acquired from the carrions in the

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first set of observations. While using the equation in order to estimate the PMI of the carrions under study, the values of larval length in the regression equations was substituted by the values of larval length acquired from the carrions whose time of death was not known. Thus, the PMI was estimated for the carrion of Lesser Indian civet which was 6.182 days and 7.304 days according to larval length of two different fly species; for squirrel the PMI was estimated to be 3.864 days; for chicken and a mongrel pup the estimated PMI was 6.000 days and 2.678 days, respectively. Molecular characterization of the sample revealed that *C. megacephala* isolate from Assam had 91.19% similarity to the isolate from Singapore. Similarly, the Assam isolate of *S. pattoni* and *C. rufifacies* had maximum similarities of 98.21% and 99.57% with the isolates from Singapore and Malaysia, respectively. This was the first detailed experimental investigation on veterinary forensic entomology using bivariate nonlinear regression analysis to estimate the PMI.



# **Pathomorphological and Molecular Studies of Respiratory Mannheimiosis in Goats**

*Amdedul Islam Mazumder*

The present investigation was conducted to study the pathomorphological and molecular studies of respiratory Mannheimiosis in goats for a period of one year from March 2021 to February 2022. The materials for the present study were collected from various sources such as slaughter houses in and around Guwahati and from postmortem examinations carried out in the Department of Veterinary Pathology, College of Veterinary Science, A.A.U., Khanapara, Guwahati-22. Based on gross observation 30 lungs showing lesions of pneumonia were collected during post mortem examination. Twenty one lung samples showing pneumonic lesions were also collected from slaughter houses. For detailed bacteriological and pathological studies all of the 51 pneumonic lungs were chosen.

A total of 43 isolates of bacteria were obtained in the present study out of which seven isolates were morphologically and biochemically positive for *Mannheimia haemolytica* (16.28%). Apart from this, other bacteria isolated were *Pasteurella multocida* (23.26%), *E. coli* (20.93%), *Klebsiella* spp. (18.60%), *Staphylococcus* spp. (13.95%) and *Streptococcus* spp. (6.98%).

All the 7 isolates of *Mannheimia haemolytica* were screened for *Lkt* and *16s rRNA* gene respectively. The *Lkt* gene with amplicon size 206 bp and the *16s rRNA* gene with amplicon size 1500 bp was detected in all the 7 isolates of *Mannheimia haemolytica*. The Phylogenetic analysis of *16s rRNA* gene of *Mannheimia haemolytica* isolated from goats in the present study showed percent identity above 97 percent with other strains of *Mannheimia haemolytica* present in the NCBI Gene Bank throughout the world.

Different types of pneumonia associated with respiratory Mannheimiosis recorded during the present study were bronchophneumonia (37.25%), interstitial pneumonia (27.45%), haemorrhagic pneumonia (19.61%), suppurative pneumonia (11.76%), and fibrinous pneumonia (3.92%).

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**Major Advisor : Dr. Shameemara Begum**

Patchy areas of consolidation in the cranioventral portion of lungs were the most commonly observed gross lesion in bronchopneumonia. Microscopically, bronchopneumonia was characterized by neutrophils and mono-nuclear cell infiltration with presence of fibrin in the bronchi, bronchiole, alveolar lumen and pleura.

Interstitial pneumonia cases were characterized by enlarged and rubbery lungs which do not collapse when the thorax is opened. The interlobular septa were distended with exudate. Microscopically, alveolar wall was thickened due to infiltration of polymorphonuclear cells and lined by cuboidal epithelial cells. Alveolar lumen was also filled with polymorphonuclear cells, macrophages and desquamated epithelial cells.

Haemorrhagic pneumonia cases revealed multifocal, patchy to diffuse areas of haemorrhage throughout the lung surface. Microscopically, there was hemorrhage within the alveoli and inter alveolar septa with leukocytic infiltration in the bronchus. The wall of the bronchus also showed the inflammatory changes. Areas of emphysema were also observed.

Gross pathological alterations observed in suppurative pneumonia were multiple focal abscess formation on lung surface. Presence of creamy suppuration could also be noticed in tracheal lumen. Microscopically, heavy infiltration of neutrophils could be seen in bronchial and alveolar lumen. In some cases necrotic mass admixed with bacterial colonies surrounded by thick connective tissue capsule were also recorded with infiltration of polymorphonuclear cells, mononuclear cells, plasma cells and macrophages.

In fibrinous pneumonia, lungs were covered with stringy net like material. Excess serous fluid was present in the pleural and peritoneal cavities. In few cases the lungs was tightly adhered to the thoracic wall due to deposition of fibrin. The interlobular septa were prominent due to accumulation of fibrin. Microscopically, fibrinous pneumonia was characterized by the presence of intra alveolar fibrin in the form of “fibrin balls” within the alveolar spaces. The traditional ‘oat cells’ and necrotic macrophages were present inside the damaged alveoli.

# **Prevalence and Pathology of Duck Pasteurellosis and Its Concurrent Infection With Duck Virus Enteritis**

*Anjali Das*

Duck Pasteurellosis is a contagious and septic bacterial disease of ducks. Duck Pasteurellosis remains as constant threat to duck farming. Among the viral diseases, duck virus enteritis is one of the major contagious and fatal disease of ducks, geese and swan. Sometimes duck Pasteurellosis and duck virus enteritis occur concurrently making high mortality of ducks. Recorded occurrence of duck Pasteurellosis and its concurrent infection with duck virus enteritis in Assam is found to be scanty in available literature. Though both the diseases are studied separately there is no detail study of both the diseases together. The present work was undertaken to study the prevalence and pathomorphological alterations of duck Pasteurellosis and its association with duck virus enteritis.

In the present study, prevalence and pathology of duck Pasteurellosis and its concurrent infection with duck virus enteritis were studied in different age group of ducks during the period of April, 2017 to December, 2019. Besides clinical and postmortem findings, laboratory diagnosis is utmost necessary for confirmation of the disease.

For the laboratory diagnosis, swab samples were collected from trachea, nasal orifice and cloaca as well as tissue samples from lungs, liver, spleen, heartblood, heart and kidneys. Out of a total 2,130 ducks from organized and unorganized farms, 500 swab samples (Tracheal swab, nasal swab and cloacal swab) and necropsy samples from 233 number of ducks were examined. The total prevalence rate of duck Pasteurellosis, duck virus enteritis and concurrent infection were recorded as 1.69%, 2.20% and 0.42% respectively on the basis of molecular diagnosis of swab samples and necropsy samples.

Occurrence of duck Pasteurellosis was found highest in ducklings (63.88%) followed by adult (22.22%) and 13.88% in growers. In case of duck virus enteritis highest occurrence was found in ducklings (53.19%) followed by adult (29.78%) and

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growers (17.02%). Occurrence of concurrent infection was found highest in ducklings (66.66%) followed by adult (22.22%) and grower (11.11%).

Clinical signs in all the three conditions were similar with huddling together, ruffled feather, fever, oculonasal discharge, greenish diarrhoea and death. Grossly, the vascular changes in all the visceral organs were invariably present in all the three conditions. Congestion, petechial to ecchymotic haemorrhages in lungs, liver, kidneys, heart, spleen and intestine were recorded in all the three conditions. Formation of pseudomembrane in oesophagus was observed in duck virus enteritis.

Microscopic lesions in all the three conditions were characterized by haemorrhage, congestion, degeneration and necrotic changes of the parenchymatous organs. Liver showed multiple areas of focal coagulative necrosis. In duck virus enteritis, intra nuclear, eosinophilic inclusion bodies with a distinct halo were observed inside the degenerated hepatocytes. In duck Pasteurellosis, cellular infiltration and serous exudates were recorded in lung samples. Congestion, mucosal thickening and necrosis were observed in tracheal mucosa. Necrosis and sloughing of intestinal villi, lymphocytic depletion in splenic follicles, glomerular atrophy in kidneys were also observed in all the three conditions. The lesions were found severe in concurrent infection.

Out of total 537 samples only 46 (18.25%) post-mortem tissue samples and 12 (4.21%) clinical samples showed positive for *Pasteurella multocida* specific PCR. Highest number of tissue samples that showed positive for PCR were lung (24%) and liver (20%) followed by spleen (15.38%) and heart blood (10%). All the 12 clinical samples that showed positive for *Pasteurella multocida* were from tracheal swabs (5.58%).

Out of total 512 samples, 58 (25.55%) post-mortem samples and 20 (7.01%) clinical samples showed positive for duck enteritis virus specific nucleic acid. Highest numbers of tissue samples that showed positive for PCR were liver (36%) and spleen (28.84%) followed by heart (20%) and kidney (12%). All the 20 clinical samples that showed positive for duck enteritis virus specific nucleic acid were from cloacal swabs (9.30%). In concurrent infection highest positive isolates were recorded in liver samples.

# **Etiopathological Studies on Bacterial Pneumonia In Goats**

*Deepjyoti Saharia*

The present investigation was conducted to study the etiopathology of bacterial pneumonia in goats in and around Guwahati. A total of 139 goat carcasses were examined, among which 62 carcasses showed pneumonia as the primary cause of death.

Pneumonic cases were screened on the basis of gross, microscopic, bacteriological and biochemical analysis. Detailed post mortem examination followed by histopathological examination was conducted. For confirmation of the etiological agent, bacteriological examination of the lung tissue samples from 62 representative cases were collected and examined. The etiology of pneumonia was then correlated with the gross pathomorphological and microscopic changes.

The maximum number of pneumonia cases was observed in the month of February, with the death of 16 goats (25.80%) exposed to the risk of pneumonia. Similarly, the highest mortality was reported in the month of monsoon and winter, where 21 goats (33.87%) died due to pneumonia each. In kids, less than 1 year age group, the mortality due to pneumonia was at its peak with a total of 35 kids (56.45%).

During the study, various types of pneumonia recorded were bronchopneumonia in 18 samples (29.03%) followed by interstitial pneumonia in 14 (22.58%), sero-fibrinous pneumonia in 12 (19.35%), haemorrhagic pneumonia in 9 (14.51%), suppurative pneumonia in 4 (6.45%) and other miscellaneous lesions in 5 samples (8.06%) respectively.

In bronchopneumonia, the surface of the apical lobes of the lungs was dark and consolidated. In some cases, distinct lines of demarcation between affected and non-affected parts were found. The microscopic lesions in bronchopneumonia were established by the accumulation of mononuclear cells in the alveolar lumen, interstitium and bronchiolar lumen, along with mild denudation of the bronchial epithelium.

In interstitial pneumonia grossly, the lungs were voluminous, and microscopically it was characterized by thickening of alveolar septa due to mononuclear cell infiltration, proliferation of type II pneumocytes and engorgement of alveolar capillaries.

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In haemorrhagic pneumonia, gross examination indicated the presence of haemorrhagic patches throughout the lobes of the lungs. Microscopically, the lung parenchyma revealed diffused areas of haemorrhage with congested blood vessels.

In the case of suppurative pneumonia, the affected portions of the lungs revealed the formation of nodules of multiple abscesses filled with pus. The microscopic lesions were established by the infiltration of degenerated neutrophils, mononuclear phagocytic cells and denuded epithelial cells in the alveolar spaces along with disruption of the alveolar walls.

In sero-fibrinous pneumonia, lung parenchyma revealed focal to diffuse areas of consolidations involving the right apical lobe in most cases either alone or with cardiac and anterolateral borders of the diaphragmatic lobes. In some cases, the affected lobes were covered by a layer of fibrinous membrane. Microscopically, there was presence of intra alveolar fibrin within the alveolar spaces.

Pneumonia associated with other pathological conditions revealed various conditions like pneumo-enteritis (39.28%), pneumonia with haemonchosis (25%), pneumonia with hepatitis (17.85%), pneumonia with anaemia (10.71%) and pneumonia with septicemia (7.14%).

Out of the total 62 samples collected for microbiological examination to detect the aetiological agent, *Pasteurella multocida* was isolated from 21 samples (33.87%), *Staphylococcus spp.* from 15 (24.19%), *Escherichia coli* from 13 (20.96%), *Streptococcus spp.* from 9 (14.51%) and *Klebsiella spp.* from 5 samples (8.06%). PCR based detection revealed that a total of 12 (57.14%) isolates were positive for the *kmt1* gene of *Pasteurella multocida* isolate.

Lung tissue samples collected from 62 numbers of affected goats and 31 apparently healthy goats were used for estimation of enzyme activities of SOD (U/mg protein), Catalase (U/mg protein), ALT (IU/L), and AST (IU/L). The average SOD and catalase activity in the affected goats showed a significant decrease compared to apparently healthy goats, whereas a significant increase in average ALT and AST levels was found.

# **Etiopathology of Bacterial Diarrhoea in Dogs With Special Reference to *Escherichia coli***

*Farhin Aktar Choudhury*

The present investigation was conducted to study the occurrence and etiology of bacterial diarrhoea in dogs for a period of one year from March 2019 to February 2020, with special reference to *Escherichia coli*. A total of 138 dogs with history of diarrhoea were examined and screened by simplex polymerase chain reaction (PCR) for the common enteropathogens, including Canine parvo virus (CPV). The organisms that were screened include *E. coli* encoding various virulence factors associated with pathogroups such as– STEC (*stx1* and *stx2*), EPEC (*eaeA*), and ETEC (*elt* and *est*), *C. perfringens* – alpha (*cpa*), *C. difficile* (*gluD*) and CPV-VP-2 gene of the canine parvovirus. Ninety-two samples which were biochemically and morphologically positive for *E. coli* were screened for presence of virulent factors of which fifty-seven samples were positive for at least one virulence factor gene. Enteropathogenic *E. coli* (EPEC) were the most frequently (40.35%) detected pathovar. 17 (29.82%) and 10 (17.54%) isolates were positive for Shiga toxin-producing *E. coli* (STEC) strains and contained the toxin genes *stx1* and *stx2* respectively. 8.77% and 3.51% were positive for heat labile (*elt*) and heat stable (*est*) enterotoxin genes. Out of 52 morphologically positive samples, 32 (94.12 %) were positive for *C. perfringens* – alpha (*cpa*) toxin, and two (5.88 %) for *C. difficile* (*gluD*) gene. Dogs suspected of CPV infection were subjected to PCR for molecular diagnosis, targeting the CPV-VP-2 gene of canine parvovirus with amplicon size of 583bp.

The present study recorded highest occurrence of diarrhoea in the younger age group, i.e. 0-3 months (53.62%). The puppies in the age group 0 to 3 months were highly infected with *E. coli* (59.46%). A very little seasonal variation was recorded in occurrence of diarrhoea. It was observed occurrence of diarrhoea was slightly higher in males than in females.

Hematological studies revealed significant decrease in the Hb, PCV, TEC, MCH and MCHC in dogs affected with diarrhoea, significant increase was also noticed

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in neutrophil and eosinophil count. A non-significant increase in WBC and lymphocytes were also noticed and a non significant decrease in thrombocyte and monocyte count was observed. Biochemical analysis revealed significant increase in ALT, AST and BUN level with significant decrease in glucose, protein, albumin, Na, K and Cl. A nonsignificant increase was observed in creatinine along with a non-significant decrease in P and Ca was observed.

The clinical signs observed in dogs were anorexia, vomiting, fever, dehydration, weakness or lethargy and most commonly acute diarrhoea. In new-born puppies sometimes the symptoms shown were acute and the only symptom observed was weakness and death. Gross examination revealed congested and haemorrhagic gastric mucosa, haemorrhagic and ulcerative enteritis. The cut section of the kidneys showed congestion and hemorrhage in the medullary region. In some dogs, the kidneys were pale. The histopathological study revealed congestion and haemorrhage in most of the organs. The consistent histopathological lesion in the small intestine of the diarrhoeic dogs were degeneration, necrosis and sloughing of the mucosal epithelium. There was infiltration of the inflammatory cells into the lamina propria. Large numbers of Gramnegative bacilli (red stained) indicating *E. coli* were attached at the tip of the villus. Kidney showed generalized congestion and haemorrhage throughout the parenchyma. There was increase cellularity in the glomerulus associated with swelling of the glomerular tuft. Changes in the mesenteric lymph node consisted of diffuse haemorrhage throughout the cortex, medulla and also in the subcapsular space.

The Pathogenicity test of virulent genes of *E. coli* and *Clostridium* spp. detected from diarrheagenic dogs were tested in adult albino mice. Variable pathogenicity of *E. coli* pathotypes were observed in the present study. The *eaeA* and *stx1* gene was found to be highly pathogenic, causing diarrhoea and death within 24 hours and 48 hours of the inoculation in 100% of the mice, while *stx2* was found to be moderately pathogenic causing mortality in only 50% of the mice inoculated. The *cpa* gene of *C. perfringens* caused 50% mortality while *gluD* gene of *C. difficile* caused mortality in only 33.33% of the mice.

In the present study, the role and the intensity of intestinal alkaline phosphatase and acid phosphatase activity were studied. In dog with enteritis the mucosa of the intestine was found to be sloughed off and activity was also found to be negative or minimal.



# **Clinico Pathological Studies of Canine Parvoviral Infection**

*Ginah Maria Binn*

Present study was investigated for a period of one year from March 2018 to February 2019. A total of 138 diarrheic dogs were suspected for Canine Parvovirus (CPV) infection and were examined. CPV was confirmed on the basis of rapid diagnostic kit. 62 dogs showed positive in the rapid diagnostic kit. 62 fecal samples from each dog showing positive in the rapid kit test were subjected for polymerase chain reaction (PCR) and haemagglutination (HA). In the current study 54 (87.10%) fecal samples were found positive by PCR and 41 (66.13%) were positive by HA. Dogs of the age group above 3 to 6 months were found to be most susceptible (37.09 %). Season wise highest occurrence of CPV was found in the monsoon (40.03 %). The unvaccinated dogs showed higher occurrence of CPV (45.16 %) in comparison to the partially vaccinated dogs (30.64 %) and the vaccinated dogs (24.19 %). It was observed that occurrence of CPV had no significant effect on either of the sex. Haematological studies revealed significant decrease in Hb, PCV, TEC, MCV, MCH and MCHC in CPV affected dogs along with significant increase in eosinophils. There was significant thrombocytopenia and lymphocytopenia. A non-significant increase in WBC, neutrophils and monocytes were also recorded. Biochemical estimation revealed significant increase in ALT, AST and BUN levels with significant decrease in Na and K level of CPV affected dogs. A non-significant decrease in glucose, creatinine and chloride level was also recorded.

Cytological studies were done in 12 live dogs affected by CPV and 19 dogs that died due to clinically confirmed CPV. Among the total 31 dogs, tongue smears from 22 dogs showed the presence of intracytoplasmic basophilic inclusion bodies both in the Diff quick and Giemsa stain.

The prominent clinical signs observed in the affected dogs were anorexia, dehydration, depression, lethargy, emaciation and fever. Foul smelling diarrhea was the most common finding. The conjunctival mucous membrane and the gums were pale due to anemic condition of the dog. Severely affected dog when presented showed prolonged capillary refill time, poor pulse rate, tachycardia and hypothermia. Gross

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examination revealed congested gastric mucosa, hemorrhagic enteritis and hepatomegaly. Hemorrhage was observed in the medulla of kidney in some of the CPV affected dogs. Cerebrum congestion of the capillaries. Erosive hemorrhagic ulcers were frequently seen in the tongue.

The histopathological examination revealed the presence of intracytoplasmic and intranuclear inclusion bodies in the brain, tongue, lungs and intestine. Endothelial cell proliferation was observed in most of the organs. Brain showed congestion, neuronophagia and satellitosis. Tongue revealed sloughing of the villi and congestion of blood vessel in the sub epithelial layer. Hyperplasia of the basal cell layer was also observed in the tongue of some cases. Heart showed degeneration of the myocardial fibers, congestion and focal infiltration of mononuclear cells. Interstitial and serous pneumonia associated with hyperplasia of bronchial epithelium were recorded in the lungs of the affected dogs. Liver sections revealed congestion and hemorrhage in the sinusoidal space and proliferation of biliary epithelial cells. Intestine revealed necrosis and sloughing of the epithelium, flattening of the villi associated with congestion and hemorrhage in the mucosal and muscular layer. Necrosis of the Peyer's patches with depletion of the lymphocytes were also recorded. Shrinkage of the glomerular tuft with associated cystic glomeruli was observed in the renal parenchyma. Interstitial nephritis, congestion and hemorrhage were the common findings. Changes in the lymphoid organs such as spleen, thymus and lymph node consisted of hemorrhage, congestion and depletion of lymphocytes from lymphoid follicle.

PCR was found to be more sensitive in the diagnosis of CPV in comparison to the HA test. HA test showed that although CPV can agglutinate both swine and chicken RBCs, the characteristic agglutination was observed when the swine RBCs were used. PCR confirmed CPV isolates by molecular detection of CPV-VP2 gene at 160 bp. The phylogenetic analysis revealed that the isolates recorded in the present study were CPVtype 2b and was in the same cluster as other CPV-VP2 isolates from Hissar (EU2743041.1), India, Anand (JN625224.1) and India, Tamilnadu (MH536199.1).

# **Pathology and Molecular Detection of Classical Swine Fever (CSF) and Its Association with Porcine Circovirus Associated Disease (PCVAD) in Pig**

*Karthikan. S*

Sero-prevalence of Classical Swine Fever virus (CSFV) and Porcine Circovirus 2 (PCV2) was investigated in 22 different districts under six (6) agro-climatic zones of Assam at various times during the period from 1st February, 2019 to 30th June, 2020. Out of total 402 serum samples tested, 78 (19.40%) and 124 (30.84%) samples showed seropositivity for CSFV and PCV2 antibodies alone respectively. However, 91 (22.64%) samples showed sero-positivity for both CSFV and PCV2 antibodies. Agro-climatic zone wise, Upper Brahmaputra and North Bank Plain zone recorded highest sero-positivity (26.92%) for CSFV, followed by Central Brahmaputra Valley (17.95%), Lower Brahmaputra (12.82%), Barak Valley (7.69%) and Hill zone (7.69%). For PCV2, Barak Valley (26.61%) recorded highest sero-positivity, followed by Lower Brahmaputra (21.77%), Central Brahmaputra Valley zone (17.74%) and Hill zone (17.74%), North Bank Plain zone (9.68%) and Upper Brahmaputra (6.45%). In co-infection, North Bank Plain zone registered highest sero-positivity (27.47%), followed by Lower Brahmaputra (19.78%), Central Brahmaputra Valley (18.68%), Upper Brahmaputra (15.38%), Hill zone (12.08%) and Barak Valley (6.59%). Breed-wise, highest sero-positivity for CSFV was recorded in crossbred (48.72%) followed by Large White Yorkshire (30.77%), Indigenous (12.82%), Hampshire (6.41%) and Duroc (1.28%). Highest sero-positivity for PCV2 was shown by crossbred (54.84%), followed by Large White Yorkshire (23.39%), Indigenous (9.68%), Duroc (8.87%) and Hampshire (3.23%). In co-infection, crossbred (50.54%) showed highest sero-positivity, followed by Large White Yorkshire (30.76%), Indigenous pigs (12.08%), Duroc (4.39%) and Hampshire (2.19%). Age-wise, highest sero-positivity for CSFV was recorded in the 3-12 months old (73.08%), followed by 1-2 years old (19.23%), 0-3 months old (6.41%) and above 2 years old (1.28%). Pigs of 3-12 months old animals (64.52%) showed highest sero-positivity for PCV2, followed by 1 – 2 years old

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**Major Advisor : Dr. Biswajit Dutta**

(24.19%), 0-3 months old (7.26%) and above 2 years old (4.03%). Highest seropositivity for co-infection was recorded in the 3-12 months old (78.02%), followed by 1-2 years old (12.08%), 0-3 months old (6.59%) and above 2 years old (3.29%). Sex-wise, both males (50%) and females (50%) showed equal seropositivity for CSFV. Highest seropositivity for PCV2 was recorded in females (53.23%) than males (46.77%). In co-infection, males showed slightly higher positivity (50.54%) than females (49.45%). Season-wise, highest seropositivity for CSFV was recorded in monsoon (70.51%), followed by pre-monsoon (15.38%), post-monsoon (10.26%) and winter (3.85%). Highest seropositivity for PCV2 was recorded in monsoon (50.81%), followed by post-monsoon (18.55%), pre-monsoon (16.13%) and winter (14.52%). Highest seropositivity for co-infection was recorded in monsoon (70.32%) followed by pre-monsoon (14.28%), post-monsoon (13.18%) and winter (2.19%).

Clinically, most of the CSF affected pigs showed high fever (103°-105°F), depression, staggering gait, difficulty in breathing, conjunctivitis, ocular discharge, huddling together, erythematous purple skin discolouration in the back of the ear, ventral abdomen and in the medial side of the legs. In Porcine circovirus associated disease (PCVAD), observed signs were wasting of muscle, icterus and unthriftiness and less frequently labored breathing, diarrhoea and anorexia. Grossly, animals affected with CSF showed multiple petechiation in the skin of the ventral abdominal region and in the medial side of legs. No skin lesions were seen in PCVAD and co-infection. In CSF, gastric mucosa showed focal to diffuse areas of haemorrhage with thickening of the gastric mucosa. No gastric lesions could be seen in PCVAD. However, haemorrhagic gastritis was seen in co-infection. In CSF, the intestinal mucosa showed linear haemorrhages. In PCVAD, intestine showed congestion of serosa and pin point haemorrhages. However, in co-infection also, intestine showed haemorrhagic enteritis. Ascites was observed only in CSF. In CSF, the hepatic parenchyma showed focal to diffuse areas of necrosis, but, no gross alterations could be seen in PCVAD. However in co-infection, liver showed focal areas of necrosis. Splenomegaly and splenic infarction were seen in CSF and co-infection. However no gross alterations in spleen could be observed in PCVAD. Lymph nodes showed congestion, enlargement and haemorrhages in CSF, PCVAD as well as in co-infection. In CSF, kidneys showed petechial haemorrhages, giving the appearance of “turkey egg”. In PCVAD, focal areas of necrosis and haemorrhages could be seen in kidneys. However, in co-infection, kidneys showed diffuse petechial haemorrhages. Hydrothorax was commonly observed in PCVAD. In CSF, lung parenchyma showed varying degrees of consolidation. In PCVAD also, the lungs were congested, edematous, haemorrhagic, non-collapsed, tan discoloured and consolidated. In co-infection, lungs showed haemorrhages, tan discolouration, edema and non-collapsing in consistency and sometimes suppurative pneumonia. In CSF, the cardiac parenchyma showed congestion of the blood vessels in the epicardium with mild to moderate petechial haemorrhages. But no gross alterations could be observed in PCVAD. However in co-infection, heart showed congestion of the blood vessels as well as petechial and ecchymotic haemorrhages on the epicardium. In

CSF, palatine tonsils showed enlargement and congestion. However, no gross alterations could be seen in PCVAD and co-infection. Brain showed congestion of cerebral blood vessels in both CSF, PCVAD as well as in co-infection.

Microscopically, in CSF, the intestinal mucosa showed catarrhal enteritis, ulceration of the intestinal villi with depletion of lymphocytes from the Peyer's patches. In PCVAD also, intestine showed mild to moderate catarrhal enteritis and atrophy of the intestinal villi. In co-infection, intestine showed haemorrhagic enteritis and hyperplasia of the goblet cells. In CSF, liver showed congestion of central vein with focal areas of necrosis. In PCVAD, liver showed lympho-histiocytic inflammatory infiltration in portal zones. In co-infection, the hepatic parenchyma showed cytoplasmic vacuolation, nuclear degeneration and mild haemorrhage in the hepatic parenchyma. In CSF, the splenic parenchyma showed depletion of lymphocytes from the splenic corpuscles. In PCVAD, the presence of basophilic intracytoplasmic inclusion bodies in the splenic lymphocytes could be seen. In co-infection, spleen showed depletion of lymphocytes from the lymphoid follicles, aggregation of histiocytes and eosinophilic necrotic debris. In CSF, the lymph nodes showed congestion of the capillaries with focal areas of haemorrhages and depletion of lymphocytes. Similar alterations were recorded in PCVAD and coinfection. In CSF, the renal parenchyma showed focal to diffuse areas of coagulative necrosis, cystic dilatation and subcapsular haemorrhages. In PCVAD, kidneys showed haemorrhages in Bowman's space as well as in the interstitium and presence of intracytoplasmic basophilic inclusion bodies in the tubular epithelium. In co-infection, kidneys showed extravasation of RBCs into the interstitial spaces, coagulative necrosis of the tubular epithelium and proliferation of fibrous connective tissues. In CSF, lung parenchyma showed thickening of interalveolar septa, bronchiolar hyperplasia, and serous exudation. In PCVAD, lungs showed peribronchial and perialveolar fibrosis, formation of multinucleate giant cells in the thickened interalveolar walls and presence basophilic intracytoplasmic inclusion bodies in alveolar macrophages. In co-infection, lungs showed alveolar emphysema, congestion and sero-fibrinous exudation. In CSF, the cardiac muscle showed various stages of degeneration, congestion, haemorrhages. In PCVAD, degeneration, haemorrhages and focal areas of necrosis could be seen in heart. However, in co-infection, the cardiac muscle showed haemorrhages with focal to diffuse areas of necrosis and thickening of tunica adventitia of blood vessels. In CSF, tonsils showed lymphoidal depletion with or without infiltration of macrophages. However, in PCVAD and co-infection, no microscopic alterations could be seen. In CSF, brain showed cerebral congestion and perivascular cuffing. Apart from mild to moderate congestion, no specific alterations could be seen in PCVAD and co-infection.

Out of the total 115 tissue samples collected from six (6) districts of Assam viz. Kamrup (R), Kamrup (M), Dhemaji, Lakhimpur, Nalbari and Mangaldai, 5 samples (4.34%) were positive for CSFV alone; 11 samples (9.56%) for PCV2 alone; 13 samples (11.30%) for co-infection in PCR.

# **Pathomorphology and Molecular Detection of Duck Virus Enteritis Virus (DVEV) Infection in Assam**

*Krishna Kalita*

In the present study, a total of 465 serum samples were tested for detection of Duck Enteritis Virus (DEV) antibodies from 11 districts of Assam under different agro-climatic zones. Out of the total samples tested, 44.51 percent showed sero-positivity by i-ELISA. Among the different age groups, the highest sero-positivity was recorded in adults (59.90%), followed by growers (29.46%) and ducklings (10.62%). Among different breeds of ducks, the highest sero-positivity was recorded in Pati ducks (29.95%), followed by Indian Runner (22.22%), White Pekin (17.87%), Nageswari (16.42%) and Khaki Campbel (13.52%). Health status-wise, 40.70 percent sero-positivity was recorded in adult ducks followed by growers (35.39%) and ducklings (23.89%) from ailing flock. In apparently healthy flock, adult ducks had sero-positivity of 42.55 percent followed by growers (37.23%) and ducklings (20.21%). Season-wise, the highest prevalence was recorded in pre-monsoon season (38.64%) followed by post-monsoon (30.43%), winter (21.25%) and monsoon (9.66%) season.

During the period of study, a total of nineteen (19) outbreaks of Duck Virus Enteritis (DVE) were recorded, with a morbidity and cause specific mortality of 50.33 percent and 66.40 percent respectively. Age-wise the highest mortality was recorded in adults (76.70%) followed by growers (60.14%) and ducklings (51.18%). Among different breeds, the highest mortality was recorded in Indian Runner (80.39%) followed by White Pekin (65.44%), Pati ducks (62.97%) and Khaki Campbel (54.79%). Season-wise, the highest mortality was recorded in monsoon (89.88%) followed by pre-monsoon (67.65%), post-monsoon (44.39%) and winter (31.97%).

The DEV affected ducks showed emaciation, dehydration, ruffled feather, soiled vent, greenish watery diarrhoea etc. However, sometimes adult ducks showed corneal opacity, leg paralysis, drooping of wings and opisthonous condition.

The gross alterations were predominantly seen in the oesophagus, large intestine, small intestine, liver and heart. Apart from these, sometimes mild to moderate alterations were observed in brain, trachea, proventriculus, kidney, spleen, bursa of

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**Major Advisor : Dr. Biswajit Dutta**

Fabricius and thymus. The mucosa of the oesophagus showed formation of mild to moderately thick whitish loosely adhered pseudomembranous plaque. The intestine showed annular band as intensely reddened ring due to haemorrhages. The liver showed hepatomegaly with mild to moderate congestion and fatty change and sometimes focal to diffuse areas of necrosis. Heart showed petechial and ecchymotic haemorrhages on the epicardium and myocardium, which gave the heart a characteristic “paint brush” appearance. Kidney showed mild to moderate congestion and petechial haemorrhages on the surface of capsule. The spleen showed the presence of whitish necrotic foci in the capsular surface. The thymus showed atrophy with multiple focal to ecchymotic haemorrhages. The bursa of Fabricius, trachea and brain showed mild to moderate congestion.

Microscopically, the oesophageal mucosa showed degeneration and necrosis of the stratified squamous epithelium. In most of the cases the oesophageal mucosa showed attachment of diphtheritic membrane to the mucosa. The pseudomembrane was mainly composed of degenerated and necrosed epithelium, fibrins and inflammatory cells. The sub-mucosa showed extravasation of RBCs from the capillaries with mild to moderate congestion of submucosal blood vessel. Cytoplasmic vacoulation in the sub-mucosal glandular epithelium with fragmentation of the nuclear materials were observed. In some cases, intra-nuclear eosinophilic inclusion body could be seen in the glandular epithelium. The intestine showed necrosis and sloughing of mucosal epithelial cells. There was haemorrhages and infiltration of polymorphonuclear cells in the mucosal layer. In addition, hyperplasia and hypertrophy of goblet cells were also recorded. The hepatocytes of liver showed degeneration and disintegration with focal areas of coagulative necrosis. There was presence of intra-cytoplasmic eosinophilic inclusion bodies in the degenerated hepatocytes with a distinct halo. The cardiac muscle fibres showed degeneration and necrosis characterised by pyknosis and karyorehxis of the nuclei. Sometimes there was aggregation of mononuclear phagocytic cells. The lung parenchyma showed thickening of inter-alveolar septa with infiltration of mononuclear phagocytic cells. Sometimes there was inter and intra vascular haemorrhages. Syncytia formation characterised by fusion of the alveolar epithelial cells were also prominent in some cases. The spleen showed marked depletion of lymphocytes from the splenic corpuscle. At place there was proliferation of reticular cells. Sometimes there were splenic necrosis characterised by the presence of eosinophilic cellular debris. The renal parenchyma showed degeneration and necrosis of the tubular epithelium of proximal and distal convoluted tubules. The interstitial spaces were dilated along with atrophy of the glomerular tuft. Extravasation of RBCs could also be seen in interstitial tissue. Necrosis of the tubular epithelium was also prominent. In brain, there was proliferation of microglial cells and formation of glial nodule. Sometimes the brain showed perivascular cuffing characterised by aggregation of leukocytes in the perivascular spaces. The bursa of Fabricius showed focal areas of coagulative necrosis and depletion of lymphocyte from follicle.

During molecular detection, DEV specific PCR targeting the *UL 30* gene produced the amplification band exactly at 446 bp.

On phylogenetic analysis, it was observed that different nucleotide sequences of partial *UL30* gene formed three distinct clade designated as cluster 1, 2 and 3. The phylogenetic tree depicted that the sequence obtained in this study *viz.* ASM/DEV-01/2020 was present in cluster 1 and found to be closely related with the DEV isolates of Bangladesh and China, particularly strain VMH\_BAU\_DPV\_MAI5 (accession No. MT085742.1) of Bangladesh and Chinese strain VAC (accession no. EU082088.2).



## **Etiopathology of Mortality in Captive Wild Animals in and Around Guwahati**

*Mousumi Namasudra*

The present study was undertaken to enrich the knowledge regarding the cause of mortality in captive wild animals. A total of 80 captive wild animal carcasses belonging to the Assam State Zoo, were used in the study. The cause of death was ascertained on the basis of gross, histopathology and whenever warranted microbiological and parasitological analysis of samples were undertaken. The department of pathology had collected 55 specimens during 2009-2018 from the same zoo and remaining 25 specimens were collected from December 2018 to February 2020.

Pneumonia was responsible for the highest number of deaths. Pneumonia caused death of 14 (17.5%) captive wild animals. Mortality due to trauma was recorded in 10 (12.5%) cases. Traumatic injury due to (i) human-wild life conflict, (ii) inter or intra species fighting, (iii) cage injury and (iv) surgical interventions. Septicaemia caused 8 (10%) deaths in captive wild animals. Gastritis caused death in 7 (8.75%) animals. The cases of death due to nephritis or nephrosis were recorded in 6 (7.5%) animals. Nephritic lesion was a common finding in most animals as associated lesions. Enteritis was recorded in 5 (6.25%) animals of different species with the isolation of *E.coli* in few cases. Hepatitis was also recorded in 5 (6.25%) animals, they were two African rhino, two golden langur and one Asiatic black bear. Encephalitis caused death in 3 (3.75%) animals. They were Hoolock gibbon, Asiatic black bear and Royal Bengal tiger.

Other than this death due to drowning was recorded in a leopard cat. Capture myopathy caused death in Sambar deer and Spotted deer. Organophosphorus poisoning was recorded in one royal Bengal tiger. Cystitis caused death in one pigmy hog. Death due to electrocution was recorded in 2 elephants. In four pygmy hog polycystic kidney associated death was recorded. Death due to senility was recorded in an Assamese macaque and Rhino. Inanition associated with myocardial atrophy was recorded in a hoolock gibbon. One clouded leopard was died due to obesity. Thrombosis was observed in the heart of a Hoolock gibbon.

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**Major Advisor : Dr. C. V. Phangcho**

The different parasites recovered during post-mortem examination included- *Toxocara cati* and *Diphyllbothrium latum* from the small intestine of leopard cat, *Toxocara cati* from the small intestine of jungle cat, *Haemonchus* spp. from abomasums of swamp deer, *Amphistome* spp. from the intestine of rhino.

# **Pathomorphological and Molecular Detection of Avian Leukosis Virus Infection in Chicken**

*Nibedita Tamuly*

Avian Leukosis being a common neoplastic disease of the commercial poultry farm, causes significant economic losses to the farmers. The present study was undertaken to determine the status of the infection in the poultry population from 7 different locations in Kamrup district of Assam. During the period of study, twenty two (22) outbreaks of avian leucosis were recorded from seven (7) different locations of undivided Kamrup district of Assam. A total 243 numbers of post mortem was conducted from which 65 positive cases were reported on the basis of gross examination, histopathological alteration and molecular detection. The overall mortality percentage was recorded as 4.11%. Among different age groups maximum mortality was reported in adult birds above 20 weeks of age (7.36%). However few cases were also reported below 16 weeks of age. Breed/strain wise study revealed highest mortality was reported in BV-380(6.17%) followed by BV-300 (4.47%) which was further followed by Kamrupa (3.49%) and Daothigir (3.47%). Season wise occurrence of the infection was more during winter (4.86%) followed by pre-monsoon (4.11%) and post monsoon (3.68%).

Clinically, affected birds did not exhibit any typical clinical signs, however some of the affected birds showed signs like anaemia with pale comb, emaciation with decrease growth rate and productivity and osteopetrosis.

The gross pathological study gives a presumptive diagnosis of the diseases where prominent lesions were found in liver, spleen, kidney and heart. In all the cases hepatomegaly was most commonly seen. The affected liver also showed nodular, eucosis or diffuse form of lesions. Spleen, kidney and heart also showed enlargement, necrosis and the presence of nodular growth. Even though the bursal involvement could not be detected due to its rudimentary form in adult birds but in two cases the lesions in bursa was prominent.

Microscopic alterations were severe in liver, spleen, kidney, heart and lung characterized diffuse infiltration of immature lymphoid cells, causing distortion of normal parenchyma.

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**Abstract of M.Sc. Thesis**

**Department : Veterinary Pathology**

**Major Advisor : Dr. Biswajit Dutta**

Molecular detection by targeting gp85 *env* gene produced amplification bands at 229 bp. The phylogenetic analysis of the resultant sequences showed 99-100% homology with the endogenous forms of isolates from China, USA and South Korea.

Virus can be isolated on 6th day old embryo where replication of the virus was showed by severe hemorrhages and mortality 48-96 hours of post infection.

In field condition presence of other neoplastic diseases like Marek's disease produces similar lesions which complicates proper diagnosis of avian leucosis. In such situations differential diagnosis can be made on the basis of cell cytology, histopathology and Polymerase chain reaction. In histopathology Marek's diseases affected tissue showed infiltration of pleomorphic cells and on molecular detection positive samples produced bands at 225bp.

Myeloid form and erythroid forms were not found during the study. And the present study reveals that infective form of subgroup E of avian leucosis is circulating in the residential poultry population which might undergo mutation along with exogenous forms and create a more severe form of the disease.

# **Clinico-Pathological Studies of Ethanol Toxicity in Rat and Its Ameliorative Effect with Commercially Available Herbal Preparations**

*Prakash A.N.*

The present study was conducted to study the clinico-pathology of acute and subacute ethanol toxicity and to evaluate the ameliorative effect of commercially available hepato-protective herbal preparations against ethanol toxicity in Wister rats. The acute toxicity was conducted for 14 days with two groups *viz.* control and ethanol treated group comprising of 6 female rats in each group as per OECD guideline (OECD 420, 2001). The ethanol treated group received 50% ethanol @ 6g / kg body weight as single dose orally. The serum biochemical profile *viz.* GGT, AST, ALT, bilirubin, triglyceride and creatinine levels were significantly elevated at 24 hpt in ethanol treated group as compared to control group. Significantly elevated hepatic MDA was observed in the ethanol treated rat group as compared to control group. No significant gross alterations in major visceral organs like liver, kidney, heart, lung, spleen and brain in control as well as ethanol treated group could be observed. Microscopically, no architectural alterations were recorded in parenchyma of liver, kidney, heart, spleen and brain of control group. The hepatic parenchyma in ethanol treated group showed microvesicular steatosis, capillary congestion, various nuclear degenerative changes like karyolysis, karyorrhexis and pyknosis, increased eosinophilia of cytoplasm and multi-focal coagulative necrosis of hepatocytes. The renal parenchyma showed capillary congestion, interstitial oedema, glomerular hypertrophy and multifocal areas of renal tubular coagulative necrosis. Severe capillary congestion was seen in heart. Spleen showed multi-focal accumulation of hemosiderin pigments in the parenchyma. The brain of treated group showed mild focal areas of haemorrhages in cerebral region. The sub-acute toxicity was conducted for 28 days with six groups (Group A, B, C, D, E and F) of rats comprising of 3 male and 3 female rats in each group as per OECD guideline (OECD 407, 2008). Group A considered as control group and received *ad libitum* drinking water. Group B considered as ethanol treated group, received 20% ethanol @ 3.76 g/ kg body weight orally twice daily. Group C received ethanol (20% ethanol @ 3.76 g/ kg body weight orally twice daily) along with Liv-52 (@ 1ml/kg body weight

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**Major Advisor : Dr. Biswajit Dutta**

twice daily), Group D received ethanol (20% ethanol @ 3.76 g/ kg body weight orally twice daily) along with Rohitakarista (@1ml/kg body weight twice daily), Group E received ethanol (20% ethanol @ 3.76 g/ kg body weight orally twice daily) along with Silymarin (@100mg/kg body weight once daily), Group F received ethanol (20% ethanol @ 3.76 g/ kg body weight orally twice daily) along with Liv-52 (0.5ml/kg body weight) and Rohitakarista (0.5ml/kg body weight). The serum biochemical parameters viz. GGT, AST, ALT, bilirubin, triglyceride and creatinine levels were significantly elevated in ethanol treated group (Group B) as compared to control group (Group A). However all the parameters were significantly reduced in herbal treated group (Group C, D, E and F) while comparing to ethanol treated group (Group B). Body weight was increased significantly in control group (Group A) every week; however the elevation was significantly less in ethanol treated group (Group B). Significantly elevated weekly body weight was observed in the herbal treated group (Group C, D, E and F) while comparing to ethanol treated group (Group B). Organ weights including liver weight and kidney weight were significantly elevated in the ethanol treated group (Group B) as compared to control group (Group A). In herbal formulations treated group (Group C, D, E and F), significantly reduced liver and kidney weights were recorded as compared to ethanol treated group (Group B). Significantly elevated hepatic MDA was observed in the ethanol treated group (Group B) as compared to control group (Group A). Treatment with herbal formulations in Group C, D, E and F significantly reduced hepatic MDA which was elevated by ethanol toxicity. Grossly, no significant gross alterations were recorded in major visceral organs viz. liver, kidney, heart, lung, spleen and brain in the control, ethanol treated as well as herbal formulations treated groups. Microscopically, no architectural alterations were recorded in parenchyma of liver, kidney, heart, spleen and brain of control group. The hepatic parenchyma of liver in ethanol treated group (Group B) showed congestion, degenerative changes, fatty changes, kupffer cell hyperplasia, presence of apoptotic cells, oedema, presence of Mallory bodies, necrosis, biliary epithelial hyperplasia and infiltration of inflammatory cells. Treatment with herbal preparations significantly reduced histopathological changes caused by ethanol. The histological alterations of kidney in ethanol treated rat (Group B) showed congestion, degeneration of tubular epithelium, oedema, glomerular hypertrophy, haemorrhage, infiltration of inflammatory cells, tubular necrosis and renal fibrosis. Treatment with herbal preparations (Group C, D, E and F) significantly reduced the histological alterations caused by ethanol. Rats treated with ethanol (Group B) showed congestion, oedema and myocardial necrosis. Treatment with herbal formulations restored the histological changes caused by ethanol in the heart. Severe lymphoid depletion and haemosiderosis were observed in the spleen of Group B rats. Brain parenchyma in Group B showed capillary congestion. Goblet cell hyperplasia and infiltration of inflammatory cells were observed in the intestinal mucosa of Group B rats. Normal architecture of spleen, brain and intestine were observed in Group C, D, E and F.

## **Pathomorphology and Molecular Detection of Mycoplasma infection in Broiler Chicken**

*Risabh Sarmah*

In the present study, a total of 400 sera were tested for detection of *Mycoplasma* antibodies from 29 farms from 11 different locations of undivided Kamrup district, Assam. Out of the total samples tested, 13.25 per cent showed sero-positivity for *Mycoplasma gallisepticum* (MG) and 7.25 per cent showed sero-positivity for *Mycoplasma synoviae* (MS) by i-ELISA. Among different age groups, highest sero-positivity was recorded in age group of above 5 weeks (8.5%) and lowest sero-positivity was recorded in birds of age 3-4 weeks (0.75%) for MG. For MS, the highest sero-positivity was recorded in birds of age group of above 5 weeks (5.25%) and lowest sero-positivity was recorded from age 3-4 weeks (0.5%). Season-wise highest sero-positivity was recorded in winter (6.5%), followed by post-monsoon (4.25%), monsoon (1.75%) and pre-monsoon (0.75%) for MG. In case of MS, highest sero-positivity was recorded in post-monsoon (3%), followed by winter (2.75%), monsoon (1%) and pre-monsoon (0.5%).

During the period of study, a total of eleven (11) outbreaks of Chronic Respiratory Disease (CRD) were recorded, with a morbidity of 26.40 per cent and cause specific mortality of 34.25 per cent. Age-wise highest morbidity was seen in age group of above 5 weeks (28.93%) and lowest in birds of 3-4 weeks (23.28%). Age-wise highest mortality was recorded in the age group of 3- 4 weeks (38.80%) followed by 4- 5 weeks (34.86%) and lowest mortality was recorded in the age group of above 5 weeks (32.06%). Season-wise highest morbidity was observed in winter (31.17%) and lowest in monsoon (22.03%). Season-wise, the highest mortality was recorded in winter (37.35%) followed by pre-monsoon (33.04%), post-monsoon (32.94%) and monsoon (24.16%).

The *Mycoplasma gallisepticum* infected birds showed clinical signs like respiratory rales, coughing, sneezing and nasal discharges where the nostrils and eyes contained frothy exudates. Some of the affected birds showed difficulty in breathing, presence of mucous exudates in the oral cavity along with suborbital swelling. However, conjunctivitis and sinusitis could also be recorded in some of the isolated cases. Most of the outbreaks were recorded between 3<sup>rd</sup> and 6<sup>th</sup> week of age.

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**Major Advisor : Dr. Biswajit Dutta**

The gross alterations were predominantly seen in the lungs, trachea and air sacs. Apart from these, mild to moderate alterations were occasionally observed in the liver and heart. In most of the cases, the tracheal lumen was filled with mucopurulent exudates. Haemorrhages and congestion could also be commonly observed. Sometimes there was accumulation of yellowish cheesy materials in the lower part of the trachea along with tracheitis. Presence of blood stained mucus in the tracheal lumen could also be observed in some cases. The lungs mostly appeared consolidated with haemorrhage and congestion. Cut surfaces revealed the presence of frothy exudates. Sometimes the lungs were covered with thick creamy to yellowish exudates. In most of the cases, the air sacs appeared cloudy and deposition of yellowish cheesy materials over the air sacs was also observed in severe cases. Generally, the liver and heart appeared to be normal. In few cases, the liver showed pale discolouration with or without fibrinous perihepatitis. In severe cases, a thick fibrinous covering was seen over the heart.

Microscopically, lesions were mostly seen in the trachea and lungs. However, other organs like liver and heart were also affected. Congestion and haemorrhage in the tracheal epithelium along with the accumulation of various inflammatory cells and fibrin could be recorded in most of the cases. Thickening of the mucosa, necrosis and hyperplasia of the glandular epithelium could also be seen. Other recorded lesions included hyperplasia of the muscularis layer of trachea and aggregation of lymphocytic mononuclear phagocytic cells in the mucosa and sub-mucosa. The lung parenchyma revealed congestion and haemorrhages with the accumulation of fibrinous and sero-fibrinous exudates. In severe cases, there was sloughing of the bronchiolar epithelium with the presence of exudates. Severe congestion and haemorrhages were also seen in the interstitium of the parabronchi with presence of different types of inflammatory cells like heterophils, lymphocytes, macrophages and plasma cells. Degeneration, necrosis and hyperplasia were also seen in the epithelium of the secondary and tertiary bronchi.

During molecular detection, *Mycoplasma gallisepticum* specific PCR targeting the *mgc2* gene produced the amplification band exactly at 185 bp.

On phylogenetic analysis, it was observed that different nucleotide sequences of partial *mgc2* gene formed two distinct clade designated as cluster 1 and 2. The phylogenetic tree depicted that the sequences obtained from Chhaygaon and Mirza were present in cluster 1 and found to be closely related with the MG isolates of other parts of India (Mumbai, Tamil Nadu, Punjab), Pakistan, South Africa, USA, etc. During the period of study no outbreak of Infectious synovitis could be recorded on the basis of gross, microscopic and molecular detection in undivided Kamrup district, Assam.



# **Clinicopathological Study of Anemia with Special Reference to Canine Babesiosis**

*Ruby Devi Nath*

The present investigation was conducted to study clinicopathology of anemia with special reference to canine babesiosis for a period of 7 months from 1st November, 2021 to 31st May, 2022. During this period 2,905 dogs were screened and 1,213 of them were found to be anemic. A sample size of 200 was considered for a detailed study of anemia.

The present study revealed prevalence of anemia accounted 41.75 per cent. The age-wise prevalence revealed highest prevalence rate of anemia was observed in adult (50.80%) dogs. The sex wise prevalence revealed higher status of anemia in male (44.80%) dogs. Breed wise prevalence of canine anemia in the present study was found to be highest in non-descript (58.20%) breed of dogs.

In present study etiological classification of anemia revealed highest occurrence of anemia due to haemoprotozoan infection (57%) and among them highest infection was caused by *B. gibsoni* (69.20%) followed by *Ehrlichia platys* (24.50%) and *B. canis* (6.10%). Most common type of anemia was found to be microcytic normochromic and mild type in severity.

Gross lesions observed were hepatomegaly, splenomegaly and congested kidney. Histopathologically, degenerative changes in liver, lymphoid depletion in spleen and tubular degeneration with atrophied glomeruli in kidney were observed.

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**Abstract of M.Sc. Thesis**

**Department : Veterinary Pathology**

**Major Advisor : Dr. Sushanta Goswami**

# **Pathomorphological and Molecular Detection of Bacterial Pathogens Associated With Porcine Pneumonia**

*Sabina Yasmin*

The present investigation was conducted to study the pathomorphological and molecular detection of bacterial pathogens associated with porcine pneumonia for a period of one year from February 2020 to March 2021, with special reference to *Streptococcus suis*. In the present study, a total of 180 pigs of either sex and different age groups from various sources, such as slaughter houses, private pig farms in and around Guwahati and from post mortem conducted in the Department of Veterinary Pathology, College of Veterinary Science, A.A.U., Khanapara, Guwahati-22 were subjected to detailed post mortem examination. The lungs with pneumonic lesions and upper respiratory tract were collected. Based on gross and histopathological examination, definitive lesions of various types of pneumonia were found in 127 (70.55%) lungs. Various types of pneumonic lesions recorded in the pig lungs during the present study were broadly classified into bronchopneumonia (32.28%), interstitial pneumonia (29.13%), haemorrhagic pneumonia (21.26%), suppurative pneumonia (11.81%) and fibrinous pneumonia (5.51%). Patchy areas of consolidation in the cranioventral portion of lungs was the most frequently observed gross lesion in bronchopneumonia. Microscopically, diffuse fibrin exudation, hemorrhage into the alveolar lumina, alveolar congestion and infiltration of cellular debris, mucus, fibrins and large number of polymorphonuclear cells in bronchi and bronchioles were noted. In the present study, *Streptococcus suis* (11), *Pasteurella multocida* (9), *E. coli* (4), *Staphylococcus* spp. (3), *Salmonella* spp. (1) and *Klebsiella* spp. (1) were isolated from bronchopneumonia cases. Interstitial pneumonia cases were characterized grossly by pale, heavy, firm and edematous lungs having elastic or rubbery consistency. Microscopically, alveolar wall was thickened and lined by cuboidal epithelial cells and infiltrated by polymorphonuclear cells. Alveolar lumen was filled with fibrinous exudate, polymorphonuclear cells, macrophages and desquamated epithelial cells. Various bacterial pathogens isolated from interstitial pneumonia cases were *Pasteurella*

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**Major Advisor : Dr. S. A. Begum**

*multocida* (11), *Streptococcus suis* (5), *E. coli* (5), *Staphylococcus* spp. (3) and *Salmonella* spp. (1).

Gross pathological changes observed in haemorrhagic pneumonia cases were patchy to diffuse areas of haemorrhages throughout all the lobes of the lungs along with vascular congestion. Microscopically, there was diffuse areas of haemorrhages throughout lung parenchyma associated with thickened interalveolar septa. Bronchiolar and alveolar lumina were filled with erythrocytes along with different inflammatory cells such as neutrophils, macrophages mixed with fibrin. *E. coli* (3) and *Pasteurella multocida* (2) were isolated from haemorrhagic pneumonia cases in the present study. Suppurative pneumonia cases revealed gross pathological alterations such as presence of large number of small purulent foci in the apical and cardiac lobes of the lungs. Thickened pleura and presence of grayish purulent exudates in the trachea and bronchi were also noted. Histopathological examination, revealed several suppurative foci consisting of central caseonecrotic mass along with presence of degenerated neutrophils were seen. *Streptococcus suis* (8), *Staphylococcus* spp. (7), *Pasteurella multocida* (6) and *Klebsiella* spp. (2) were isolated from suppurative pneumonia cases. In fibrinous pneumonia, grossly, all the lobes of the lungs were covered with stringy, yellowish, net like material and interlobular septa were prominent. Microscopically, eosinophilic fine thread like materials indicating the presence of fibrin were noticed in the broncho-alveolar lumen and interlobular septa. There was marked thickening of pleura due to deposition of fibrinous exudates. *Pasteurella multocida* (3), *E. coli* (3) and *Streptococcus suis* (2) were the bacterial pathogens isolated from fibrinous pneumonia cases in the present study. A total of 90 isolates of bacteria were obtained in the present study. Among the isolates, *Pasteurella multocida* (34.44%) were found to be predominant, followed by *Streptococcus suis* (28.89%) and *E. coli* (16.67%). Other bacteria isolated were *Staphylococcus* spp. (14.44%), *Klebsiella* spp. (3.33%) and *Salmonella* spp. (2.22%). Biochemically and morphologically positive twenty six (26) isolates of *Streptococcus suis* and thirty one (31) isolates of *Pasteurella multocida* were screened for *gdh* and *kmt1* gene respectively. The *gdh* gene with amplicon size 688bp was detected in seventeen (17) out of twenty six (26) isolates and the *kmt1* gene with amplicon size 460bp was detected in twenty seven (27) out of thirty one (31) isolates. The Phylogenetic analysis of *gdh* gene of *Streptococcus suis* from pigs of Assam in the present study showed percent identity above 99% with Germany, Canada and China strain of *Streptococcus suis*. Antibiotic Sensitivity Test conducted on *Streptococcus suis* in the present study revealed that majority of the isolates showed greater sensitivity to antibiotics such as amikacin (AK), chloramphenicol (CL), netilmicin (NET) and gentamicin (GEN). It has also been observed that the isolates showed high degree of resistance to antimicrobials such as ceftriaxone (CTR), amoxicillin + clavulanic acid (AMC), cotrimoxazole (COT), amoxicillin (AMX) and furazolidone (FR).

# **Etiopathology OPF Pre-Weaning Mortality in Piglets with Particular Emphasis on Anemia and Hypoglycemia**

*Samiran Borah*

The present investigation was conducted to study the etiopathology of pre-weaning mortality in piglets with particular emphasis on anemia and hypoglycemia to reduce the mortality of pre weaned piglets for the economic benefits of the farmers.

A total of 168 pre weaned piglets of the age group ranging from 0-42 days old were examined out of 951 live born piglets during the period of October, 2019 to September, 2021. The pre weaned piglets were collected from All India Co-ordinated Research Project/ M.S.P. on Pigs; 30 Sow Unit, College of Veterinary Science, A.A.U., Khanapara and private farms in and around Guwahati. A detailed post mortem examination was conducted in 116 pre weaned piglets, out of which 4 piglets were decomposed. A clinico-pathological examination was conducted in 52 live neonatal piglets for detection of anemia and hypoglycemia.

In this investigation, the population mortality of pre weaned piglets was determined 11.78% on the basis of total mortality out of total 951 live born piglets.

The pre weaned piglet mortality was caused by both infectious (78.58%) and non infectious causes (21.42%). The highest mortality in infectious conditions occurred due to enteritis (23.27%) and lowest due to pneumoenteritis (4.38%). In case of non infectious conditions, the highest mortality occurred in anemia (13.79%) and lowest due to traumatic injury (0.87%).

A total of twenty six piglets out of live 52 piglets were positive for anemia (50%). There was death of anemic piglets out of 26 anemic piglets where 16 piglets (30.76%) could not recover and died and 10 piglets recovered (19.23%) after administration of iron (Ferritas™ inj.). The blood picture of anemic piglets showed poikilocytosis and microcytic hypochromic erythrocytes.

A total of fifteen piglets below 1 week of age (28.84%) were positive for hypoglycemia out of 52 piglets examined. Of these, 6 piglets (11.53%) died due to hypoglycemia and 9 piglets recovered naturally (17.30%) out of 15 hypoglycemic piglets.

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There was significant increase of hematobiochemical parameters such as erythrocytes, Hb level, hematocrit value, Serum Fe level, reticulocytes and blood glucose level till 8 days of age but it was statistically insignificant upto 14 days age ( $p < 0.05$ ).

The reticulocyte count was lowered (0.2%) when it was stained by modified brilliant cresyl blue stain in anemic pre-weaned piglets.

Post mortem examination revealed various infectious and non infectious pathological conditions related to pre weaned piglet mortality. The infectious conditions of pre weaned piglet mortality were enteritis (24.11%), pneumonia (16.96%), classical swine fever (16.07%) gastroenteritis (9.82%), gastritis (7.14%) and pneumoenteritis (4.46%). Similarly, deaths due to non infectious diseases were anemia (14.28%), hypoglycemia (5.35%), hernia (0.89%) and traumatic injury (0.89%). The isolated bacteria from various pathological conditions were *Staphylococcus spp.*, *Streptococcus spp.* and *E. coli*.

# **Pathomorphology and Molecular Diagnosis of Newcastle Disease Virus Infection in Poultry in and Around Guwahati**

*Taufique Ansari*

The present investigation was conducted to study the Pathomorphology and Molecular Diagnosis of Newcastle disease virus infection in Poultry in and around Guwahati.

In the present investigation 23 outbreaks were examined in 12 places in and around Guwahati where rate of morbidity was 42.65 per cent and mortality 64.17 per cent. During postmortem examination 12.69 per cent dead birds showed NDV positive gross lesions.

The rate of morbidity 48.19 per cent and mortality 67.87 per cent of nonvaccinated farms respectively is higher than the rate of morbidity 37.67 per cent and mortality 59.96 per cent of vaccinated farms. The rate of morbidity 45.56 per cent and mortality 67.38 per cent in broiler is higher than the rate of morbidity 39.68 per cent and mortality 60.40 per cent in layer. The Breed/Variety wise highest mortality was recorded in Cobb birds (48.49%) and lowest mortality in guinea fowl (0.15%). Season-wise, highest mortality rate was recorded in winter season (33.54%) and lowest during postmonsoon (15.36%).

Grossly, the affected proventriculus was thickened and with hemorrhages at the tips of the glands and all over the mucosa. The intestine and caecal tonsils showed focal narcotizing haemorrhagic ulcer. Liver was congested and necrotic. Lungs were congested and pneumonic. Spleen showed hemorrhages and splenomegaly. In few cases; concurrent infection was noticed in intestine with parasitic infection including coccidia (6.25%), ascaridia (18.75%) and reproductive disorder (12.5%). Histopathologically, proventriculus showed hemorrhages with sloughing of epithelium into the lumen. The intestine revealed hemorrhages and infiltration of mononuclear cells with necrosis and sloughing off villi. Caecal tonsils and spleen showed lymphoid depletion, hemorrhages and necrosis. The brain revealed mild gliosis, and neuronophagia with intracytoplasmic eosinophilic inclusion body in the HeLa cells

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cerebrum and necrosis of purkinje cells in cerebellum. The trachea showed congestion, hemorrhages and necrosis with infiltration of mononuclear cells.

The significant gross and histopathological lesions in the specific organ systems showed close relevance with the results of pathotyping of NDV virus isolates. The disease was confirmed by HI (63%) test and by RT-PCR (71.5%) from tissue samples. Pathotyping of samples on the basis of F gene by RFLP methods showed all the isolates were virulent i.e. 18 (100%). On the basis of MDT, 13 (73.22%) and 5 (27.77%) were found to be mesogenic and velogenic respectively. Sequencing and Phylogenetic analysis revealed that the sequences of representative samples belonged to genotype XIII in Class II of APMV-1 which was responsible for causing the disease outbreak in poultry of this region.

# **Pathomorphological and Molecular Detection of *Riemerella anatipestifer* Infection in Duck**

*Udaya Sai Sitaram Tella*

The present investigation was conducted to study the patho-morphological and molecular detection of *Riemerella anatipestifer* infection in ducks in and around Guwahati. A total of 302 duck carcasses were examined, among which 91 carcasses showed positive for *Riemerella anatipestifer* infection as the primary cause of death.

The samples from suspected cases were screened based on gross, microscopic, bacteriological, and biochemical analyses. A detailed post-mortem examination followed by a histopathological examination was conducted. For confirmation of the etiological agent, bacteriological examination and molecular detection of the samples from representative cases were collected and examined. The maximum number of cases was observed in March, with the death of 56% exposed to the risk of *R. anatipestifer* infection. Similarly, the highest mortality was reported in the month of pre-monsoon with a record of 49.3% due to *Riemerella anatipestifer* infection. In the age group of 3-6 weeks, the mortality due to *R. anatipestifer* was at its peak with a total of 40%.

The *Riemerella*-affected ducks showed lethargy, droopiness, weight loss, greenish diarrhoea, necrotic dermatitis, respiratory signs including nasal and ocular discharge, and nervous signs with paddling of legs, tremors of the head and neck.

The gross alterations like haemorrhages and congestion of blood vessels were observed in other visceral organs like the liver, lung, heart, brain, and intestine. In the spleen, the mottling appearance was one of the most common lesions recorded. The liver showed an area of necrosis, hepatomegaly, fibrin deposition, and fibrosis were mostly seen. However, in a few cases, mucopurulent discharge in the trachea and air sacs appeared to be cloudy and thickened, and accumulation of yellowish cheesy materials over the air sacs and airsacculitis were noticed.

Most characteristic microscopic alterations like haemorrhage, congestion, mild focal to diffused areas of necrosis, and high amount of infiltration of inflammatory cells are found in all visceral organs like trachea, lung, heart, liver, intestine, brain, spleen, and kidney. The trachea and intestine show loss of mucosal epithelium were commonly noticed. However, in a few cases, fibrin deposition over the epicardium of the heart,

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lung parenchyma, and serosal surface of the liver along with hyperplasia of the bile duct was recorded.

On morphological examination, 115 isolates suspected of *R. anatipestifer*, were identified based on cultural characteristics and staining of culture. All the isolates produced small, smooth, circular, mucoid, glistening, and dew drop-like colonies on incubation under micro-aerophilic conditions for 24-48 hours in 5% sheep blood agar, trypticase soya agar and brain heart infusion agar.

All the morphologically identified *R. anatipestifer* isolates were subjected to molecular confirmation by PCR assay targeting *16S rRNA*, *gyrB gene*, and *RNAse Z gene*. The PCR assay targeting *16S rRNA*, *gyrB gene*, and *RNAse Z gene* revealed amplification of 91 (79.1%) isolates with anticipated products of 654bp, 162bp, and 546bp obtained following agarose gel electrophoresis.

Biochemically, all the 91 isolates showed positive for catalase, oxidase, and urease test whereas negative for indole test, methyl red test, Vokes-Proskauer test, citrate utilization test, nitrite reduction test, and different sugar fermentation tests such as Xylose, Mannitol, Maltose, Lactose, Sucrose, Dulcitol, Sorbitol, and Dextrose.

# **Evaluation of Wound Healing Properties of *Zanthoxylum oxyphyllum*: An Indigenous Medicinal Plant**

*Kushal Rabha*

The present study was conducted to evaluate the wound healing and analgesic properties of hydro-ethanolic and chloroform extract of *Zanthoxylum oxyphyllum* in rats and mice. The selected plant was also studied for phytochemical constituents, anti-oxidant properties, and acute oral and dermal toxicity of both the extracts.

The dried pulverized fine powder of *Zanthoxylum oxyphyllum* were extracted using a standard technique where hydro-ethanolic and chloroform extract yield were found to be 14% and 6% respectively. The extracts were found to be positive for Alkaloids, Steroids, Flavonoids, Phenols, Carbohydrates, Diterpenes, Triterpenes and negative for Glycosides, Tannins and Saponins. The extracts did not show any acute oral or dermal toxicity even at the highest oral dose level, i.e., 5000 mg/kg body weight of all the groups. Both the hydro ethanolic and chloroform extract of the selected plants were positive for antioxidant properties, Viz, DPPH and Nitric oxide scavenging activity.

The analgesic activity of both the extracts viz hydroethanolic and chloroform extract were evaluated by using Eddy's hot plate analgesiometer and acetic acid induced writhing test where animals were divided in eight groups with each group having six animals. Group I served as normal control with no treatment and Group II as standard control received oral meloxicam suspension @ 5mg/kg. Other six groups were test groups where hydroethanolic and chloroform extract of *Zanthoxylum oxyphyllum* were administered in 10, 30 and 100 mg/kg concentrations. In case of Eddy's hot plate method, both the extracts showed significant increase in latency period after administration of 10, 30, or 100 mg/kg orally to the mouse. The writhing responses were also markedly reduced after administration of 10, 30, and 100 mg/kg hydroethanolic and chloroform extract of *Z. oxyphyllum* as compared to the control.

Both excision and incision wound models were created in rats using xylazine-ketamine anaesthesia and wound contraction percentage and breaking strength of the

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**Major Advisor : Dr. Pritam Mohan**

wound were measured respectively. The test ointments were prepared in 1%, 3% and 10% w/w concentrations for both hydroethanolic and chloroform extract using Vaseline. Rats were randomly divided in groups of nine of six animals in each group for both the wound models. Group I, Group II and group III served as normal (untreated), vehicle (petroleum jelly) and standard (povidone iodine) control groups. Other six groups were treated topically with test ointments of hydro-ethanolic and chloroform extract of *Zanthoxylum oxyphyllum*. In case of incision wound model, the wound breaking strengths were markedly increased after application of both the extracts when compared to the normal and vehicle control groups. The differences were not statistically significant at 1% level of the standard control, 1%, 3%, and 10% w/w extract groups of *Zanthoxylum oxyphyllum*. Maximum breaking strength was observed in higher concentrations, i.e., 10% w/w extract of *Zanthoxylum oxyphyllum*. In case of excision wound model, the wound contraction percentage elevated significantly in standard and extract treated groups as compared to the normal and vehicle control groups. The higher (10%) concentration of extract showed higher wound contraction (%) as compared to the other two extract groups

## **Role of Nanocurcumin on Experimentally Induced Alpha-Amanitin Tototoxicity in Rats**

*Khumtya Debbarma*

*Amanita phalloides* is responsible for more than 90% of mushroom-related fatalities, and no effective antidote is available. Alpha-amanitin ( $\alpha$ -AMA), the main toxin of *Amanita phalloides*, inhibits RNA polymerase II (RNAP II), causing hepatic and renal failure. The aim of the present study is to investigate the beneficial effects and nanocurcumin in the alpha-amanitin induced hepatotoxicity in rats. In the *in vivo* protocol, Group I served as negative control group (PBS @2 ml/200 gm body weight p.o on the day of administration of  $\alpha$ -AMA to the treatment groups for 4 weeks), Group II served as positive control group ( $\alpha$ -AMA @0.2 mg/kg in PBS p.o single dose), Group III served as Standard group ( $\alpha$ -AMA @0.2 mg/kg in PBS p.o single dose + silymarin @100 mg/kg p.o. once in a week), Group IV ( $\alpha$ -AMA @0.2 mg/kg in PBS p.o single dose + curcumin @800 mg/kg p.o once in a week), Group V ( $\alpha$ -AMA @0.2 mg/kg in PBS p.o single dose + nanocurcumin @200 mg/kg p.o. once in a week), Group VI ( $\alpha$ -AMA @0.2 mg/kg in PBS p.o single dose + nanocurcumin @400 mg/kg p.o. once in a week), Group VII ( $\alpha$ -AMA @0.2 mg/kg in PBS p.o single dose + nanocurcumin @800 mg/kg p.o. once in a week) for four consecutive weeks. Blood and liver samples were collected for hematological, biochemical and histopathological analysis respectively. A histopathological examination was carried out after last treatment on 28<sup>th</sup> day. Hemoglobin levels were analyzed manually using Sahli's hemoglobinometer which was found to be decreased in alpha-amanitin administered group; transaminase levels, Creatinine, Total protein(TP), Urea, BUN and glucose were analyzed in serum. Nanocurcumin showed a beneficial effect by significantly improving the functional parameters particularly in alpha amanitin-induced hepatotoxicity and partially renal toxicity. In the histopathological evaluations, the toxicity that was generated with alpha-amanitin was significantly reduced by nanocurcumin, showing a possible hepatoprotective effect.

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**Department : Veterinary Pharmacology and Toxicology**

**Major Advisor : Dr. Rohini Kumar Roy**

# **Toxic Potential of Acephate on Rainbow Rooster Chicken**

*Lakhyajyoti Saikia*

The present investigation was undertaken to study the acute and chronic toxicity of acephate on rainbow rooster chicken. A total of 45 numbers of rainbow rooster chickens were included in the experiment which were divided into 3 groups (Group A, B and C), each comprising 15 chickens. Group A birds served as acute toxicity group and were administered a single LD<sub>50</sub> dose of acephate i.e., 820 mg/kg body weight orally while Group B served as chronic toxicity group and were administered dose of 82 mg/kg body weight orally daily for a period of 90 days. Group C served as control. For acute toxicity study, blood was collected at 0, 3, 6, 12, 24 and 36 hours whereas blood was collected at weekly interval for chronic toxicity study. All the birds were monitored for any observable toxic symptoms throughout the experimental period and they were also weighed weekly to monitor body weight gain. Severity and extent of clinical signs varied accordingly to dosage administered to the birds. In case of acute toxicity group, within 3 hours of acephate administration birds exhibited clinical signs which included depression, anorexia, diarrhoea, excessive salivation, curved position and rigid stance with drooping of wings. Progressively the birds were unable to stand and sat on their hocks with curled toes followed by tremor, convulsions and recumbency before death. However the signs observed in Group B were less pronounced except the birds exhibited reduced feed intake, reduced body weight, slightly staggering gait, leg weakness, curled toes and diarrhoea were noticed in the latter part of the experiment. The haematological parameters (Haemoglobin, Total Erythrocyte Count, Total Leucocyte Count, Packed Cell Volume and Lymphocyte) were significantly decreased in both the treated groups as compared to the control. Significant increase in serum enzyme activities (Alanine Amino Transferase, Aspartate Amino Transferase, Total Cholesterol and Creatinine) was observed in both the treated groups. However the level of Serum Acetylcholinesterase and Serum Total Protein were found to be significantly reduced in treated groups as compared to the control. On postmortem, gross changes on liver, kidney and brain were recorded and mostly included necrosis, congestion and haemorrhage in liver, kidney and brain while edema was observed in the brain. In

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**Major Advisor : Dr. D. C. Roy**

histopathological study, hepatic parenchyma shows degeneration of hepatocytes and lymphoidal aggregation in acute toxicity study while the liver in chronic toxicity group showed multiple areas of coagulative necrosis. In most of the cases there is extensive fibrosis with proliferation of biliary epithelial cells leading to formation of new bile canaliculi. The section of kidney showed extravasation of RBC with mild congestion, atrophy of glomerular tuft. In some places interstitial nephritis characterized by focal aggregation of mononuclear phagocytic cells could be noticed. Most of the renal tubules showed accumulation of hyaline cast. In chronic toxicity group, the brain parenchyma showed degeneration, necrosis of the nerve fiber, neuronophagia along with congestion. From the present study it was concluded that Acephate at both the dose rates produce toxicity to multiple systems of growing birds.

## ***In Vitro* Evaluation and Molecular Mechanism of Parthenin as Anti-Cancer Agent**

*Monoshree Sarma*

Parthenin, a sesquiterpene lactone was evaluated for its anti-cancer potential. Looking at the prevalence of head and neck cancer and triple negative breast cancer in North-Eastern India, parthenin was screened against FaDu (Human pharyngeal cancer) cells and MDA-MB-231 (triple negative breast cancer) cells. For studying the cytotoxicity of parthenin against FaDu cells and MDA-MB-231 cells, MTT assay was used. Cytotoxicity was observed against FaDu and MDA-MB-231 cells. The IC<sub>50</sub> of parthenin against FaDu and MDA-MB-231 are 5.11 $\mu$ M and 5.65 $\mu$ M respectively. The cytotoxicity of parthenin against FaDu cells is at par with that of the standard drug hydroxychlorquine. However, the standard drug hydroxychlorquine is more potent against MDA-MB-231 cells as compared to that of parthenin. The nuclear and cellular morphologies of parthenin treated FaDu were studied using Hoechst 33258 dye that revealed that parthenin induces nuclear fragmentation and damage in two doses PAR-1 (1.23 $\mu$ M) and PAR-2 (5.11  $\mu$ M). The nucleus of parthenin treated FaDu cells assumed the shape of horse-shoe indicating the potential of parthenin to bring about apoptosis.

Mitochondrial membrane potential (MMP) of parthenin treated FaDu cells were studied using JC-1 dye. For this study, two doses were considered: PAR-1 (1.23  $\mu$ M) and PAR-2 (5.11  $\mu$ M). The study revealed that parthenin causes disruption of mitochondrial membrane potential and integrity which was higher in PAR-2 dose. This illustrates that parthenin might activates the intrinsic pathway of apoptosis. Parthenin treated FaDu cell exhibited up regulation of pro-apoptotic factor BAX and down regulation of anti-apoptotic factor BCL-2. This result confirms the activation of intrinsic pathway by parthenin in FaDu cells. Other factors like Caspase-9 and Caspase-3 which are involved in intrinsic pathway of apoptosis were also up regulated by parthenin in FaDu cells. Also, there was up regulation of p53, a gene which is involved in tumour suppression and generally found inactivated in malignant tumours. Parthenin also causes down regulation of PARP 1 and NF $\kappa$ B in FaDu cells, two factors involved in cell signalling, cell proliferation and repairment of DNA damage. Parthenin brings about cell death of FaDu cells by activating and inhibiting pro-apoptotic and anti-apoptotic

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pathways respectively. Parthenin enhances the expression of BAX and decreases the expression of BCL-2 of MDA-MB-231 cells. Not only this, in MDA-MB-231 cells, parthenin also up regulates the expressions of various pro-apoptotic factors involved in intrinsic way of apoptosis like Caspase-9 and Caspase-3. The expression of p53, a tumour suppressor gene, which is inactivated in most of the malignant tumours is up regulated in parthenin treated MDA-MB-231 cells. In MDA-MB-231 cells, parthenin also causes down regulation of PARP 1 and NFκB, two factors involved in cell signaling, cell proliferation and repairment of DNA damage. Parthenin causes death of MDA-MB-231 cells by activating and inhibiting pro-apoptotic and anti-apoptotic pathways respectively.



## **Evaluation of In-Vitro Antiviral Effect of Nanocurcumin and Nano Eugenol Against Goat Pox**

*Namitha. A*

Five treatment combinations namely Curcumin, Eugenol, Nanocurcumin, nano eugenol and their combinations were considered, which are known for their medicinal values especially their anti-viral effects against various viruses are screened for their anti-viral effect against Goatpox virus replication in-vitro. Nanocurcumin and Nano eugenol prepared by Evaporative precipitation of nanosuspension (EPN) and ultrasonication method had Z-average particle size of 64.22nm and 7.270nm, respectively which was found to be physically stable without any phase separation. All the treatments viz. Curcumin, Eugenol, Nanocurcumin, Nano eugenol were found to be safe for oral administration up to 2000mg/kg body weight. In-vitro cytotoxicity studies of curcumin, Eugenol, Nanocurcumin, Nano eugenol and their combinations showed their Maximum Non-Toxic Doses to be 39.06µg/ml, 78.12µg/ml, 140.62µg/ml, 156.25µg/ml and 296.875µg/ml, respectively and Cytotoxic Concentration<sub>50</sub> values to be 290.4±1.419µg/ml, 319.7±1.301µg/ml, 1462±1.0620µg/ml, 432.7±1.1656µg/ml, and 1309±1.2887µg/ml, respectively. All the treatments viz. Curcumin, Eugenol, Nanocurcumin, Nano eugenol and their combinations were found to have their viral percentage inhibition of 74.88, 79.43, 97.48, 99.55 and 99.85, respectively which are found to be significant at P<0.05 at their MNTDs. Out of which Nanocurcumin, Nano eugenol and their combinations showed >80% inhibition and their EC<sub>50</sub> values found to be 92.47±1.586µg/ml, 54.93±1.1220µg/ml and 52.48±1.1481µg/ml with their therapeutic indices to be 15.81, 7.877 and 24.94, respectively. One step growth inhibition of goatpox virus by Nanocurcumin showed inhibition up to 0 hour post infection, but Nano eugenol and combination of nanocurcumin and nano eugenol showed inhibition upto 72 hour post infection. The nano-ointment was prepared by the combination of nanocurcumin and nano eugenol and applied on skin lesions of positive goatpox cases which resulted in better and faster healing. Results indicated that combination of nanocurcumin and nano eugenol had the highest antiviral effect with

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greater therapeutic index followed by Nanocurcumin and Nano Eugenol and there was dose dependent increase in percentage of inhibition of goatpox virus with their action being virucidal and also inhibited viral entry and some steps of viral replication in-vitro. Combination of nanocurcumin and nano Eugenol Nano-ointment showed better healing in clinical cases of goatpox.

# **Elucidating Intracellular Signalling Mechanism in Nitric Oxide Mediated Effects on Goat Detrusor Muscle**

*Navya L.N*

In the current investigation, the role of nitric oxide on intracellular signalling in goat DSM was examined. Firstly, role of NO on intracellular calcium release mechanism was investigated in goat DSM. SNP-mediated inhibitory effect was reversed by L-NAME ( $10^{-5}$ M) as well as ODQ ( $10^{-5}$ M) on CCh-contracted goat DSM. SNP-mediated inhibitory effects were potentiated substantially by low calcium (0.63mM) PSS on CCh-contracted tissues. Replacing calcium (1.2mM) with strontium in PSS (Zero calcium) also potentiates SNP-mediated inhibitory effect on CCh-contracted tissues. In addition, SNP-mediated inhibitory effect was augmented in presence of L-type  $Ca^{2+}$  channels blocker, nifedipine ( $10^{-5}$ M). SNP-mediated inhibitory effect on CCh ( $10^{-5}$ M)-contracted goat DSM was reversed by prior incubation with fluoroaluminate ( $10^{-5}$ M) which suggest involvement of G-protein in the inhibitory effect of SNP. Similarly, phorbol-12-myristate ( $10^{-5}$ M) reverses SNP-mediated inhibitory effect on CCh-contracted goat DSM implicating a role of protein kinase in SNP-mediated inhibitory effect. Theophylline ( $10^{-5}$ M), a methyl xanthine, potentiates the inhibitory effect of SNP on CCh-contracted tissue. These results indicate that SNP causes decrease sensitivity to both extracellular  $Ca^{2+}$  as well as intracellular  $Ca^{2+}$  which play a role in augmenting inhibitory effect of SNP observed in low  $Ca^{2+}$  PSS and in presence of  $Ca^{2+}$  blockade in goat DSM. Secondly, role of NO on modulation of  $K_{ATP}$  channel on goat DSM was studied. Pinacidil ( $10^{-5}$ M and  $10^{-4}$ M) elicited dose dependent relaxant response on CCh- contracted goat detrusor. This was inhibited by SNP in a way similar to that of glibenclamide ( $10^{-5}$ M). 8-br-cGMP ( $10^{-5}$ M and  $10^{-4}$ M) elicited concentration-dependent relaxations of CCh-contracted tissues which were blocked by SNP ( $10^{-5}$ M). The results suggest that inhibitory effect of SNP on pinacidil-induced relaxation have direct interference with the  $K_{ATP}$  channel or regulatory protein in goat DSM. The result of present study suggest that SNP-mediated inhibitory effects on CCh-induced contraction are due to i) inhibition of both extracellular  $Ca^{2+}$  as well intracellular  $Ca^{2+}$  release mechanism and ii) inhibition of  $K_{ATP}$  channel in goat DSM.

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## **Abstract of M.Sc. Thesis**

**Department : Veterinary Pharmacology and Toxicology**

**Major Advisor : Dr. Dilip Kumar Deka**

## **Evaluation of Anti-Inflammatory, Analgesic and Antipyretic Activity of *Nyctanthes arbor-tristis* Leaf Extract**

*Sumitra Debnath*

The present study was an attempt to evaluate the anti-inflammatory, analgesic and antipyretic activity of *Nyctanthes arbor-tristis* leaf extract. Based on indigenous technical knowledge and ethnomedical uses Four types of extracts, viz: ethanolic, hydroethanolic, aqueous and chloroform leaf extracts of *Nyctanthes arbor-tristis* were used in the present study. Mice were used as experimental animal. A total of fourteen groups four types of extracts and three different doses (250, 500 and 1000 mg/kg body weight) consisting of six mice in each group were used for pharmacological studies. For subacute toxicity study five groups (control, NAEE, NAHE, NAAE and NACE) consisting of six mice in each group were used. Tramadol hydrochloride was used as standard drug for evaluation of analgesic activity by Eddy's hot plate method and Tail clip method. Melonex was used as standard drug for evaluation of analgesic activity by Acetic acid induced writhing method and evaluation of anti-inflammatory activity by Carrageenan induced hind paw oedema method. Paracetamol was used as standard to evaluate antipyretic activity by Brewer's yeast induced pyrexia method. In subacute toxicity study mice were orally fed with four different extracts @ 500 mg/kg body weight for 21 days. Blood was collected on 0, 14<sup>th</sup> and 21<sup>st</sup> day to observe for any change in hematological parameters i.e. Haemoglobin, Total Erythrocytic Count, Total Leucocytic Count, Packed Cell Volume and biochemical parameters i.e. Alanine Transaminase Activity, Aspartate Amino Transferase Activity, Total Protein and Creatinine. On 22<sup>nd</sup> day post mortem was conducted to see any gross or histopathological changes in liver and kidney.

The ethanolic extract of *Nyctanthes arbor-tristis* leaves showed presence of steroids, alkaloids, phenolic compounds, glycosides, flavonoids, diterpenes and triterpenes The hydroethanolic extract of *Nyctanthes arbor-tristis* leaves showed presence of steroids, alkaloids, phenolic compounds, glycosides, flavonoids, tannins, diterpenes, triterpenes and saponins. The aqueous extract of *Nyctanthes arbor-tristis*

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**Major Advisor : Dr. Archana Hazarika**

leaves showed presence of steroids, alkaloids, phenolic compounds, flavonoids, glycosides, diterpenes and triterpenes. The chloroform extract of *Nyctanthes arbor-tristis* leaves showed presence of steroids, phenolic compounds, flavonoids, diterpenes and triterpenes.

The ethanolic, hydroethanolic, aqueous and chloroform extracts of leaves of *Nyctanthes arbor-tristis* were subjected to acute toxicity study as per OECD guidelines 425. The absence of behavioural alteration, gross abnormality or symptoms of toxicity and mortality at 2000 mg/kg body weight indicates that the leave of the plant is safe for oral administration.

The anti-inflammatory activity of the ethanolic, hydroethanolic, aqueous and chloroform extracts of *Nyctanthes arbor-tristis* was evaluated using carrageenan induced hind paw edema method. NAEE at 250 mg/kg body weight showed significant ( $P < 0.05$ ) inhibition of paw volume in the later phase of inflammation i.e. in between 5-6 hours of observation period. Whereas NAEE at 500 and 1000 mg/kg body weight showed inhibition of paw volume at 2 hours, but at 3 hours it showed maximum increase in paw volume. From 4 hours onwards upto 6 hours of observation period there was significant ( $P < 0.05$ ) inhibition of paw volume. NAHE at 250, 500 and 1000 mg/kg body weight showed inhibition of paw volume at 2 hours, but at 3 hours it showed maximum increase in paw volume. From 4 hours onwards upto 6 hours of observation period there was significant ( $P < 0.05$ ) inhibition of paw volume. NAAE at 250, 500 and 1000 mg/kg body weight showed inhibition of paw volume at 2 hours, but from 3 hours to upto 4 hours it showed increase in paw volume. From 5 hours there was significant ( $P < 0.05$ ) inhibition of paw volume upto 6 hours of observation period. NACE at 250, 500 and 1000 mg/kg body weight also showed inhibition of paw volume at 2 hours, but at 3 hours it showed increase in paw volume. From 4 hour onwards there was significant ( $P < 0.05$ ) inhibition of paw volume upto 6 hours of observation period.

All the four (ethanolic, hydroethanolic, aqueous and chloroform) extracts of *Nyctanthes arbor-tristis* at all doses produced significant narcotic analgesic activity by Eddy's Hot Plate Method and Tail Clip Method and non-narcotic analgesic activity by Acetic acid induced writhing method.

The antipyretic activity of the ethanolic, hydroethanolic, aqueous and chloroform leaf extracts of *Nyctanthes arbor-tristis* was evaluated using brewer's yeast induced pyrexia method. Leaf extracts of NAEE, NAHE, NAAE, NACE and standard drug paracetamol showed significant ( $P < 0.05$ ) antipyretic activity from 1 hour upto 5 hours of observation period which was maximum at 5 hours post administration of test extracts.

The present subacute toxicity study revealed no such significant changes in the hemato-biochemical parameters such as Haemoglobin, Total Erythrocytic count, Total Leucocytic count, Packed cell volume, Alanine Aminotransferase, Aspartate AminoTransferase, Total Protein and Creatinine. Although there were some insignificant changes on 21<sup>st</sup> day in haemoglobin content, Total Leucocytic Count,

Alanine Aminotransferase and Creatinine levels. Histopathology studies revealed mild degenerative changes in liver and kidney of treated group.

In conclusion, All the four leaf extracts (ethanolic, hydroethanolic, aqueous and chloroform) of *Nyctanthes arbor-tristis* has significant anti-inflammatory activity. Ethanolic, hydroethanolic, aqueous and chloroform leaf extracts of *Nyctanthes arbor-tristis* was found to possess significant narcotic analgesic activity when tested by Eddy's Hot Plate method and Tail Clip method. The four leaf extracts was also found to possess significant non-narcotic analgesic activity by Acetic acid induced writhing method. All the four extracts (ethanolic, hydroethanolic, aqueous and chloroform) of *Nyctanthes arbor-tristis* also possessed significant antipyretic activity when tested by Brewer's Yeast Induced Pyrexia method. The present study indicated that leaves of *Nyctanthes arbor-tristis* can be used as an alternative to anti-inflammatory, analgesic and antipyretic drug. However further studies are necessary to validate the toxicity effect of herbal drugs. The present study has contributed to the fact that naturally occurring herbal drugs may not be safe/non-toxic in every situation.

# **Monitoring Certain Physiobiochemical Parameters of Post Weaned Crossbred Kids Raised under Three Different Climate Resilient Housing System**

*Dhiman Patgiri*

The present experiment was conducted to study the growth and physiobiochemical performances of post-weaned (90 days) female crossbred kids (Beetal × Assam Hill Goat) kept under three different climate resilient housing system (i.e., Shed-A, Shed-B and Shed-C) from weaning (90 days) till the attainment of puberty. A total of 21 numbers of post-weaned (90 days) female crossbred kids (Beetal × Assam Hill Goat), maintained in intensive care of management and fed a uniform ration in accordance to ICAR, 2013 feeding standard were randomly divided into three groups of average equal body weight having 7 animals in each group and housed in three different housing system which differed in terms of their ventilation system, materials used, colour, ground clearance etc. Temperature, relative humidity and THI of the ambient surrounding and inside the three sheds were recorded thrice daily viz., morning, afternoon and evening hours during the experimental period and it was found that temperature and THI varied significantly among the ambient surrounding and the three Sheds with lowest temperature and THI recorded in the Shed-B i.e., having side ventilation with walls and floor made of bamboo material. The physiological parameters related to thermal stress viz., respiratory rate, pulse rate and rectal temperature were recorded at alternate days in the morning hours during the experimental period and statistical analysis revealed significant differences ( $P < 0.01$ ) in those parameters with the lowest value recorded in the Shed having the lowest THI. The body weight measurement was done at fifteen days (Fortnightly) interval and statistical analysis revealed significant differences ( $P < 0.01$ ) in the body weight of the animals in the different housing system and the housing system having lowest THI showed highest body weight gain ( $9.75 \pm 0.24$  Kg) compared to the animals of other housing systems. Similarly, the age of attainment of puberty was attained by close monitoring of the animals for signs of puberty and statistical analysis revealed significant differences

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( $P < 0.01$ ) in the age of attainment of puberty with the lowest age ( $200.43 \pm 5.96$  Days) of attainment of puberty was found in animals reared in the system having the lowest THI value. Blood samples were collected at fifteen days (Fortnightly) interval for the analysis of certain haemato-biochemical parameters. Statistical analysis revealed non-significant differences in the Hb, RBC, Glucose and SOD concentrations. Although, there was an apparent decrease in the SOD ( $1.25 \pm 0.03$  u/g) concentration in the housing system having lowest THI value. The PCV concentration showed significant differences ( $P < 0.01$ ) among the various housing system with the minimum PCV ( $18.86 \pm 0.16$  %) value was recorded in the animals housed in the Shed having lowest THI. Analysis of variance revealed that the Cortisol, T3 and T4 concentration showed significant differences ( $P < 0.01$ ) among the animals housed in the different housing system. Thereby it can be seen that housing system having strong implication on various physiobiochemical parameters of an animal and also has the potential to ameliorate the effect of thermal stress on animal.



## **Hysiological Effect of Cryoprotectants in Freezing of Embryonic Fibroblast Cells**

*Faijun Toufiki*

Fibroblast cells are the most common cells of connective tissue and form structural framework. In the present study duck embryonic fibroblast cells were developed up to third subcultures and were cryopreserved in three freezing media consisting of freezing medium 1 (10% DMSO), freezing medium 2 (0.9 M Trehalose) and freezing medium 3 (10% DMSO+ 0.09 M Trehalose in 1:1). The cells conforming the morphologically characteristics of fibroblast like typical fusiform shape, turgor vitalis cytoplasm, centrally located nuclei and flame like migration pattern were used for the experiment. The effect of cryoprotectant at equilibration and at different time of post thaw was assessed by their viability and post thaw characteristics. Trypan blue is an azo-based hydrophilic, tetra sulfonated blue acid dye which is used to determine the number of viable cells present in a cell suspension. A viable cell will have clear cytoplasm and non-viable cell will have a blue cytoplasm. The viability percentage before cryopreservation the viability of the duck fibroblast was  $90.75 \pm 0.047$ . For freezing medium 1 (10% DMSO), the viability percentage at equilibration was found to be  $89.75 \pm 0.047$  and subsequently at 7 days  $89.61 \pm 0.064$ , at 14 days  $89.30 \pm 0.035$ , at 21 days  $89.06 \pm 0.011$ , at 28 days  $89.69 \pm 0.14$ . For freezing medium 2 (0.9 M trehalose), the viability percentage at equilibration was found to be  $87.69 \pm 0.82$  subsequently at 7 days  $86.73 \pm 0.14$ , at 21 days  $86.42 \pm 0.04$ , and at 28 days  $86.00 \pm 0.06$ . The viability percentage was significantly higher ( $p < 0.05$ ) in freezing medium 3 (10% DMSO+0.9 M Trehalose in 1:1) followed by freezing medium 1 (10% DMSO) and freezing medium 2 (0.9 M trehalose). For freezing medium 3 (10% DMSO + 0.9 M Trehalose in 1:1), the viability percentage was found to be at equilibration  $90.39 \pm 0.084$  and subsequently at 7 days  $89.78 \pm 0.068$ , at 14 days  $89.78 \pm 0.068$ , at 21 days  $89.71 \pm 0.13$ , at 28 days  $89.68 \pm 0.021$  respectively. The revival of freezing media 3 (10% DMSO + 0.9 M Trehalose in 1:1) was found to be at 24 hours  $14.12 \pm 1.65$ , at 48 hours  $26.44 \pm 1.93$ , at 72 hours  $40.44 \pm 2.27$ , at 84 hours  $50.64 \pm 2.89$ , at 96 hours  $59.32 \pm 0.23$ . For freezing media 1 (10% DMSO) the confluency was found to be at 24 hours  $17.68 \pm 0.97$ , at 48 hours

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32.32±0.99, at 72 hours 43.12±1.12, at 84 hours 49.56±0.18 and at 96 hours 59.28±0.14. For freezing media 2 (0.9 M trehalose) the revivability was found to be 24 hours 9.72±0.08, at 48 hours 14.84±1.14, at 72 hours 25.20±1.20, at 84 hours 44.56±0.30, at 96 hours 53.76±0.10. The confluency of freezing medium 3 was significantly higher ( $p<0.05$ ) found better than freezing medium 1 and freezing medium 2. Found that both intracellular and extracellular cryoprotectant which may favor the normal physiological process at equilibration and at thawing. NANOG, a noble pluripotent marker was found to be present in the developed fibroblast cells as well as after cryopreservation.

## Zinc Mediated Performance in Assam Hill Goat

*Iqbal Salik Minhaz*

A total of twenty-four (24) nos. of 2-3 months aged Assam Hill Goats were studied for 120 days (4 months) that were divided into four (4) groups, viz., C, T-1, T-2 and T-3, comprising of six (6) animals in each group. Group C was fed normal basal diet without any supplementation, group T-1 was fed normal basal diet with 30 mg nano Zinc Oxide per Kg feed, group T-2 was fed 40 mg nano Zinc Oxide per Kg feed along with normal basal diet and group T-3 was fed 50 mg nano Zinc Oxide per Kg feed along with normal basal diet. Parameters recorded in this study were: Body Weight; Physiological Parameters: Temperature, Pulse Rate, Respiration Rate; Hematological Parameters: Haemoglobin, PCV, TEC, TLC; Biochemical Parameters: Total Protein, Glucose, Cholesterol, Serum Zinc; Hormones: T<sub>3</sub>, T<sub>4</sub>, Cortisol; Oxidative Stress Biomarker: Malondialdehyde; Liver Biomarker: Aspartate Aminotransferase and Kidney Biomarker: Creatinine.

Body weight of the treatment groups T-1, T-2 and T-3 was found to be significantly increased ( $P < 0.05$ ) respectively from  $5.800 \pm 0.037$  Kg,  $5.833 \pm 0.033$  Kg and  $5.833 \pm 0.049$  Kg at 0 day of trial to  $8.433 \pm 0.042$  Kg,  $8.617 \pm 0.095$  Kg and  $9.067 \pm 0.056$  Kg at 120<sup>th</sup> day. Physiological Parameters (Temperature, Pulse Rate and Respiration Rate) and Hematological Parameters (Haemoglobin, PCV, TEC and TLC) did not differ significantly in the treatment animals. Among the Biochemical Parameters, Total Protein was found to be significant ( $P < 0.05$ ) in the treatment groups T-1, T-2 and T-3 which increased respectively from  $6.400 \pm 0.019$  g/dl,  $6.395 \pm 0.037$  g/dl and  $6.383 \pm 0.020$  g/dl to  $7.135 \pm 0.015$  g/dl,  $7.332 \pm 0.010$  g/dl and  $7.412 \pm 0.012$  g/dl at the end of the trial. Also in Serum Zinc concentration it was found to be highly significant ( $P < 0.01$ ) in all the treatment groups T-1, T-2 and T-3, which increased respectively from  $0.900 \pm 0.019$  mg/L,  $0.895 \pm 0.037$  mg/L and  $0.892 \pm 0.015$  mg/L to  $1.135 \pm 0.015$  mg/L,  $1.332 \pm 0.010$  mg/L and  $1.405 \pm 0.006$  mg/L at the end of trial. However, the Glucose and Cholesterol concentration in the serum was found to be non-significant. No change in Hormonal Profiles (T<sub>3</sub>, T<sub>4</sub> and Cortisol) was noted. Liver Biomarker (Aspartate Aminotransferase) and Kidney Biomarker (Creatinine) was also found to be non-significant. Oxidative Stress Biomarker, Malondialdehyde (MDA) was found to

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apparently decrease in the treatment groups, but the change was not found to be significant.

Nano minerals have a great potential as mineral feed supplements in animals even at lower doses than the conventional sources by increasing their bioavailability in biological system due to the increased surface area and surface activity of nano minerals. Also because of increased absorption, the residual excretion is minimized and as result of which environmental pollution is decreased.

## **Strategy for Development of Stem Cell Like Embryonic Fibroblast Cells**

*Prerana Das*

Fibroblast cells are the type of cells that play an important role in the formation of connective tissue. The use of fibroblast cell is versatile, for e.g., demonstration of avian viruses, feeder cells, production of vaccines, preservation of genetic resources etc. In this present study, duck embryonic fibroblast cells were isolated, cultured, and sub-cultured up to six passages. The cells were grown in four culture media i.e., Medium 1(MEM), Medium 2(MEM+IGF-1), Medium 3 (MEM+10% FBS), Medium 4 (MEM+10% FBS+IGF-1). In serum and serum-free media the time required for the cells to attain 70% confluence in primary culture was  $84.667\pm 0.152$  hours and  $111.867\pm 0.161$  hours respectively. The cells grown in medium containing serum showed better results than cells grown in serum-free medium. The time taken to reach 70% confluence in 6th passage in Medium 2 and Medium 4 which are IGF-1 supplemented are  $94.583\pm 0.217$  hours and  $62.167\pm 0.096$  hours respectively whereas time taken in Medium 1 and Medium 3 which are IGF-1 free media are  $95.350\pm 0.039$  hours and  $62.667\pm 0.152$  hours respectively. Therefore, the cells grown in IGF-1 supplemented media showed significant difference compared than the rest of the culture media ( $p\leq 0.01$ ). Morphologically, the cells showed characteristic spindle shape, turgor vitalis cytoplasm, centrally located nuclei and flame-like pattern up to the sixth passage. The viability assessment was carried out in first, second, third, fourth, fifth and sixth sub-culture and the viability percentage of the cells in six different sub-cultures were  $89.843\pm 0.108$ ,  $91.427\pm 0.082$ ,  $91.228\pm 0.081$ ,  $91.867\pm 0.079$ ,  $92.231\pm 0.073$ ,  $93.431\pm 0.069$  in the case of Medium 1,  $90.425\pm 0.085$ ,  $92.358\pm 0.124$ ,  $93.692\pm 0.084$ ,  $93.982\pm 0.282$ ,  $94.625\pm 0.089$ ,  $94.892\pm 0.096$  in the case of Medium 2,  $89.145\pm 0.263$ ,  $90.482\pm 0.09$ ,  $91.643\pm 0.143$ ,  $92.713\pm 0.186$ ,  $93.460\pm 0.079$ ,  $94.543\pm 0.074$  in Medium 3, and  $88.597\pm 0.132$ ,  $89.387\pm 0.143$ ,  $90.552\pm 0.101$ ,  $91.423\pm 0.078$ ,  $93.077\pm 0.140$ ,  $93.077\pm 0.140$  in Medium 4. The viability percentage between the passages was significantly different ( $p\leq 0.01$ ). However, the viability of the cells was better from the second subculture compared to primary cultures. The pluripotency of the cells was observed by immunostaining using NANOG antibody, a pluripotent marker that is expressed in embryonic stem cells. It was observed that cells showed positive for NANOG at every subculture depicting their pluripotent nature.

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**Department : Veterinary Physiology**

**Major Advisor : Dr. Nikhil Ch. Nath**

# **Monitoring Physio-Biochemical Characteristics in Goat During Transition Period Following Selenium and Vitamin E Supplementation**

*Salima Siddika*

Twenty-four (24) healthy, adult and pregnant Crossbred goats, (Assam Hill Goat x Beetal) were taken to study the effect of Selenium and Vitamin E on Hemato-Biochemical profile, Reproductive performance and Stress during transition period. The duration of the experiment was four months (February 2022 to June 2022). The experimental animals were divided into four (4) groups, viz., C, T-1, T-2 and T-3, comprising of six (6) animals in each group. Group C was fed normal basal diet without any supplementation, group T-1 was fed normal basal diet with 100 mg Vitamin E and 0.5 mg Selenium, group T-2 was fed 250 mg Vitamin E and 1.25 mg Selenium along with normal basal diet and group T-3 was fed 500 mg Vitamin E and 2.5 mg Selenium along with normal basal diet. Parameters recorded in this study were: Body Weight of the kids ; Physiological Parameters (Temperature, Pulse Rate, Respiration Rate), Hematological Parameters (Haemoglobin, PCV, TEC, TLC), Biochemical Parameters (Total Protein, Glucose, Cholesterol), Hormones (T<sub>3</sub>, T<sub>4</sub>, Cortisol), Oxidative Stress Biomarker (Malondialdehyde and Super Oxide Dismutase), Liver Biomarker (Aspartate Aminotransferase and Alanine Transaminase), Kidney Biomarker (Creatinine and Blood Urea Nitrogen), Molecular stress biomarker (*HSP70*), and Temperature Humidity Index (THI).

Birth weight of the kid of the experimental group T-3 was found to be significantly ( $P < 0.05$ ) higher. Body weight gained after 4 weeks was significantly ( $P < 0.05$ ) higher for T-2 and T-3 groups. Physiological Parameters (Temperature, Pulse Rate and Respiration Rate) and Hematological Parameters (Haemoglobin, PCV, TEC and TLC) did not differ significantly ( $P > 0.05$ ) in the treatment animals, but apparent improvement was observed in Hb, TEC and PCV. Among the Biochemical Parameters, Total Protein, Glucose and Cholesterol concentration in the serum was found to be non-significant ( $P > 0.05$ ). In Hormonal Profiles T<sub>3</sub> and T<sub>4</sub> values showed significant ( $P < 0.05$ ) increase in T-2 and T-3 groups. On the contrary, in the corresponding groups Cortisol decreased significantly ( $P < 0.05$ ).

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**Major Advisor : Dr. Champak Barman**

Liver Biomarker (Aspartate Aminotransferase, Alanine Transaminase), and Kidney Biomarker (Creatinine, BUN) was also found to be non-significant ( $P>0.05$ ) Oxidative Stress Biomarker, Malondialdehyde (MDA) was found to significantly ( $P<0.05$ ) decreased with increase of SOD in T-2 and T-3 treatment groups. Molecular Stress Biomarker (*HSP70*) showed significant ( $P<0.05$ ) decrease in T-2 and T-3 groups from 5<sup>th</sup> week and 3<sup>rd</sup> week onwards respectively. THI values (78-84.7) indicated that the experimental animals were under severe heat stress during the period of experiment.

The findings of the present study have revealed that, 1. Selenium and Vitamin E improved hematological profile (Hemoglobin, Total Erythrocyte Count, Packed Cell Volume) non significantly ( $P>0.05$ ), while no effect was found on TEC. Also, there was no effect on Biochemical parameters (Total Protein, Glucose, Cholesterol), Liver Biomarkers (AST, ALT) and Kidney Biomarkers (BUN, Creatinine). 2. Selenium and Vitamin E at the dose rate of 2.5 mg and 500 mg respectively, significantly ( $P<0.05$ ) increased the body weight of the newborn kids at birth and after one month of kidding. 3. Vitamin E and Selenium helps in reducing the oxidative stress by decreasing the lipid peroxidation in the body.

## **Physio-Biochemical Studies of Adult Pati Ducks Reared Under Semi-Intensive System**

*Tenzing Lopsang Lachenpa*

The Pati duck is the only recognized duck breed of India and is indigenous to Assam. It has remained a largely popular duck variety among the locals due to its ability to grow with low inputs and easy management, greater resistance to diseases and hot and humid weather conditions which is prevalent across most parts of the state. The present experiment was carried out to study some hematological and biochemical parameters of adult Pati ducks reared under semi-intensive system for summer (July-August) and winter (December-January) seasons. A total of 24 ducks comprising 12 males and 12 females aged 10 weeks and above were considered for the experiment. The ducks were maintained in the duck farm adjacent to a pond and were housed during the night on concrete floor with deep litter and let loose during day time. The experimental ducks were subjected to blood collection at 7-day intervals during both the seasons and analyzed for total erythrocyte count, hemoglobin content, hematocrit, differential leukocyte count, and total leukocyte count for hematological study and superoxide dismutase (SOD), lactate dehydrogenase (LDH), total protein, alkaline phosphatase (ALP), HSP90 and cortisol for blood biochemical study. The hematological parameters were almost similar between male and female Pati ducks within the same season. However, the monocyte count was significantly higher ( $P<.01$ ) in male Pati ducks and the lymphocyte and eosinophil counts were significantly higher ( $P<.01$ ) in female Pati ducks during winter season. The hemoglobin content (Hb), and the total leukocyte count (TLC) were significantly higher ( $P<.01$ ) for both male and female Pati ducks during summer season whereas the total erythrocyte count (TEC), and hematocrit (PCV) were significantly higher ( $P<.01$ ) during winter season for both the sexes. Similarly, the biochemical parameters were also almost similar between male and female Pati ducks within the same season. However, alkaline phosphatase (ALP) and HSP90 levels were significantly higher ( $P<.01$ ) during summer season in both male and female Pati ducks while lactate dehydrogenase (LDH) activity, total protein concentration, superoxide dismutase (SOD), and cortisol levels were significantly higher ( $P<.01$ ) during winter season. Thus, from the experimental findings we can conclude that LDH, SOD, and cortisol could be considered good indicators of cold stress whereas HSP90 could be considered a good indicator for heat stress.

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**Abstract of M.Sc. Thesis**

**Department : Veterinary Physiology**

**Major Advisor : Dr. Anup Dutta**



## **Analysis of Duck Farming Systems in Morigaon District of Assam**

*Anuj Dutta*

A survey study was conducted to analyze the duck farming systems in Morigaon district of Assam. For this, two villages from each of the six development blocks with higher duck population were selected and from each village 12 duck farmers were taken as respondents through snow-ball sampling technique. As such 12 duck farmers from 12 villages were interviewed for the purpose making the total sample size 144. Duck farmers having atleast 10 numbers of ducks of different ages and who were experienced in duck farming were considered for the present study as a duck farmer and was interviewed personally through pre-tested interview schedule by the investigator. Further participatory extension methods were deployed to elicit responses from the Key Informants and drawal of final conclusions for the study.

Duck keeping was practiced by people from all social classes, regardless of their occupation, religion or educational background. People raised ducks primarily for their eggs and meat and kept their flocks close to their dwellings, involving every member of the family in the process. Majority (50.69%) of the farmers were from middle aged (36-50 years) group. Out of the total farmers under investigation 51.38% got qualification upto 10th standard. Majority (74.30%) of the farmers were from Hindu community. About 74.00% farmers had more than 10 years of experience in duck farming.

The demographic distribution of ducks revealed the presence of eight distinctive groups of ducks viz. Pati, Graded, Khaki Campbell, White Pekin, Muscovy, Chara-Chemballi, Indian Runner and Nageswari. The majority of farmers maintained only one breed of duck and the *desi* breed Pati constituted the majority of duck population. The flock strength ranged from 15-150 numbers of ducks with a mean of 32.27 numbers. The majority (95.83%) of farmers kept a male to female sex ratio of 1:5.

The natural incubators were broody duck or hen but few farmers practised artificial incubation. Majority (99.30%) of farmers did not clean eggs and candle the hatching eggs during the process of natural incubation. About 85.00% of duck farmers hatched their duck eggs during the month of April to July (84.84%) and only few farmers performed hatching throughout the year either through natural or artificial

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**Department : Poultry Science**

**Major Advisor : Dr. Joga Dev Mahanta**

means of hatching. According to the size of the bird, a total of 10-12 and 14-18 numbers of hatching eggs were set under each broody hen and duck, respectively. The mean hatchability percentage was recorded as 86.24% with a range of 65.00 - 95.00%.

Most of the farmers (92.36%) under study fed their duckling from second day of age onwards with raw ingredients like whole paddy grain, whole rice, broken rice, cooked rice, wheat bran and rice polish upto 4th week of age. Grower and adult ducks were reared by the farmers under scavenging or free range system. Majority (92.36%) of the farmers did not provide artificial warmth to the duckling during brooding period while few farmers (7.64%) provided artificial warmth upto 4 weeks of age. During day time duckling were confined in an open area surrounded by bamboo basket, fish trap or mosquito net where provision of drinking and feeding facilities were provided to save them from predators and wild birds. The majority (98.61%) of farmers followed free range system of rearing for adult ducks and allowed to scavenge them in the foraging field during day time. In the morning, evening and even in noon time supplementary feeds in the form of kitchen waste mixed with cooked rice and rice polish was provided. Another system of duck rearing in which a night holding pen was constructed on an elevated area amidst paddy fields, beels, ponds and other water logged areas to keep the adult ducks during night time. Few duck farmers (8.33%) adopted integrated duck cum fish farming. The major viral, bacterial and fungal diseases encountered in the surveyed area were duck plague, duck cholera, anatispestifer infection, hepatitis (aflatoxicosis) and botulism. Occasionally worm infestation was also found and mortality sometimes occurred due to predators. The mean mortality rate of 8.04% (0-20%) in ducklings, 1.55% (1-3%) in growers and 6.01% (0-10%) in adults was noticed. Majority of farmers (67.36%) did not consult veterinary doctor during the occurrence of any disease. Besides treating the ducks with common antibiotic, vitamin and mineral supplements, liver tonic, they also treated their ailing ducks with indigenous medications. None of the farmers vaccinated their ducks. The mean body weight of adult ducks recorded at 40 weeks of age for Pati, Khaki Campbell and Graded ducks was 1488.92±6.53, 1855.08±6.37 and 1519.00±14.57 g, respectively. The mean egg weight of Pati, Khaki Campbell and Graded ducks at 40th week of age was recorded as 67.04 ± 0.63, 66.42 ± 0.62 and 67.56 ± 0.69 g, respectively. The annual egg production of Pati, Khaki Campbell and Graded ducks was found to be in the range of 90-100, 240-250 and 140 – 150 per duck, respectively. The age at first egg for Pati, Khaki Campbell and Graded ducks ranged from 210-240, 150-180 and 180-200 days, respectively. Most of the farmers maintained their flock for 2-3 years of production. The farmers generally purchased duckling at day-old or at one month of age either from the local market or from their neighbours/local hatchery located in the nearby places. Most of the farmers reared ducks for household consumption and the excess eggs and meat ducks were sold through two types of marketing channel- (I) producer → consumer and (II) producer → middle man → consumer. The table eggs and live ducks were sold @ Rs. 9.00 -10.00 per egg and Rs. 450.00 – 600.00 per duck. Demand and consumption of duck meat increased many folds during winter and festive seasons like Durga puja, Kali puja, New

Year's Eve, Magh bihu and during picnic season starting from October to February. The duck meat becomes tastier due to fat deposition during the month of November to January. None of the farmers were dependent upon the financial supports from any financial agency. Occasionally, the Krishi Vigyan Kendra, Morigaon distributed improved varieties of duck to the beneficiaries interested in duck farming. Duck farming was found to be a subsidiary source of income for almost all the farmers under study.

Non-availability of vaccine was ranked first among all the constraints faced by the duck farmers followed by lack of Governmental financial assistance, lack of proper guidance in duck-rearing techniques, lack of availability of quality duckling, lack of scientific know-how, lack of availability of high yielding duck breeds, higher mortality rate, lack of access to veterinary services. The duck farmers earned an annual profit of Rs. 299.00 per duck.

# **Sustainable Management of Dead Birds, Poultry Slaughterhouse and Hatchery Wastesthrough Composting**

*Ferdinee Dhar*

The present study entitled “sustainable management of dead birds, poultry slaughter house and hatchery wastes through composting” was undertaken to study the feasibility of composting as an alternative for poultry waste disposal. Before undertaking poultry waste composting trials, a survey was conducted using an interview schedule with open ended questions. The study showed that 100 per cent of the farmers discarded the dead poultry birds in dumping pits, 50 per cent sold their litter materials while some of them used it as fish feed and manure/soil amendment in crop cultivation. Among the hatcheries about 20 per cent of hatchery units sold their hatchery waste to feed producing companies, while 70 per cent of them discarded hatchery waste in dumping pits and 10 per cent incinerated them in incinerator. However, 100 per cent of the poultry meat sellers in the market place discarded their waste through Municipal Corporation.

The second part of the present study included bin composting of five treatment mixtures formulated as T0 (Poultry litter + paddy straw), T1 (Poultry litter + paddy straw + dead birds), T2 (Poultry litter + paddy straw + hatchery wastes), T3 (Poultry litter + paddy straw + poultry slaughter house wastes) and T4 (Poultry litter + paddy Straw + hatchery wastes + dead birds + poultry slaughter house wastes). Proximate analysis of different waste ingredients were analyzed for total carbon, total nitrogen, moisture and a C: N was adjusted to a desirable ratio of 20:1 and moisture level at 60 per cent. The wastes materials were sequentially layered following the internationally accepted standard method. Temperatures were measured and monitored daily at different points within the pile.

The completion of composting period took 53 days for T0, 71 days for T1, 72 days for T2, 59 days for T3 and 77 days for T4. The temperature profile of all treatment groups rises from the second day and reached the peak temperature by second week of composting (56°C in T0 followed by 67°C in T1, 64°C in T2, 60°C in T3, and 58°C in T4) and started declining gradually until composting process was complete.

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The total ash content was increased at the end of secondary stage and ranged between  $60.12 \pm 3.49$  and  $70.91 \pm 3.31$  per cent whereas the total organic matter content and total organic carbon content were reduced at the end of secondary stage and ranged between  $29.09 \pm 1.30$  to  $39.99 \pm 1.73$  per cent and between  $16.24 \pm 0.94$  to  $19.75 \pm 1.38$  per cent respectively. There was significant reduction in total nitrogen content from primary to secondary stages in all treatments. Highest amount of nitrogen content at the end of secondary stage was observed in T4 ( $13.99 \pm 0.78$ ) group. At the end of composting process the C:N ratio of different treatment mixtures did not differ significantly and it ranged between 13.02 :1 and 18.37:1 which ensured compost stability.

The mean calcium, phosphorus, and potassium content of all treatment mixture was progressively increased during composting period which ranged between  $29.62 \pm 0.83$  to  $176.32 \pm 0.69$  g/kg,  $11.94 \pm 0.86$  to  $24.01 \pm 0.66$  g/kg and  $7.85 \pm 0.58$  to  $22.56 \pm 0.89$  g/kg respectively at the end of secondary stage.. Highest concentration of calcium content was recorded in T2 ( $176.32 \pm 0.69$  g/kg) group, highest phosphorus content was recorded in T1 ( $24.01 \pm 0.66$ ) group and highest potassium content was recorded in T3 ( $29.45 \pm 0.46$  g/kg) group.

The mean Salmonella count under different treatment groups during loading was recorded to be  $0.41 \pm 0.03$  log<sub>10</sub> cfu/g,  $0.72 \pm 0.05$  log<sub>10</sub> cfu/g,  $0.65 \pm 0.04$  log<sub>10</sub> cfu/g, ii  $0.78 \pm 0.04$  log<sub>10</sub> cfu/g and  $0.88 \pm 0.24$  log<sub>10</sub> cfu/g for T0, T1, T2, T3 and T4 groups, respectively. However, after the end of the secondary stage Salmonella count was not detected. The mean total coliform count under different treatment groups initially during loading was recorded to be  $5.45 \pm 0.65$  log<sub>10</sub> cfu/g,  $4.21 \pm 0.26$  log<sub>10</sub> cfu/g,  $3.23 \pm 0.41$  log<sub>10</sub> cfu/g,  $4.03 \pm 0.39$  log<sub>10</sub> cfu/g and  $6.36 \pm 0.52$  log<sub>10</sub> cfu/g for T0, T1, T2, T3 and T4 groups, respectively which remarkably reduced in the secondary stage to values lower than recommended international guidelines. Thus, it is concluded that composting technology is an environmentally safe method of poultry waste disposal which is simpler process to be operated by the farmers with locally available equipments, and the finished compost can be used as a soil amendment and would provide efficient calcium, nitrogen, phosphorus and potassium for soil health.

## **Utilization of Chicken Whole Blood for Preparation of Chicken Nuggets**

*Konmoni Goyari*

The present study was undertaken to study the utilization of chicken whole blood for preparation of chicken nuggets and study the physico-chemical qualities, microbial and sensory properties of the developed product. The study was conducted in the Department of Poultry science, Assam Agricultural University, Khanapara, Guwahati-781022.

The entire experiment was carried out in two phases, in the first phase a total of five replicates of chicken nuggets comprising of four different formulations with different blood levels *viz.* T<sub>0</sub> (0 %), T<sub>1</sub> (11%), T<sub>2</sub> (14%) and T<sub>3</sub> (17%) were prepared with extender, binder, oil, spices, condiments and ice flakes. The prepared nuggets were sliced, packed in normal packaging (low density poly ethylene) and stored under refrigeration temperature (4°C). In the second phase the shelf life of the product was studied under normal refrigeration temperature (4°C) and quality characteristics were evaluated at 0, 3<sup>rd</sup>, 6<sup>th</sup>, 9<sup>th</sup>, 12<sup>th</sup> and 15<sup>th</sup> days of storage period.

Different parameters such as iron estimation, physico-chemical qualities, proximate composition (moisture, crude protein and fat), organoleptic quality evaluation, microbial quality, shelf-life including cost of production were studied.

The iron content (mg/100mg) significantly (P<0.01) increased in proportion to the increasing level of blood incorporation in chicken nuggets. Highest iron content was found in T<sub>3</sub> (174.51±1.86) and lowest in T<sub>0</sub> (57.83±1.06) group. The blood incorporated nuggets showed a significant (P<0.01) difference between the control and treatment groups. However no significant (P>0.05) difference was observed between T<sub>2</sub> and T<sub>3</sub> groups.

The physico-chemical studies in chicken nuggets showed no significant difference (P>0.05) between the control and treated groups in emulsion stability. However incorporation of blood replacing lean meat resulted in higher emulsion stability (ml of oil/100g emulsion) numerically in the treated nuggets groups compared to control. The pH value of the chicken nuggets increased significantly (P<0.01) among groups with incorporation of blood as well as during refrigerated storage period from 0

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to 15<sup>th</sup> day. The water activity ( $a_w$ ) of the nuggets increased significantly ( $P<0.01$ ) with increase in days of storage. The water activity ( $a_w$ ) was found to be lowest in  $T_0$  and highest in  $T_3$  group. The TBA value (mg malondialdehyde/kg) showed significant ( $P<0.05$ ) differences between  $T_3$  and other groups ( $T_0$ ,  $T_1$  and  $T_2$ ) as well as with increase in storage of days. The tyrosine value (mg/100g) was found to increase with increase incorporation of blood. However, analysis of variance revealed significant ( $P<0.05$ ) difference in tyrosine value with increase storage of days.

Proximate composition studies of nuggets revealed that the moisture percent was seen to increase with corresponding increase in the level of blood.  $T_3$  ( $66.12\pm 0.49$ ) group had highest moisture percent, followed by  $T_2$  ( $65.80\pm 0.30$ ),  $T_1$  ( $65.74\pm 0.60$ ) and  $T_0$  ( $65.66\pm 0.47$ ) group. The moisture per cent showed no significant ( $P>0.05$ ) differences among the various treatment groups. The protein per cent in the products showed significant ( $P<0.01$ ) increase in the samples with incorporation of blood and the highest value was recorded in  $T_3$  ( $20.83\pm 0.82$ ) group and lowest in  $T_0$  ( $18.61\pm 0.50$ ) group. The fat per cent of chicken nuggets incorporated with whole blood showed significant ( $P<0.05$ ) difference between the control and blood incorporated groups. The fat per cent was recorded to be highest in  $T_0$  ( $5.38\pm 0.24$ ) group which gradually decreased in  $T_1$  ( $4.99\pm 0.00$ ),  $T_2$  ( $4.82\pm 0.10$ ) and  $T_3$  ( $4.74\pm 0.04$ ) group.

On overall acceptability in sensory evaluation of chicken nuggets, the highest score (7-point hedonic scale) was seen in  $T_0$  and  $T_1$  group followed by  $T_2$  and  $T_3$  group. Progressive reduction in overall acceptability of the products was found with incorporation of blood and with increase in storage of days. The overall acceptability scores differed significantly ( $P<0.01$ ) among treatment groups.

The total plate count (log cfu/g) recorded in the study were significantly ( $P<0.01$ ) higher in all nugget samples during all storage period at refrigerated temperature. The highest total plate count (log cfu/g) was recorded in  $T_3$  (3.41 to 5.77) followed by  $T_2$  (3.38 to 5.64),  $T_1$  (3.10 to 5.11),  $T_0$  (2.92 to 4.99) from 0 to 15 days but were within the permissible level. Yeast and mould (log cfu/g) were not detected throughout the storage period. Shelf-life of the blood added nuggets products were lower as compared to control.

The cost of production of chicken nuggets decreased with increased level of blood incorporation. The highest cost of production was found in  $T_0$  (Rs. 272.42) followed by  $T_1$  (Rs. 238.80),  $T_2$  (Rs. 229.58) and  $T_3$  (Rs. 220.40) per kg respectively. Thus it can be concluded that whole blood can successfully be used for preparation of chicken nuggets for better iron and protein content in the nuggets.

# **Effect of Dietary Supplementation of Aloe Vera (*Aloe barbadensis* M.) Leaves Powder on the Performance and Carcass Quality of Commercial Broiler Chickens**

*Manasjyoti Thakuria*

The present study was undertaken to investigate the effect of feeding Aloe vera (*Aloe barbadensis* M.) leaf powder (ALP) as natural feed additive on growth performance of commercial broiler chickens. A total of 144 day-old commercial broiler chicks (Vencobb-430Y) from a single hatch were procured. The chicks were weighed; wing banded and randomly divided into 4 groups viz. T0, T1, T2 and T3 containing 36 chicks in each group. Each group was further subdivided into 3 replicates of 12 chicks in each. The chicks were reared under deep litter system of management throughout the period following standard hygienic and uniform managemental practices. The groups (T0, T1, T2 and T3) were provided Aloe vera powder in the basal diet of broiler chicken at the level of 0.00, 0.20, 0.30 and 0.40%, respectively. Local variety of raw Aloe vera leaves were procured from Paikan market of Goalpara district of Assam. Aloe vera leaves were first washed and cleaned properly to make it free from dirt and dust. The leaves were then left overnight to dry under room temperature. On the following day, these leaves were kept in the hot air oven at 50oC for 8 hours to dry. The leaves were stirred regularly to facilitate proper drying. The dried leaves were then pulverized and stored in an air tight container to avoid contamination and spoilage for use in the proposed experiment for a period of 6 weeks. All birds under control and treatment groups were offered *ad libitum* feed and clean water throughout the experimental period of 6 weeks.

The following parameters were studied during the experimental period of 6 weeks: performance traits which included weekly feed intake and total feed consumption, weekly body weight and body weight gain, Feed Conversion Ratio (FCR), Broiler Performance Efficiency Index (BPEI), livability, economics of production; carcass traits like pre-slaughter live body weight, dressed weight, dressing percentage, giblet weight, giblet yield, yield of cut-up-parts and relative organ weights including

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lymphoid organs; haematological parameters comprising of Haemoglobin, Packed Cell Volume (PCV), total RBC count, total WBC and WBC differential count; blood biochemical parameters comprising of total serum glucose (mg/dl), superoxide dismutase (unit/mg protein), total serum cholesterol (mg/dl), total serum protein (g/dl), total albumin (g/dl) and total globulin (g/dl) count and sensory evaluation.

The highest feed consumption was recorded in T3 (3627.38 g) group followed by T2(3597.42 g), T1(3585.49 g) and T0(3543.39 g) groups, respectively. The final body weight per broiler was highest in T3 group ( $2201.16 \pm 27.77$  g) followed by T2 group ( $2158.13 \pm 27.52$  g), T1 group ( $2102.63 \pm 26.01$  g) and T0 group ( $2010.55 \pm 27.73$  g). The overall Feed Conversion Ratio (FCR) was observed as 1.80, 1.74, 1.70 and 1.68 for T0, T1, T2 and T3 groups, respectively. The T3 group showed the best FCR followed by T2, T1 and T0 groups.

The BPEI was noted to be 111.66, 120.68, 126.47 and 130.95 for the treatment groups T0, T1, T2 and T3, respectively. The T3 group showed the highest BPEI value followed by T2, T1 and T0 groups. The livability was noted to be 100 per cent in all the treatment groups. The cost of production per broiler was found to be highest in T3 ( $\square 257.56$ )group followed by T2 ( $\square 253.67$ ), T1 ( $\square 251.81$ )and lowest for control ( $\square 246.26$ )group. On a similar note, the gross profit per broiler was found to be highest for T3 ( $\square 28.44$ ) group followed by T2 ( $\square 25.83$ ), T1 ( $\square 21.19$ )and T0 ( $\square 15.04$ ) groups, respectively

All the different parameters under carcass quality traits (pre-slaughter live weight, dressed weight, dressing percentage, giblet weight and giblet yield) showed non-significant ( $P>0.05$ ) difference among the different treatment groups except for pre-slaughter live weight and dressed weight. The pre-slaughter live weight was significantly ( $P\leq 0.05$ ) higher in T3 ( $2250.20 \pm 34.34$  g) group as compared to T2 ( $2173.80 \pm 40.84$  g), T1 ( $2063.40 \pm 41.73$  g) and T0 ( $2007.20 \pm 40.46$  g) groups, respectively. Among the experimental groups of broilers, there was a significant difference ( $P<0.05$ ) in dressed weight between T3 ( $1565.46 \pm 26.81$  g) and other treatment groups. The T2 ( $1514.40 \pm 24.47$  g) and T1 ( $1405.00 \pm 28.77$  g) dressed weights were similar with each other with T0 having the lowest dressed weight ( $1386.80 \pm 25.43$  g). The per cent yield of different cut-up parts on pre-slaughter live weight basis like neck, wings, back, breast, thighs and drumsticks did not differ significantly ( $P>0.05$ ) among the different experimental groups.

The per cent weights of relative organs on pre-slaughter live weight basis of broiler chicken did not differ significantly ( $P>0.05$ ) among the different treatment groups. Among the lymphoid organs, the spleen, thymus and bursa of Fabricius showed non-significant ( $P>0.05$ ) difference in per cent weights among the different experimental groups.

The mean Haemoglobin values, mean percentage of Packed Cell Volume (PCV) values, mean total Red Blood Cells (RBC) values, mean total White Blood Cells (WBC) values and mean WBC differential count values of different treatment groups T0, T1, T2

and T3 were recorded and the analysis of variance showed non-significant ( $P>0.05$ ) difference of their values among the entire group of broiler chickens.

With the exception of total serum glucose, the Aloe vera powder supplemented groups had no significant ( $P>0.05$ ) impact on the biochemical markers. The total serum glucose level was significantly decreased in T3 ( $219.00 \pm 1.87$  mg/dl) group but the values were within normal serum glucose range. The decrease in the level of total serum glucose was similar in T2 ( $222.00 \pm 1.10$  mg/dl) and T1 ( $223.20 \pm 1.66$  mg/dl) groups with T0 ( $224.80 \pm 2.66$  mg/dl) group having the highest values among all the groups but it was within normal total serum glucose range.

The mean scores for colour, texture, juiciness and overall acceptability of broiler breast meat and drumstick of T0, T1, T2 and T3 groups were studied and it was found that there was no significant ( $P>0.05$ ) difference in these parameters of the broiler breast meat and drumstick among the different treatment groups. However, the mean scores for flavour of broiler breast meat for different treatment groups were noted and the groups T1 ( $5.40 \pm 0.13$ ) and T2 ( $5.53 \pm 0.13$ ) were significantly ( $P<0.05$ ) different in flavour as compared to groups T0 ( $4.60 \pm 0.13$ ) and T3 ( $4.73 \pm 0.18$ ). The average flavour ratings for the various treatment groups of drumstick were noted and the groups T1 ( $5.33 \pm 0.15$ ) and T2 ( $5.53 \pm 0.23$ ) significantly ( $P<0.05$ ) differed from groups T0 ( $4.53 \pm 0.16$ ) and T3 ( $4.73 \pm 0.18$ ) in terms of flavour. Because the mean overall acceptability of the drumstick and breast meat ranged from 4.66 to 5.26 on the Hedonic scale, the meat can be considered to be of good grade.

Thus, it can be suggested that AVP can be efficiently and economically used as a natural feed additive in the diet of broiler chicken at the level of 0.4% to enhance the overall performance of broiler chicken.

## **Effect of Fenugreek (*Trigonella foenum-gracum* L.) Seed powder Natural Feed Additive on Growth performance of Commercial Broiler Chicken**

*Metung Kamchi*

The present study was undertaken to investigate the effect of feeding fenugreek (*Trigonella foenum-gracum* L.) seed powder as natural feed additive on growth performance of commercial broiler chicken. A total of 150-day-old commercial broiler chicks (Cobb-400) from a single hatch were procured. The chicks were weighed, wing banded and randomly divided into 5 groups viz. T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> containing 30 chicks in each group. Each group was further subdivided into 3 replicates of 10 chicks in each. The chicks were reared under deep litter system of management throughout the period following standard hygienic and uniform managerial practices. The birds under T<sub>0</sub> group (control) were offered basal diet without addition of fenugreek seed powder. The birds under T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> groups were offered basal diet with incorporation of fenugreek seed powder at the level of 0.25, 0.50, 0.75 and 1.00 per cent in the feed, respectively. For preparation of fenugreek seed powder, local varieties of fenugreek seed were procured from the Beltola market of Guwahati city of Assam. The fenugreek seeds were first cleaned thoroughly to make it free from dirt and dust and then grinded into fine powder and were stored at room temperature for use in the proposed experiment for a period of 6 weeks. All birds under control and treatment groups were offered *ad libitum* feed and clean water throughout the experimental period.

The following parameters were studied during the experimental period of 6 weeks: Performance traits which included weekly feed intake and total feed consumption, weekly body weight and body weight gain, feed conversion ratio (FCR), livability, economics of production, carcass traits like pre-slaughter live body weight, dressed weight, dressing percentage, giblet weight, giblet yield, yield of cut-up-parts and relative organ weights including lymphoid organs, sensory evaluation, serum biochemical parameters like serum protein, glucose, triglycerides, cholesterol, GGT, albumin and bilirubin and haematological parameters like haemoglobin and packed cell volume.

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The final body weight per broiler was highest in T<sub>4</sub> group (2269.30 ± 23.17g) followed by T<sub>3</sub> group (2203.48 ± 13.24g), T<sub>2</sub> group (2166.96 ± 12.50 g), T<sub>1</sub> group (2132.10 ± 21.37 g) and T<sub>0</sub> group (2107.07 ± 13.26 g). The total feed consumption per broiler was highest in T<sub>4</sub> group (3967.36g) and lowest in T<sub>0</sub> group (3851.83 g). The overall FCR for the entire period of the experimental groups was found best in T<sub>4</sub> group (1.75) followed by T<sub>3</sub> (1.76), T<sub>2</sub> (1.79), T<sub>1</sub> (1.82) and T<sub>0</sub> (1.83) groups.

Among the various experimental groups T<sub>4</sub> showed the highest livability per cent (100) followed by T<sub>3</sub> (96.66), T<sub>1</sub> (96.66), T<sub>2</sub> (93.33), and T<sub>0</sub> (90.00) per cent.

The cost of production per broiler including the additional cost of fenugreek seed powder were found to be (Rs.)242.94, 246.13, 248.09, 249.74 and 255.18 for T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> groups, respectively. However, gross profit per broiler was found to be the highest in T<sub>4</sub> (Rs. 27.32) group followed by T<sub>3</sub> (Rs. 25.26), T<sub>2</sub> (Rs. 20.66), T<sub>1</sub> (Rs. 17.62) and T<sub>0</sub> (Rs. 10.81) groups, respectively.

All the carcass quality traits (pre-slaughter live weight, dressed weight, dressing %, giblet weight and giblet yield) except for pre-slaughter live weight and dressed weight showed a non-significant (P>0.05) difference among the different treatment groups. The pre-slaughter live weight and dressed weight were significantly (P≤0.01) higher in T<sub>3</sub> (1985.66, 1429.00 g) and T<sub>4</sub> (1994.66, 1447.66 g) groups as compared to T<sub>0</sub> (1703.33, 1201.00 g), T<sub>1</sub> (1832.00, 1324.00g) and T<sub>2</sub> (1880.33, 1373.00g) groups. The per cent yield of different cut-up parts on pre-slaughter live weight basis like neck, wings, back, breast, thighs and drumsticks did not differ significantly (P>0.05) among the different experimental groups.

The per cent weights of relative organs on pre-slaughter live weight basis of broiler chicken did not differ significantly (P>0.05) among the different treatment groups except the per cent weight of abdominal fats. The per cent weights of abdominal fats in T<sub>4</sub> group (1.77±0.14) was significantly (P≤0.01) higher as compared to the other treatment groups T<sub>0</sub> (0.91±0.19), T<sub>1</sub> (0.81±0.09), T<sub>2</sub> (1.73±0.18) and T<sub>3</sub> (1.30±0.41). Among the lymphoid organs, the spleen and Bursa of Fabricius showed non-significant (P>0.05) difference in per cent weights among the different experimental groups.

The serum biochemical parameters (serum protein, glucose, triglycerides, cholesterol, GGT, albumin and serum bilirubin) except serum glucose recorded in the present study did not differ significantly among the different experimental groups. The serum glucose recorded in the present study was found to be significantly (P≤0.05) higher in T<sub>2</sub> group (252.82 mg/dl) followed by T<sub>4</sub> (250.26 mg/dl), T<sub>3</sub> (236.60 mg/dl), T<sub>0</sub> (233.97mg/dl) and T<sub>1</sub> (232.21 mg/dl) groups.

Both the haematological parameters *viz.* haemoglobin and packed cell volume recorded in the present study did not differ significantly (P>0.05) among the different treatment groups.

The different organoleptic parameters of broiler meat like colour, flavour, texture, juiciness and overall acceptability among the different treatment groups did not differ significantly (P>0.05) due to supplementation of fenugreek seed powder in feed.

From the result obtained in the present study it can be concluded that the fenugreek seed powder can be used economically as natural feed additive in broiler chicken diet at the level of 1.00 per cent to improve the overall performance of commercial broiler chicken.

# **Effect of Dietary Supplementation of Marigold Flower Powder on the Productive Performance of Broiler Chickens**

*Rajsekhar Sapkota*

The present study was undertaken to evaluate the effect of feeding Marigold flower (*Tagetes erecta*) powder as a natural feed additive on the performance parameters, economics, carcass characteristics, relative organ weights, cut-up parts weights, subjective meat qualities, objective meat qualities, gut histomorphometry and humoral immunity of commercial broiler chickens.

From a single hatch, 120-day-old commercial broiler chicks (Cobb-430y) were obtained. The chicks were weighed, their wings were banded and were then randomly separated into 4 groups: C (control), T1, T2, and T3, each of which contained 30 chicks. Each group was divided into three replicates, each with ten chicks. The chicks were raised using a deep litter management method during the course for a time period of 6 weeks while adhering to hygienic, standard and uniform managerial protocols. The birds under C group were offered basal diet using common feed ingredients (ICAR,2013) with no marigold flower powder (MFP). The birds under T1, T2 and T3 groups were offered basal diet with supplementation of MFP at the level of 0.3%, 0.6% and 0.9% in the feed, respectively.

For preparation of MFP, local variety of the same was procured from the flower market of Fancy Bazaar of Guwahati city of Assam. The marigold flowers were first cleaned thoroughly with water to make it free from dirt, dust and foreign bodies and then dried in hot air oven at 50°C for 6-8 hours till crisp and warm, and then ground to a fine uniform powder in a kitchen grade mixer-grinder, and then stored hermetically in a cool, dark and dry place till use. Throughout the course of the trial, all birds in the Control and treatment groups received unlimited access to food and fresh water.

The following parameters were examined throughout the six-week trial: Performance parameters which included weekly body weight change and body weight gain, feed consumption, feed conversion ratio (FCR), economics of production and livability; carcass characteristics like pre-slaughter live body weight, de-feathered

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weight, de-feathering loss, dressed weight, dressing percentage, abdominal fat weight and abdominal fat percentage; relative organ weights such as that of liver, heart, gizzard, head and shank; relative yield of cut-up parts like breast, back, drumsticks, wings, thighs and neck; sensory evaluation on the basis of subjective parameters like colour, flavour, juiciness, texture and overall acceptability; meat quality analysis on the basis of objective parameters such as texture and shear force; gut histomorphometric characteristics, hematological parameters like hemoglobin, packed cell volume, RBC, WBC, MCV, MCH, MCHC counts; and HI antibody titers against Newcastle disease virus.

The final body weight per broiler was highest in T2 group (2410.83±22.06g) followed by T1 (2367.23±39.48g), T3 (2127.73±23.18g) and C (2008.73±31.24g) groups. The T1, T2 and T3 groups had achieved 17.84%, 20.01% and 5.92% more live body weight than the control group, respectively. There was significant ( $P<0.01$ ) difference between the control and MFP fed groups. And amongst the latter, T1 and T2 did not differ significantly ( $P>0.05$ ) but there was significant difference between T1, T2 and T3 group. The total feed consumption per broiler was highest in T2 group (4016.14g), followed by T1 (3984.17), T3 (3638.69 g) and lowest in C group (3475.98g). The overall FCR for the entire period of the experimental groups was found best in T2 group (1.70) followed by T1 (1.72), T3 (1.75) and C (1.77) groups.

The cost of production per broiler was found to be highest in T2 (₹ 284.50) group, followed by T1 (₹ 282.60), T3 (₹ 261.86) and C (₹ 252.00) groups. However, the highest gross profit per broiler was found in T2 (₹ 28.91) group, followed by T1 (₹ 25.14), T3 (₹ 14.74) and C (₹ 9.13) groups. All the experimental groups had 100% livability. Among the carcass quality traits, the pre-slaughter live weight (PSLW) of T2 was found to be the highest (2315.62 ±27.35g) followed by T1 (2247.62±36.23g) T3 (2000.09 ±24.35g) and C (1865.46 ±24.50g) groups. Similarly, the T2 group had the highest dressed weight (1667.26 ±17.79 g) followed by T1 (1617.5 ±37.10g) T3 (1441.45 ±15.35g) and C (1328.64 ±16.85g) groups. T2, T1 and T3 groups had 25.48%, 21.74% and 8.49% higher dressed weights than the Control group, respectively. The T2 group had the highest abdominal fat weight (89.95 ±1.58 g) followed by T1 (87.38 ±1.73g), T3 (73.73 ±0.45g) and C (62.48 ±1.96g) groups. In all these three parameters, there was significant difference ( $P<0.01$ ) between the treatment and control groups, however, among the treatment groups, T1 and T2 did not differ significantly ( $P>0.05$ ).

The relative per cent liver weight of T2 (3.15 ±0.0%) was found to be the highest followed by T1 (3.12 ±0.05%) T3 (2.92 ±0.05%) and C (2.57 ±0.08%) groups. Among the marigold fed groups, T2, T1, and T3 had 22.56%, 21.40%, and 13.61% higher liver weights, respectively than their Control counterpart. The MFP supplemented groups had significantly ( $P<0.01$ ) higher liver weights than their control counterparts, but amongst the former, T1 and T2 did not differ significantly ( $P>0.05$ ). On the other hand, relative intestinal weight of T2 (5.12±0.05%) was found to be the highest followed by T1 (4.89 ±0.05%), T3 (4.72 ±0.05%) and C (4.68±0.06%) groups. In comparison to their Control

counterpart, the marigold fed groups i.e., T2, T1, and T3 had 9.40%, 4.48%, and 4.00% higher intestinal weights. The treatment groups had significantly ( $P<0.01$ ) higher intestinal weights over the control group and amongst them they differed significantly ( $P<0.05$ ) as well.

The mean per cent yield of breast was found to be the highest in T2(24.35  $\pm$ 0.08%) followed by T1 (23.23  $\pm$ 0.18%) T3 (22.52  $\pm$ 0.05%) and C (20.25  $\pm$ 0.21%) groups. The mean per cent yield of drumsticks were found to be the highest in T2(12.75  $\pm$ 0.04 %) followed by T1 (11.38  $\pm$ 0.10%) T3 (10.81  $\pm$ 0.05%) and C (9.63  $\pm$ 0.12%) groups. The mean per cent yield of thighs were found to be the highest in T2(13.45  $\pm$ 0.04 %) followed by T1 (12.28  $\pm$ 0.11%) T3 (11.71  $\pm$ 0.03%) and C (10.46  $\pm$ 0.12%) groups. The marigold fed groups differed significantly from the control ( $P<0.01$ ) as well as amongst them ( $P<0.05$ ).

The organoleptic qualities of breast and drumstick meats were studied in terms of colour, flavour, juiciness, texture and overall acceptance by utilizing semi trained taste panelists employing Hedonic scale of 1(least) to 7(best).The mean overall acceptance scores of broiler breast and drumstick meats for different treatment groups was found to be the highest in T3 (5.89 $\pm$ 0.21 and 6.19 $\pm$ 0.21)followed byT2 (5.66 $\pm$ 0.16 and 5.97 $\pm$ 0.16), T1 (5.58 $\pm$ 0.21 and 5.59 $\pm$ 0.17) and C (5.00 $\pm$  0.23 and 5.05 $\pm$ 0.25) groups. The MFP supplemented groups had significantly ( $P<0.01$ ) higher scores of overall acceptance over the control group but did not differ significantly among them ( $P>0.05$ ).

The objective meat quality of breast meat was done using Texture Meter as well as Warner-Bratzler shear force apparatus. The hardness values (kg) of breast meat was found to be the lowest in T2 group (2910.738), preceded by T1 (3060.325), T3 (3085.681) and C (4981.010) groups. Chewiness (g) and Resilience (ratio) were found to be lowest in T3 group (589.094 and 0.111), preceded by T2 (591.11 and 0.127), T1 (868.333 and 0.137) and C (875.273 and 0.142) groups. The mean shear force values (kg) of broiler breast meat was recorded to be the highest in C group (2.50 $\pm$ 0.10) followed by T3 (2.02 $\pm$ 0.09), T1(2.00 $\pm$ 0.07) and T2 (1.80 $\pm$ 0.07) groups.

In the gut histomorphometric study, it was found that the overall duodenal villi height ( $\mu$ m)along with the number of villi was found to be highest in T2 group, followed by T1, T3 and C. The jejunal villi height was also recorded highest in T2 group followed by T1, T3 and C. Duodenal and jejunal villi crypt ratio was recorded to be the highest in T2 group (4.07 and 12.39), followed by T1 (2.93 and 10.57), T3 (2.12 and 9.84) and C (1.02 and 8.49) groups.

All the hematological results are found to be within the standard range, indicating that feeding MFP did not evoke adverse effects in the broilers. In the HI antibody titers study against Newcastle disease virus, there was significant increase ( $P<0.001$ ) in antibody titer progressively at different days post immunization in all the groups. However, no significant difference was observed between control and any of the three MFP supplemented treatment groups in the 35 days study period, which indicated



that the dietary MFP had no significant role in modulation of antibody titer in broiler chickens.

According to the findings of the current study, MFP may be utilized costeffectively as a natural feed additive in the diet of broiler chickens at a level of 0.60 % to enhance their general performance as well as meat quality.

# **Quality Evaluation and Shelf Life Study of Chicken Meat Patty Incorporated with Chicken Blood Plasma and Mint Powder**

*Shakura Siddika Barbhuiya*

The objective of the present study was to evaluate the quality and shelf life study of chicken meat patties incorporated with chicken blood plasma (CBP) and mint powder (*Mentha spicata*). The parameters studied were physico-chemical properties, microbial count and organoleptic properties of the developed product. The study was conducted in the Department of Poultry Science in collaboration with the Department of Livestock Products Technology and Veterinary Biochemistry, C.V.Sc, Assam Agricultural University, Khanapara, Guwahati-781022. For the experiment required quantity of fresh mint leaves were procured from vegetable *mandi* and chicken blood from local market. Sodium citrate was used as an anticoagulant. Chicken blood plasma (CBP) was separated from whole blood by centrifugation and preserved in refrigeration (4°C) till use. Mint leaves were dried by exposing the leaves to 50°C for 2 hrs in a hot air oven and powdered (MP) by using Lab grinder, preserved hermetically till further use. The whole experiment was carried out in two phases. Five replicates of chicken meat patties were made in the first phase consisting of chicken blood plasma (15%) at a fixed level for making four groups at different combinations with MP as; T<sub>0</sub> (0% CBP + 0%MP), T<sub>1</sub> (15% CBP + 0%MP), T<sub>2</sub> (15% CBP+0.5% MP), T<sub>3</sub> (15% CBP+1% MP) and T<sub>4</sub> (15% CBP+1.5% MP) while preparing chicken patties blending with the emulsion of following compositions: However, the broiler meat used in T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> group was 70.0, 55.0, 54.5, 54.0, and 53.5%, respectively. The meat was mixed with following ingredients, vegetable oil (10%), corn flour (5%), spice mix (1.5%), salt (1.5%), condiments (2%) and ice cube (10%). The prepared patties were sliced to its standard size, vacuum packed and stored under refrigeration temperature (4°C) till use. The shelf life of the product was studied under second phase using the parameters such as TBARS, microbiological studies and taste panel evaluation at 0, 3rd, 6th, 9th, 12th and 15th days of storage period at 4°C. The physico-chemical evaluation revealed that 15% addition of CBP increased the pH in T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> groups. Similar results were obtained from the emulsion stability, protein per cent, moisture

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**Major Advisor : Dr. D. Sapkota**

content and tyrosine value where significant ( $P < 0.01$ ) increase were found in plasma incorporated group. No effect of mint addition was noticed in any of the above mentioned parameters. TBARS value recorded to be decreased significantly ( $P < 0.01$ ) among the groups and increased with progression in storage period of 15 days. Water activity found to be increased significantly ( $P < 0.01$ ) due to 15% CBP incorporation but mint addition at 0.5%, 1.0% and 1.5% level resulted in significant decrease of water activity. No effect of CBP or mint powder (0.5%, 1.0% and 1.5%) incorporation was noticed in the thickness (mm) and diameter (mm) of the product. The microbiological study revealed that total plate count ( $\log_{10}$ cfu/g) and psychrophilic count ( $\log_{10}$ cfu/g) significantly ( $P < 0.01$ ) increased with the incorporation of 15 % CBP in the product whereas mint addition at 0.5 %, 1.0% and 1.5% significantly ( $P < 0.05$ ) decreased the microbial count. Also microbial load increased in all groups during 15 days of storage under refrigeration (4°C). Yeast and mould counts were not found in any of the groups when evaluated at 3 days interval for 15 days. The organoleptic evaluation of chicken meat patties was carried out by using semi trained taste panelist. It involved subjective evaluation and objective evaluation.

The subjective evaluation of chicken meat patties showed the most preferred and least liked among the treatment groups. Appearance score was best recorded in T2 group and T4 was least preferred. Colour of the patties was found to be highest in T1 group and T4 received lowest score. Flavour score was recorded highest in T2 group and T4 group found to be received lowest score. Juiciness was recorded to be significantly ( $P < 0.01$ ) higher in plasma added group (T1, T2, T3 and T4). Similarly, texture was found significantly higher in T1, T2, T3 and T4. The T2 group was found most preferred among groups for overall acceptability.

The subjective study was carried out using texture analyzer and chromameter. It included texture profile (Hardness, springiness, cohesiveness, chewiness and resilience) shear force and colour profile. Texture profile was found to be significantly ( $P < 0.01$ ) increased due to incorporation of 15 % CBP and mint powder addition at 0.5 %, 1.0% and 1.5% level. The shear force was recorded to be increased among the groups. The colour profile was evaluated by measuring  $L^*$ ,  $a^*$  and  $b^*$  value. The  $L^*$  and  $b^*$  were found to be significantly ( $P < 0.01$ ) decreasing among the groups as compared to the Control group, whereas, significant increase was found in  $b^*$  value among the groups compared to the Control group. The cost of production revealed that the Control group was most dearer (Rs. 248.10) followed by T4 (Rs. 237.20), T3 (Rs. 228.50), T2 (Rs. 219.80) and T1 (Rs. 237.20). From the various above findings it could be concluded that chicken meat patties can be prepared with 15% meat replacement by chicken blood plasma incorporating mint leaf powder at three different levels. Among all options the chicken meat patties with 15% CBP and 1.0 % mint leaf powder gave the best results in terms of economy and value addition.

# **Effect of Dietary Supplementation of Curry Leaves (*Murraya koenigii*) Powder on the Performance and Histology of Certain Lymphoid Organs of Commercial Broiler Chicken**

*Sukanya Deori*

The present research work was performed to study the “Effect of dietary supplementation of curry leaves (*Murraya koenigii*) powder on the performance and histology of certain lymphoid organs of commercial broiler chicken”. The study was carried out with 144 numbers of day-old commercial broiler chicks (Cobb-400) obtained from a single hatch with uniform body weight. The weighing and wing banding of the chicks were done individually. The broiler chicks were reared in four different experimental groups viz. T0, T1, T2 and T3 having 36 birds in each group with 3 replicates of 12 birds in each group. The chicks were reared under deep litter system of rearing following standard and uniform managemental practices. The chicks under T0 (control) group was supplemented with only basal diet, whereas the chicks under T1, T2 and T3 groups were supplemented with dried Curry Leaves Powder (CLP) at the level of 0.25, 0.50 and 0.75% in the basal diet, respectively. For the preparation of dried CLP, fresh, and matured curry leaves were collected from the local villages. Then the curry leaves were sun dried for 6 to 7 days on newspaper, until they become crispy while retaining the greenish colouration. After proper drying, leaves were grinded and stored in cellophane bags for further use during the 6 weeks of experimental period. The proximate composition of curry leaf powder was analyzed and incorporated it into the basal diet of broiler chicken at the level of 0.00, 0.25, 0.50 and 0.75%, respectively.

During the six weeks of experimental period, the following parameters were studied: performance traits which included weekly feed intake and total feed consumption, weekly body weight and body weight gain, Feed Conversion Ratio (FCR), Broiler Performance Efficiency Index (BPEI) and livability and economics of production, carcass traits like pre-slaughter live weight, dressed weight, dressing percentage, giblet weight, giblet yield, yields of cut-up parts and relative organ weights, organoleptic properties of chicken meat, blood biochemical parameters like serum

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glucose and superoxide dismutase, and histological observations of lymphoid organs (spleen, thymus and bursa of Fabricius) and jejunum of intestine after the end of six weeks of age.

In the present study, the highest feed intake per broiler was recorded in the T3 group (3253.88g) and lowest in the T1 group (3014.19g). The final body weight per broiler was found to be significantly ( $P<0.05$ ) highest in the T3 group ( $1989.43\pm 43.16g$ ) followed by T2 ( $1793.34\pm 34.56g$ ), T0 ( $1733.76\pm 57.33g$ ) and T1 ( $1653.31\pm 49.57g$ ) group. During the 6th week of age, the body weight gain was significantly ( $P<0.05$ ) higher in T3 group ( $546.37\pm 27.97g$ ) and lowest in the T1 ( $360.11\pm 17.48g$ ) group. The overall FCR of the entire experimental period was best in the T3 group (1.67) followed by T2 (1.83), T1 (1.87) and T0 (1.90) group. Among the different treatment groups, highest BPEI was found in the T3 group (119.11) followed by T2 (97.99), T0 (91.21) and T1 (88.40) group. The per cent livability of CLP supplemented groups (T1, T2 and T3) was found to be higher (97.22) as compared to control (91.67) group.

The production cost per broiler was highest in the T3 group (2) (226.28) followed by T0 (224.90), T2 (224.48) and T1 (213.88) group, respectively. However, the recorded gross profit per broiler was highest in the T3 group (2) (28.87) followed by T2 (17.17), T1 (8.87) and T0 (8.65), respectively.

The carcass traits comprising of pre-slaughter live weight, dressed weight, dressing percentage, giblet weight and giblet yield did not differ significantly ( $P>0.05$ ) under different experimental groups. The per cent yields of cut-up parts like neck, wings, back, breast, thighs and drumsticks showed no significant ( $P>0.05$ ) differences among the different treatment groups. The per cent weights of relative organs on pre-slaughter live weight basis did not differ significantly ( $P>0.05$ ) for different experimental groups. In the present study, the blood biochemical parameters like serum glucose and superoxide dismutase (SOD) showed significant ( $P<0.05$ ) differences among the different experimental groups. The serum glucose level decreased gradually as the level of incorporation of CLP was increased. On the other hand, the SOD level increased gradually with the increased level of CLP in the basal diet.

The organoleptic evaluation of broiler chicken meat for colour, flavour, texture, juiciness and overall acceptance did not show any significant ( $P<0.05$ ) differences among the different treatment groups.

The gross, histology and ultrastructure (scanning electron photomicrograph) of lymphoid organs (spleen, thymus and bursa of Fabricius) and jejunum of intestine of T0, T1, T2 and T3 groups of broiler chicken were studied. From the histological observations of lymphoid organs and jejunum, it was found that the average length, diameter, thickness and weight of spleen, thymus and bursa of Fabricius were significantly ( $P<0.05$ ) higher in T3 group of broiler chicken along with numerous lymphocytes aggregation in these organs. The mean length of villi and diameter of crypts of the jejunum of T3 group of broiler chicken were also significantly ( $P<0.05$ ) higher as compared to the T0, T1 and T2 groups of broiler chicken. The lymphoid

follicle of jejunum of T3 group of chicken contained numerous T and B lymphocytes. This might be due to the concentration and immunogenic effect of CLP.

Hence, it can be concluded that, the CLP can be supplemented as herbal feed additives in the diet of broiler chicken at the level of 0.75% to improve the overall performance of broiler chicken with higher gross profit per broiler. The observations in the current study has established a major role in recording the anatomical norms in respect of gross, histology and ultrastructure of lymphoid organs and jejunum of intestine of broiler chickens fed with CLP at different levels.

# **Sero-Prevalence and Risk Factor Analysis of Leptospirosis among Cattle Population in West District of Tripura State**

*Banitya Mohan Tripura*

Leptospirosis is a re-emerging zoonotic, occupational and water-borne bacterial disease. The disease is endemic in our country since 20th century. The current study was investigated to know the seroprevalence of this particular zoonosis among cattle population in West District of Tripura. The research was carried out from March 2018 to February 2019. A total of 255 blood samples were collected from 3 (three) subdivisions of West Tripura both from clinically ill and apparently healthy cattle randomly irrespective of their age, breed and sex. The presence of anti-Leptospiral antibody is screened by Enzyme Linked Immunosorbent Assay (ELISA) and detection of serovars by Microscopic Agglutination Test (MAT).

Out of the 255 serum samples screened, the overall seroprevalence was recorded to be 24/255 (9.41%) and 17/255 (6.66%) by ELISA and MAT respectively. Also the following serovars were encountered *viz.* Autumnalis (29.41%) followed by Bataviae (23.52%), Ballum, Australis, Grippytyphosa, Hebdomadis and Javanica. A comparative study was made out for the sensitivity and specificity of ELISA and MAT with 100% and 70.83% respectively and concordance (97.25%). From the study it was observed that ELISA is superior than MAT based on its sensitivity, easy and rapid to detect circulating antibody.

Out of the three subdivisions studied, the seroprevalence was recorded highest in Mohanpur (15.29%) followed by Sadar (9.41%) and lowest in Jirania (3.52%). Statistical analysis by Chi-Square test showed that there was significant association of *Leptospira* seropositivity with the risk factors *viz.* health status, farm hygiene, rodent infestation, feeding quality, water source, herd size and season (P-value<0.05). Average temperature and rainfall were also recorded highest in monsoon. Seropositivity among cattle was recorded more with clinically ill cattle (21.43%) than apparently healthy cattle. Farm with poor hygiene was recorded highest (18.05%) with *Leptospira* infection. Farm with history of rodent infestation was recorded higher with leptospirosis

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**Major Advisor : Dr. P. Hussain**

(32.3%). In consideration to feeding quality more cases of leptospirosis was recorded in cattle fed with cultivating grasses (13.63%). The recorded leptospirosis associated with stored water as risk factor was 15.18%. Farm with herd size >5 of animals was recorded with *Leptospira* infection (15.45%). Based on season highest *Leptospira* infection was recorded in monsoon (20.75%) and lowest in winter (3.38%). Whereas, there was no significant association with the risk factors viz. breed, sex, age, farm location, grazing pattern and contact with other animals.

Therefore, the current study will give a baseline seroprevalence of leptospirosis among cattle population in West District of Tripura.



# **West Nile Virus: Sero-Prevalence in Duck and Molecular Detection of the Virus in Mosquitoes in and Around Guwahati**

*Jakir Hussain*

West Nile Virus belongs to the genus *Flavivirus* in the family *Flaviviridae* and is a member of the *Japanese encephalitis virus (JEV)* sero-complex which is an arthropod-borne virus of public health importance. The present study was envisaged to collect baseline data on peri-urban duck farms and urban duck shops, study the sero-prevalence of West Nile virus infection in ducks, study the density pattern and determine the West Nile virus infection rate in mosquito vectors and to prepare prevalence map of West Nile virus in selected study areas of Guwahati. A total of 12 locations comprising of 6 locations each for peri-urban areas *viz.*, Chandrapur, Hajobari, Hekera, Nagarbera, Bagibari Pathar and Bherakuchi Pathar and urban areas of Guwahati *viz.*, Borbari, Ganeshgur, Sijubari, Basistha Chariali, Lokhra and Sixmile were selected.

Baseline data *viz.*, respondent information, details of farming practices, hygiene and sanitation, vector control measures and health measures were recorded.

Baseline data revealed that majority of the farmers were educated upto higher secondary (61.11%) in peri-urban duck farms followed by secondary education (72.22%) in urban duck shops of Guwahati. Most of the farmers and sellers were recorded age below 46 years. An overall 66.67% of the peri-urban duck farmers adopted disinfection weekly and 50.00% of the farmers never consult veterinarian. Sum of total 432 serum samples of ducks were screened by ELISA which was further established by HI showed the sero-prevalence of WNV to be higher in urban areas (17.13%) in comparison to peri-urban areas (9.72%) of Guwahati. WNV sero-prevalence was recorded higher in monsoon season as compared to rest three seasons. WNV sero-prevalence was recorded higher in Bherakuchi Pathar (33.34%) of peri-urban areas whereas, WNV sero-prevalence was recorded higher in Sijubari of urban areas of Guwahati. There was no significant statistical variation in sero-positivity of WNV with educational qualification, source of livelihood, number of ducks in the farms, rearing

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system, hygiene of the farms and shops, in-contact animal species, presence of water bodies close to farms and shops.

Sum of total 4,722 mosquitoes were trapped within a period of 1 year from 18 farms and 18 shops respectively. The collected mosquitoes belonged to 5 genera including 12 different species. Out of which the most predominant species was *Culex quinquefasciatus* (36.85%) followed by *Cx. vishnui* group (19.55%). Density pattern of *Mansonia uniformis*, *Culex quinquefasciatus*, *Cx. vishnui* group, *Cx. Bitaeniorhynchus* and *Armigeres subalbatus*, ( $D > 5\%$ ) were identified as dominant species whereas *Mansonia annulifera*, *Culex gelidus*, *Culex whitmori*, *Anopheles vagus*, *Aedes albopictus*, and *Anopheles barbirostris* ( $1 < D < 5\%$ ) and *Anopheles kochi* ( $D < 1\%$ ) were sub-dominant and satellite species, respectively during the study period.

Screening by Real time one-step RT-PCR of a total of 50 pooled mosquito samples detected negative for NS5 gene of *Flavivirus*.

# **Detection of Bacterial Biofilms in Drinking Water Systems in Peri-Urban Dairy Farms of Guwahati City**

*Johnson Th.*

The quality of drinking water is critical to the health of both human and animal populations. Biofilms are microbial colonies that are usually found on any surface in contact with water. These organisms have a very high potential to colonise the drinking water systems in any farm distribution and hence, continuous exposure to such organisms can lead to adverse conditions for the animal populations. In the present study, the prevalence of bacterial biofilm in farm drinking water systems in peri-urban dairy farms of Guwahati city was carried out from March 2021 to February 2022. Baseline information for each dairy farm was collected using the interview method by using a suitable questionnaire. Based on the availability of data on cattle in peri-urban dairy farms in Guwahati, the area of study was identified and a total of 20 locations were selected. From each location, a total of 3 farms were selected, encompassing 60 farms. Baseline data on socio-demographic characteristics of dairy farming communities revealed 55.00% of farmers in peri-urban areas belong to the middle-aged group of 30-45 years old. Majority (38.33%) of the farmers were found to have secondary education. The main sources of livelihood for the farmers were recorded to be dairy farming and agriculture (33.33%). Intensive rearing system (63.33%) was recorded to be the most commonly adopted rearing system followed by the farmers. The source of water varied according to the demography of the places where the hilly areas used streams (35.00%) on their farms, the plain regions used bore wells or hand pumps (33.33%). Farms using house-hold pipe water supply for drinking water distribution to the farms was 61.67%. Buckets were used by the 68.33% of the farmers for providing water to the animals, and 78.33% of the farmers cleaned the containers daily. Treatment of farm drinking water was not practised by 88.33% of the total farmers. Only 6.67% of the dairy farms followed regular disinfection practices. The cleanliness of the farm revealed 45.00% of the shed to be dirty. Most dairy farmers used farm waste for composting (38.00%). Bacterial biofilm was found to be prevalent in 46.11% of the peri-urban dairy farms in

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Guwahati. Biofilm positivity was recorded in 83 (74.10%) bacterial isolates. Weak biofilm producer (51.80%) was the most predominant biofilm type recorded, followed by moderate biofilm producers (26.50%) and strong biofilm producers (21.68%). The end of the water distribution system had the most biofilm forming bacterial isolates (41.07%), followed by water reservoirs (26.78%) and the unprotected water source (6.25%). Prevalence of bacterial biofilms was recorded to be 41.46% in farms using stream as a source of water. The bacterial biofilm prevalence of dairy farms using household water pipes was recorded to be 75.61%. Farms that never treated water recorded 95.12% prevalence. Farms using buckets for providing water to the animals recorded 68.04% prevalence. Bacterial biofilm prevalence of 87.80% was recorded in farms which rarely carried out disinfection practices, whereas no prevalence was recorded in farms which disinfected regularly. Dirty sheds recorded 58.54% biofilm prevalence.

# **Sero-Prevalence and Molecular Detection of Canine Brucellosis in Urban and Peri-Urban Areas of Guwahati**

*Malela Saikrishna Goud*

Brucellosis is an important neglected lingering zoonotic disease of increasing veterinary and public health concern particularly in developing countries which is highly underreported in India. In Assam, the abundance of non-confined free roaming dogs in peri-urban livestock farms and enormous increase in dog ownership in metropolitan city of Guwahati has become a significant threat rendering the owners vulnerable to various zoonotic diseases including canine brucellosis. The present investigation was carried out from January, 2022 to June, 2022 to collect baseline data on dog owners, study the sero-prevalence of brucellosis in dog, detect the presence of *Brucella* spp. in dogs using molecular technique and prepare canine brucellosis prevalence map in peri-urban and urban areas of Guwahati.

A total 24 locations comprising of 12 locations each for peri-urban areas viz., Sonapur Rewa NC, Mirza, Khankar Gaon, Kahikuchi, Digaru Gaon, Shanti Basti, Bonda, Gorol, Gomoria Gaon, Birkuchi, Jorabat, Hatisila, and urban areas of Guwahati viz., Khanapara, Six Mile, Hatigaon, Uzan Bazar, Zoo Road, Hengrabari, Ganeshguri, Chandmari, Beltola, Bharalumukh, Boragaon and Kahilipara were selected. From each peri-urban location 10 livestock farms having in-contact dogs and from each urban location 10 households keeping dogs were selected.

Baseline data revealed that most of the peri-urban farmers were educated up to secondary (78.34%) level and below 50 years (92.507%), having moderately clean or dirty farms (82.50%) and reared non-descript (85.00%) local or cross breed dogs which were fed on garbage and homemade food (50.83%). Majority of the farmers did not consult veterinarian and used unsafe method of waste and carcass disposal. Contrary to this, in urban areas the dog owners were highly educated, reared descript pure breed dogs, fed commercial and homemade food to dogs (93.33%), but 94.17% owners were unaware about brucellosis. Dogs were showing various symptoms of brucellosis viz., infertility (11.25%), scrotal dermatitis (2.90%), still birth (2.50%), fetal maceration

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**Department : Veterinary Public Health**

**Major Advisor : Dr. Archana Talukdar**

(2.50%), fetal mummification (1.25%), fetal resorption (1.67%), vaginal discharges (12.09%), abortion (7.91%) and lymphadenopathy (5.41%) in both urban and peri-urban areas of Guwahati.

Screening of a total of 240 serum samples of dog by RBPT and further confirmation by STAT and LFA revealed the overall sero-prevalence of canine brucellosis to be 4.16%, with 2.50% sero-positivity in urban compared to 5.83% in peri-urban areas. Highest sero-prevalence of brucellosis was recorded in Sonapur Rewa NC (2.50%) of peri-urban Guwahati.

Association between sero-prevalence of canine brucellosis with respect to the feeding habit of dogs and cases of abortion in livestock were found to be very highly significant ( $P < 0.001$ ). Significant association ( $P < 0.05$ ) between sero-prevalence of canine brucellosis was recorded with respect to the educational qualification of the farmers, sex of dogs, health status of dogs, method of disposal of farm waste and hygienic status of farms.

Molecular detection of genus specific BCSP31 gene in dog blood samples indicated the presence of *Brucella* organism, which were confirmed as *Brucella abortus* by species specific AMOS, Bruce Ladder and a multiplex PCR.

GIS maps were prepared to visualize the topographic distribution of canine brucellosis in urban and peri-urban areas of Guwahati on the basis of *Brucella* sero-prevalence in dogs, which will be of immense support in future for strategic disease control at the interface of human, animal and environment.

# Prevalence of Cysticercosis in Jorhat District of Assam

*Mrinmoyee Sarma*

A study on prevalence and seroprevalence of porcine cysticercosis and its associated risk factors and a retrospective study of NCC in man were conducted for a period of one year from July'18 to June '19 in Jorhat district of Assam. A total of 104 numbers of carcasses were examined in different market places from 5 different locations, out of which 1 carcass was found positive for *Cysticercus cellulosae* infection with the prevalence rate of 0.96%. A single positive carcass (1.85%) was reported between the age group of 7-12 months. Number of positive cases in male and female was 1(1.53%) and 0 (0%) respectively. The prevalence rate in non descript and crossbred pigs was 0 (0%) and 1(1.26%) respectively. To validate the results of meat inspection, DNA sample of the cyst were examined by PCR with TBR primer and Cox-1 primer. The PCR product with molecular size of 286 bp and 984 bp were amplified targeting large subunit rRNA Gene and cytochrome oxidase sub unit 1 gene respectively. On characterization of cystic fluid protein profile of porcine larval cestode by SDS-PAGE, two highly antigenic bands and one moderately antigenic band was observed.

A total of 140 number of serum samples were collected from 20 farms from 5 locations of Jorhat district. All the serum samples were analyzed by using RIDASCREEN *Taenia solium* IgG kit (R- Biopharm AG, Germany) to detect the presence of circulating antibody against *C. cellulosae*. Out of 140 samples examined, 13 were found to be positive for antibody against porcine cysticercosis with the prevalence rate of 9.2%. The highest numbers of cases were recorded from Madhupur (17.85%). The highest seroprevalence (12.06%) was recorded in the age group of 7 to 12 months and lowest (5.4%) in the 1-6 months. Sex- wise seroprevalence in female and male was 9 (10.22%) and 4 (7.69%) respectively. The proportional distribution of infection in female and male was 57% and 43% respectively. The seroprevalence rate in non descript and crossbred pigs was 3 (7.69%) and 10 (9.9%) respectively. The proportional distribution between non descript and crossbred pigs was 44% and 56% respectively.

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**Major Advisor : Dr. A. G. Barua**

A total of 20 household associated with pig husbandry practices from 5 different locations and 50 consumers from different markets of Jorhat district were interviewed with the help of two suitable questionnaires to collect the baseline information to assess the risk factors associated with cysticercosis. Risk factors associated with cysticercosis were absence of latrines, defecation in open, poor personal hygiene, awareness to the disease, food habit, system of pig rearing, lack of meat inspection, lack of vaccination in pigs against cysticercosis, lack of periodic deworming of pigs as well as of human beings.

A total of 20 patients from Jorhat district were registered in Jorhat Medical College and Hospital for treatment of Neurocysticercosis (NCC) from July'17 to June'19. A backward study of patients (using retrospective and current data) was carried out with the help of a suitable questionnaire to determine the factors influencing the prevalence of NCC in the study area. Risk factors associated with the prevalence of NCC among the patients were gender of the patient, source of water supply, poor personal hygiene, consumption of raw salad and lack of periodic deworming.



# **Mosquito-Borne Flaviviruses in Livestock and Poultry Farms in Urban Settings of Guwahati: Mosquito Identification and Molecular Detection of Virus**

*Phunu Talkdar*

Arboviral diseases having zoonotic importance under the genus *Flavivirus* are many including Japanese encephalitis (JE) and West Nile Fever (WNV). The present investigation was envisaged to collect the baseline data on livestock and poultry farms, study the sero-prevalence of Flaviviruses in livestock and poultry, study the density pattern and determination of vector potential of certain mosquito species and mapping of Arboviral disease prevalent areas.

Baseline data *viz.*, respondent information, livestock (cattle/pig) and poultry (chicken) population, farming practices and health measures were recorded.

A total of 225 serum samples (75 from each species) collected from urban livestock (cattle and pigs) and poultry (chicken) farms of Guwahati were screened by using a competitive ELISA kit followed by HI test revealed 29.33% and 8.00% seropositivity for JEV in pig and poultry (chicken), respectively whereas 1.33% and 13.33% WNV seropositivity was recorded in cattle and poultry (chicken), respectively. Seropositivity of JEV in cattle and seropositivity of WNV in pig was recorded to be nil. There was no significant statistical difference in seropositivity of JEV and WNV with location, educational qualification of farmers, rearing system, type of floor and roof, frequency of disinfection and follow mosquito control measures in farms. Seropositivity of JEV and WNV was significantly associated ( $P < 0.05$ ) with in-contact animals/birds and presence of water source near farms. WNV seropositivity in cattle in relation to presence of water source nearby farm was found to be statistically non-significant. WNV seropositivity was significantly associated ( $P < 0.01$ ) with cattle farm hygiene.

A total of 2,893 mosquitoes were collected for 3 months (July'18-September'18) from selected farms, of which the most predominant species was *Culex quinquefasciatus* (28.79%) followed by *Cx. vishnui* group (17.49%). Density pattern of

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**Major Advisor : Dr. Rezibuddin Ahmed Hazarika**

*Cx. quinquefasciatus*, *Cx. vishnui* group, *Cx. bitaeniorhynchus*, *Mansonia uniformis*, *Armigeres subalbatus*, *Ma. annulifera* and *Cx. gelidus* were categorized as dominant species while *Cx. malayi* and *Coquillettidia crassipes* as sub-dominant and satellite species, respectively.

Correlation of environmental variables and total mosquitoes revealed significant difference between total mosquitoes and daily minimum temperature, daily maximum temperature and daily relative humidity (1730 hrs).

A total of 135 pools of mosquito were screened by Real time one-step RT-PCR for detection of NS5 gene of *Flavivirus* of these 7 pools were found to be positive for *Flavivirus*. The pools mainly consisted of *Culex* and *Mansonia* species.

# **Sero-Prevalence and Molecular Detection of Leptospires in Dogs of Peri-Urban Livestock Farms and Urban Households of Guwahati**

*Ritrisha Saikia*

Leptospirosis is a zoonotic disease found in multiple wild and domestic species including dogs. A study on the sero-prevalence of leptospirosis in dogs of peri-urban livestock farms and urban households of Guwahati was carried out from September 2021 to August 2022. The work was envisaged to collect baseline data from respondents by interview method using a questionnaire, to detect the pathogenic leptospire with serological assay and molecular technique and to map the prevalent areas of leptospirosis in dogs in Guwahati. A total of 240 dogs were selected randomly from peri-urban livestock farms (120 dogs) and urban households (120 dogs). The study recorded higher secondary as the main level of education in both peri-urban farmers (40.00%) and urban household owners (60.00%). Majority of the dogs in peri-urban farms were non-descript (98.33%) compared with maximum of descript dogs (60.00%) in urban households. Female dogs were more common in urban households (55.83%) in contrast to maximum male dogs in peri-urban farms (71.67%). Overall, majority of the dogs aged 1-5 years in both peri-urban farms (38.34%) and urban households (44.17%). Vaccination in dogs was mostly followed by urban households (84.17%). Dogs were provided mainly tap water (56.67%) in peri-urban farms compared to with filtered water in urban households (96.67%). The study recorded peri-urban farms (50.83%) to be moderately clean. Practice of disinfection procedure in peri-urban farms recorded 28.33%. History of no abortion was recorded in peri-urban farms (67.50%) as well as in urban households (85.83%) for both livestock and dogs. Dogs from peri-urban farms (79.17%) and urban households (55.00%) were apparently healthy. Most of the farmers and dog owners were not aware of leptospirosis in both peri-urban livestock farms (96.67%) and urban households (84.17%).

Leptospirosis of dogs showed an overall 10.42% sero-prevalence in peri-urban cattle and pig farms and urban households of Guwahati. Sero-prevalence was higher in peri-urban farms (15.83%) compared to urban households (5.00%). It was recorded

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higher in farms and households where farmers and dog owners were illiterate (30.76%) with non-descript (12.65%) as well as in male dogs (12.94%) and in dogs aged up to 1 year (14.54%). Non-vaccinated dogs (18.39%) were recorded with higher sero-prevalence. Higher sero-prevalence was more in farms providing stored water (52.17%), in dirty farms (29.27%) and farms which don't follow disinfection practices (20.93%). It was recorded to be higher in livestock farms having the history of abortion (13.52%), and farmers and dog owners those were not aware (10.56%) of the disease.

The samples collected from IgG positive and negative samples from blood, which were subjected to PCR for the detection of *16S rRNA* and *Lip132* genes of *Leptospira* showed their presence (8% each).

# **Comparative Evaluation of Interlocking Nailing and Locking Compression Plating Vis-a-Vis Managemnt of Long Bone Fractures in Canine**

*Anjali C J*

A total of 716 orthopedic cases were presented to the Department of Surgery and Radiology and Veterinary Clinical Complex, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati-22, from 1<sup>st</sup> November, 2021 to 31<sup>st</sup> July, 2022. Among these, 484 cases showed the signs of lameness and were confirmed as fractures. The highest incidence was reported in canine (86.16%) followed by feline (5.37%) and caprine (4.75%). Dogs less than one year of age were recorded for highest incidence of fractures. Non-descript dogs (84.65%) were most commonly affected by fractures followed by German Spitz (9.11%) and Labrador retriever (2.88). Femur bones (35.25%) as well as transverse type fractures (58.41%) were documented with highest incidence and male dogs (60.02%) were mostly affected. Automobile accident was the major cause (40.65%) of fractures in the present study.

Twelve clinical cases of diaphyseal fractures were divided into two groups viz. Group A and Group B which were subjected to Interlocking Nailing and Locking Compression Plating respectively. Lameness subsided earlier in Group B compared to Group A and by 60<sup>th</sup> day, both Groups had desired outcomes with regard to Lameness scores. Functional outcome was excellent by 45<sup>th</sup> day in Group B (83.33%). However both groups achieved excellent functional outcome by 60<sup>th</sup> day. Complete weight bearing was observed by 7<sup>th</sup> day in Group B (16.67%) compared to 30<sup>th</sup> day in Group A (16.67%).

Postoperative radiographs revealed satisfactory results in terms of alignment, apposition, angulation, apparatus, activity and architecture (6 'A's) in Group A (83.33%) and Group B (100%) throughout the observation period. Mild angulation was observed in Group A (16.67%) due to displaced fracture fragments. In both the groups the apparatus did not fatigue and secondary union with bridging of the fracture gap by callous formation was observed.

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**Major Advisor : Dr. Bitupona Deuri**

The haematological parameters viz. Hb, TEC, PCV and ESR showed highly significant difference ( $P < 0.01$ ) whereas TLC showed significant difference ( $P < 0.05$ ) between the groups. The biochemical parameters viz. ALP and CK varied significantly between the groups whereas Ca, P, blood glucose and total protein showed non-significant difference ( $P > 0.05$ ). However, the haemato-biochemical parameters fluctuated within the physiological limits.

Complications in terms of seroma formation in Group A and delayed healing in Group B were observed which resolved on appropriate treatment.

## **Evaluation of Xenogenic Acellular Pericardium Matrix of Caprine and Porcine Origin for Abdominal Wall Reconstruction in Rabbit**

*Anjali Padhan*

The present study was carried out with the aim of evaluating the efficacy of xenogenic acellular caprine and porcine pericardium in surgical reconstruction experimentally created full thickness abdominal wall defect in rabbits (*Oryctolagus cuniculus*).

The experiment was conducted in eighteen (18) numbers of adult healthy rabbits of either sex maintained under ideal and same managerial condition. The animals were randomly divided into three groups, i.e. Group A, Group B and Group C consisting of six (6) animals in each. Full thickness abdominal wall defect of 2×2 sq. cm size was created on the lateral abdominal wall in all the animals and was repaired with acellular caprine pericardium, porcine pericardium and autologous tissue in group A, group B and group C respectively. Prior to surgical procedure, caprine and porcine pericardium were decellularised using sodium deoxycholate.

Caprine pericardium was decellularised with 2% sodium deoxycholate treatment for 36 hours and porcine pericardium was decellularised with 1.5% sodium deoxycholate for 48 hours under constant agitation in an orbital shaker at 180 rpm at 35°C without disturbing the microscopic architecture of the tissue.

Clinical parameters were checked on 0, 3rd, 5th, 7th and 10th post operative days. Post operative haemato-biochemical changes were recorded on 0, 10th, 20th and 30th days of operation. The wounds were reopened on 10th, 20th and 30th day for macroscopic and histopathological examination of the implanted matrix and surrounding host tissue.

Clinical parameters were significantly increased in all groups on 3rd post operative days and decreased subsequently. Moderate degree of swelling, exudation, pain and warmth was there in all the groups on 3rd day of operation which were more pronounced in xenograft groups as compared to autograft group.

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**Major Advisor : Dr. Parsha Jyoti Nath**

There was non-significant variation of haematological parameters within physiological limit in all the groups with slight variation among the groups. Serum ALP and serum total protein was increased significantly on day 10 in group A and group B and comparatively less significantly in group C. There was uniform and remarkable increase in random blood glucose in all the groups on day 10 of operation.

Mild to moderate visceral adhesion was recorded on 10th post-operative day in group A and group B which resolved automatically by the end of the experiment. On gross evaluation the host tissue proliferation was encouraging in all the groups however the in control group was fastest followed by group A and group B. Histopathological examination showed remarkable cellular infiltration in all the groups till last day of observation which was highest in group A. Angiogenesis and fibrogenesis were maximum and best visible from 10th day in group A.



## **Anaesthetic Effects of the Different Doses of Dexmedetomidine and Ketamine in Bovines**

*Arja Avinash*

Twelve clinical cases of bovines of either sex, weighing 30 to 150 kg and of different age group requiring surgical intervention for various conditions were considered for the study. The bovines were randomly divided into two groups comprising of six calves in each group. The bovines of group I injected with dexmedetomidine @ 5µg/kg and ketamine@ 2mg/kg body weight intramuscularly; bovines of group II were injected with dexmedetomidine @ 7.5 µg/kg and ketamine@ 2mg/kg bodyweight intramuscularly.

Induction was recorded at  $4.83 \pm 0.36$  minutes, duration of anaesthesia was up to  $36.00 \pm 1.13$  minutes and recovery time was at  $50.00 \pm 2.73$  minutes in the animals of group I, and were  $3.37 \pm 0.04$  minutes,  $51.33 \pm 2.18$  minutes and  $64.50 \pm 3.58$  minutes respectively for group- II. Smooth induction and recovery were recorded in both the groups. Induction and recovery were smooth in both the groups with good anaesthesia along with muscle relaxation. Animals of both the groups exhibited signs of anaesthesia with relaxation of muscle, protrusion of tongue, on set of salivation, absence of palpebral, pedal reflex and pinprick response. Urination was recorded at the time of recovery.

Heart rate high-significantly ( $P < 0.01$ ) and respiration rate were reduced significantly ( $P < 0.05$ ) in the bovines of both the groups. Rectal temperature decreased high-significantly ( $p < 0.01$ ) throughout the study period. Tidal volume non-significant ( $P > 0.05$ ), Oxygen saturation and minute volume high-significantly ( $P < 0.01$ ) were decreased in the bovines of both the groups at different time interval but remained within the physiological range. However, MAP increased high-significantly ( $P < 0.01$ ) in both the groups. Haemoglobin, PCV, TEC, lymphocytes, neutrophils, basophilis level decreased non-significantly ( $P > 0.05$ ) initially and then increased towards the end of study. Monocytes and esoinophilis values increased non-significantly ( $P > 0.05$ ). ESR increased high-significantly ( $P < 0.01$ ). The GGT, Glucose and BUN level high-significantly ( $P < 0.01$ ) and creatinine non-significantly ( $P > 0.05$ ) increased while total protein decreased high-significantly ( $p < 0.01$ ) in the study period.

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**Major Advisor : Dr. Biraj Kr. Sarma**

Based on the findings of the present study, a combination of dexmedetomidine @ 7.5 µg/kg along with ketamine @ 2 mg/kg body weight intramuscularly produced balanced anaesthesia permitting surgical procedure. Therefore, this combination could be suggested for clinical use.

# **Efficacy of Intra-Articular Autologous Platelet-Rich Plasma (PRP) and Ascorbic Acid in Degenerative Joint Disease of Dogs Supplemented with Chondroitin Sulphate and Glucosamine**

*Assad Al Imran*

The present study was conducted to investigate the efficacy and comparative evaluation of the economical treatment regime of Ascorbic acid and Autologous Platelet-rich Plasma preparation in Degenerative Joint Disease (DJD) of dogs. The experiment was conducted in total of eighteen (18) numbers of clinically manifested and radiographically confirmed cases of Degenerative Joint Disease in dogs. The animals were randomly divided into three equal groups viz., Group I, Group II and Group III used as control, use of Ascorbic acid and use of Platelet-rich Plasma (PRP) in the treatment regime respectively. Platelet-rich Plasma (PRP) was prepared by using methods described by Landesberg *et al.* (2000) and Ascorbic acid was procured from commercially available preparations. Ultrasonography guided intra-articular injection was done on affected joints under the anaesthesia of Xylazine and Ketamine premedicated with Diazepam as per Kim *et al.* (2012) in each animal. All the animals of Group I, Group II and Group III were treated orally with Chondroitin sulphate and Glucosamine. Clinical parameters viz., pain and lameness score and radiography were evaluated on days 0th, 10th, 20th, 40th and 60th after intra-articular injection. Haematological parameters were recorded on 0th, 10th, 20th, 40th and 60th day. Blood serum was collected on 0th, 10th, 20th, 40th and 60th days for evaluation of biochemical parameters. Pain and lameness score were found to be significantly diminished till 60th day of observation in all the animal. The radiographic examination of the affected joints revealed lesions in all the cases of Group I treated with chondroitin sulphate and glucosamine on 60th day. In Group II, 3 out of 6 individual canines showed mild to moderate discernible radiographic lesions on 60th day of treatment with Ascorbic acid and remaining 3 individuals showed no discernible radiographic lesion. All the 6 individuals in Group III, showed no discernible radiographic lesions of degenerative joint disease on 60th day of treatment with Platelet-rich plasma which was

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suggestive of efficient progressive regenerative healing of affected joints. Significant decrease in the values of Neutrophil and Eosinophil from 40 to 60 days in Group III individuals were suggestive of regenerative healing in DJD affected joints which was supported with radiographic findings and clinical improvements. Significant decrease in the values of Canine C-Reactive Protein from 0 to 60 days in group III was observed which was a suggestive of regenerative healing manifested with clinical improvement, radiographic and haematological evidences. The changes of canine C-RP in the groups I and II were within the physiological limit.

The intra-articular injection of platelet-rich plasma was found better in reducing area of affection and showed better regenerative healing efficacy in the treatment of degenerative joint disease than Ascorbic acid.

# **Effect of Jackfruit (*Artocarpus heterophyllus*) Sap and Chitosan Derived Biosealant on Wound Management**

*Banashree Gogoi*

The present study was carried out in the Department of Vety. Surgery and Radiology, College of Veterinary Science, AAU, Khanapara, Guwahati-22 for a period of 1 year w.e.f. 1<sup>st</sup> October, 2020 to 30<sup>th</sup> September, 2021. The objective of the present research work was to generate a novel biosealant derived from Chitosan-Jackfruit for wound management. The study explores the primary selection of suitable concentrations of Chitosan and Jackfruit to prepare a biosealant based on physicochemical and antimicrobial properties for its clinical application. The physicochemical and antimicrobial properties of prepared biosealant showed promising outcomes with 1:2 concentrations of the Chitosan and Jackfruit which was mild acidic in pH, had viable shear strength, good storage modulus (viscosity) and antimicrobial properties.

Eighteen clinically healthy adult rabbits of either sex weighing about 2 kg body weight were used in the study. The animals were randomly divided into three groups viz. Group A (control), Group B (commercial glue) and Group C (Chitosan-Jackfruit derived biosealant) consisting of six animals each. A 6cm longitudinal full- thickness incision was created under standard surgical and anaesthetic protocol. Physiological, haematological and biochemical parameters were observed and recorded on days 0, 3<sup>rd</sup>, 7<sup>th</sup>, 14<sup>th</sup> and 21<sup>st</sup> of treatment. Grossly the wound healing was evaluated on days 0, 3<sup>rd</sup>, 7<sup>th</sup> and 14<sup>th</sup> of treatment and histopathological findings were also recorded days 7<sup>th</sup>, 14<sup>th</sup> and 21<sup>st</sup> post treatment. Physiological parameters were non-significantly increased on days 3<sup>rd</sup> and decreased subsequently with time. TEC did not show any significant variation among the groups. On days 3<sup>rd</sup>, significant increase of TLC, Neutrophil, Lymphocyte were recorded in Group A whereas, it was non significant in Groups B and C. Monocyte and eosinophil were non-significantly increased amongst the groups on day 3<sup>rd</sup>. Biochemical parameters, showed decreased in total protein and albumin level on day 3<sup>rd</sup> amongst the all the groups which later returned towards the base value. Alkaline phosphatase values was non-significantly increased upto days 14<sup>th</sup> in Group A whereas,

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it was decreased in Groups B and C. ALT and creatinine values were non significantly varied amongst the groups at different time intervals. Grossly, the wound healing was complete in groups on days 14<sup>th</sup>, whereas, it took 21 days in group A. The histopathological observation in terms of keratinisation and reorganization of collagen fibers further suggest better healing in Group C followed by Groups B and A respectively.

# **Ultrasound Guided Epidural Analgesia for Perioperative Pain Management in Dogs Undergoing Ovariohysterectomy Operation**

*Bindiya Mahanta*

The current study aimed at assessing the efficacy of Morphine and Buprenorphine as perioperative analgesics administered epidurally via a US guided lumbosacral approach in bitches undergoing elective ovariohysterectomy. Eighteen healthy female Pariah dogs of 1-4 years of age were selected that presented to the Department of Veterinary Surgery and Radiology and Veterinary Clinical Complex, College of Veterinary Science, Khanapara, Guwahati.

The animals were randomly divided into 3 groups viz. Group A, Group B, Group C with 6 animals in each group. The animals of Group A and Group B were administered Morphine @ 0.1mg/kg b.wt and Buprenorphine @4µg /kg b.wt single dose epidurally under ultrasonographic guidance before the start of the operation. The animals of Group C were kept as control for the study without any analgesic till the end of observation period.

Ultrasonographic visualization of epidural space was done by using the ultrasound probe in sagittal position. The lumbosacral intervertebral space could be accurately identified using ultrasonography. Successful deposition of analgesic into the epidural space was possible in animals of different body conditions.

The physiological parameters were recorded at 0min, 15mins, 30mins, 45mins, 60mins, 75mins, 90mins and 120mins post epidural administration. The heart rate, respiration rate, rectal temperature and mean arterial pressure had significant variation ( $p<0.01$ ) between the groups whereas oxygen concentration expressed significant variation between time intervals. All physiological parameters were found to be within physiological reference range in the study.

The assessment of pain was done by using Glasgow Composite Measure Pain Scale-Short Form (CMPS-SF). The pain assessment was done preoperatively and postoperatively at 0 min, 1 hour, 3 hours, 6 hours, 12 hours and 24 hours. The CMPS-SF scores showed a significant ( $p<0.01$ ) increase from baseline scores in the post operative

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period in all the groups at 3 hours postoperatively which gradually declined towards the end of the observation period. The animals in treatment groups had significantly lower pain scores postoperatively than the animals in the control group.

The haematological and biochemical parameters were studied preoperatively and postoperatively at 0 min, 3 hours, 6 hours, 12 hours and 24 hours. Haemoglobin and packed cell volume varied non-significantly between different groups but changed significantly between time intervals. Total erythrocyte count increased significantly 12 hours post-operatively. Blood glucose and plasma cortisol concentration varied significantly ( $p < 0.01$ ) at 3 hours post operatively in all groups. The blood glucose levels of Group A and Group B were lower compared to Group C. The cortisol levels of Group B and Group C were comparable in the initial post-operative phase which declined gradually towards the end. The blood glucose levels expressed an increasing trend while the cortisol levels presented a decreasing trend towards the end of the study period in Group C. Alkaline Phosphatase levels expressed non-significant variation in the observation period in all groups.

From the study it could be concluded that, ultrasonographic detection aided in identification of lumbosacral epidural space and deposition of analgesics which helped produce long lasting analgesia with Morphine providing better analgesia in the initial post-operative phase, which was comparable to buprenorphine for providing long lasting analgesia.



# **Surgical Affections in Free Ranging and Captive Wildlife of Assam with Special Reference to Elephants**

*Donnelly Gayle Hugh*

In the present study, data was recorded regarding the surgical affections encountered in free-ranging and captive wildlife of Assam, with special reference to Asian elephants and the incidence was calculated according to species, place, age and sex. A systematic record of the treatment schedule followed was maintained and samples were collected from elephants to conduct bacteriological, haematological and biochemical studies. A total of 674 wild animals were studied for the presence of surgical affections. Of these, 149 animals were found to be affected, therefore reflecting the incidence of surgical affections in wild animals at 22.11 per cent. The incidence of surgical affections in mammalian and avian species was relatively similar at 22.30% and 23.08%, respectively and the incidence in reptilian species was much lower at 11.77%. Among all mammals, the highest incidence of surgical affections was seen in Asiatic Lion, Golden Cat, Pig-tailed Macaque and Capped Langur at 100%. Surgical affections were also noted in other species such as Four-horned Antelope (88.34%), Golden Langur (71.43%), Blue Bull (70%), Greater One-horned Rhinoceros (62.50%), Jungle Cat (57.15%), Black Panther (50%), White Tiger (50%), Stump-tailed Macaque (42.86%), Hoolock Gibbon (42.86%), Bengal Tiger (33.34%), Asian Elephant (29.52%), Slow Loris (28.58%), Asiatic Brush-tailed porcupine(25%), Small Indian Civet (25%), Common Leopard (21.74%), Common Palm Civet (14.29%), Jackal (11.12%), Himalayan Black Bear (10%), Sambar Deer (7.57%), Indian Mouse Deer (6.67%), Barking Deer (6.56%) and Leopard Cat (5.27%). In Aves, the incidence of surgical affections was highest in Slender-billed Vulture (100%), followed by Lesser Adjutant Stork (80%), Egyptian Vulture (50%), Indian Pied Hornbill (50%), Greater Adjutant Stork (36.37%), Emu (33.34%), Indian Peafowl (25%), Himalayan Griffon Vulture (9.09%), and Great White Pelican (3.85%). Whereas, in reptilian species, the incidence was 14.28% in Common Indian Monitor 10% in Indian Soft-shelled Turtle species. The occurrence of surgical affections was higher in males (24.81%) as

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compared to females (21.69%). Among all species, 12 types of surgical affections were seen, with the highest incidence in open wounds (16.77%), followed by leg/foot affections (1.93%), cutaneous myiasis (1.48%), closed wounds (1.48%), fracture (0.89%), ocular affections (0.59%), growths (0.3%), paraphimosis (0.3%), navel ill (0.3%), umbilical hernia (0.15%), posterior paralysis (0.15%) and postpartum bleeding (0.15%). When considering cases of only Asian elephants, a total of 166 elephants were examined under the present study, and the total incidence of surgical affections was 29.52%. Concerning spatial distribution, the incidence of surgical affections among 103 captive - Forest Department elephants and 22 free-ranging wild elephants was 22.34% and 18.19%, respectively. The highest incidence of surgical affections was noted in the 41 captive privately owned elephants - 53.66%.

When considering age, the highest incidence of surgical affections was seen in the age group 31 - 40 years (84.21%), followed by the age group 41 - 50 years (71.43%) which constituted working Elephants. The overall sex-wise incidence of surgical affections was noted to be higher in females (67.35%) than males (32.66%). Individually, however, the higher incidence was noted in captive male elephants belonging to the Forest Department (26.20%) and free-ranging wild male elephants (30.77%). Conversely, in the case of captive privately owned elephants, a higher incidence of surgical affections was recorded in females (56.76%). Among affected Asian Elephants, seven types of surgical affections were recorded. In reference to types of surgical affections, the highest incidence was seen in cases of open wounds (43.37%) followed by closed wounds (10.84%), leg /foot affections (10.84%), ocular affections (3.61%), paraphimosis (1.2%), growths (1.2%) and umbilical hernia (1.2%). Standard therapeutic regimens adopted in all cases of surgical affections yielded positive results. The duration of treatment was highest in Asiatic Lion (*Pantheraleleo*) at an average of 58 days, followed by Asian Elephant (*Elephasmaximus*) at 27 days. All other species required 1-15 days of treatment depending upon the severity of surgical affection. *Staphylococcus*, *Streptococcus*, *Pseudomonas*, *Escherichia coli*, *Klebsiella* and *Enterobacter* species were the most commonly isolated species. Out of 24 *Staphylococcus* isolates, 15 were coagulase positive. The Antibiotic sensitivity pattern indicated the highest effectiveness of Ceftriaxone and Tazobactam and Enrofloxacin, followed by Ciprofloxacin. The haematological profile reflected elevated levels of neutrophils and monocytes, and a decrease in haemoglobin (Hb), red blood cell (RBC), packed cell volume (PCV) and lymphocyte levels. Serum chemistry indicated a mild increase in SGPT, Total Bilirubin, Glucose values and a significant increase in BUN.

## **Intraoperative Assessment of Intestinal Viability in Rabbits**

*Evakordor Hynniewta*

Intraoperative assessment of bowel of questionable viability remained a challenge to surgeons. In this study, a rabbit experimental model was used to compare the accuracy of standard clinical criteria (SCC), pulse oximetry technique (POX) and fluorescein dye technique (FDT) in the determination of intestinal viability. Viability end point of each segment was established by histopathological studies and results were compared with results obtained from SCC, POX and FDT. Twelve ischemic intestinal segments were created experimentally by ligation of a branch of superior mesenteric artery along with the clamping of the loop supplied by the ligated artery. Viability assessment was then carried out after 4 hours in Group I and 8 hours in Group II of ischemic intervals. Standard clinical criteria included judging the bowel based on the color, pulsations and peristalsis. Pulse oximetry readings were made by placing the probe of the pulse oximeter on the anti-mesenteric border of the intestine. Fluorescein dye technique was carried out by injection of fluorescein sodium intravenously @75mg/kg body weight and fluorescence pattern was judged following 2 to 3 minutes of administration under ultraviolet illumination using Wood's lamp in a dark room. The overall accuracy of FDT was found to be 100%, while SCC and POX had 83.33% each. Fluorescein dye technique was found to be 100% accurate in making correct predictions of bowel of questionable viability. Standard clinical criteria and pulse oximetry were equally effective in predicting the non-viable loops with 100% sensitivity. However, this was at the cost of 83.33% positive predictive value. Fluorescein dye technique was found to have 100% sensitivity and specificity. Therefore, fluorescein dye technique in combination with standard clinical criteria can be recommended for intraoperative viability assessment of ischemic intestine. Blood and peritoneal fluid were collected at zero hour and after 4 hours in Group I and 8 hours in Group II. Estimation of serum alkaline phosphatase (U/L), alanine aminotransferase (U/L), cholesterol (mg/dl), creatinine (mg/dl) and phosphorus (mg/dl) was carried out in both the groups. Peritoneal fluid evaluation of alkaline phosphatase (U/L) and lactate dehydrogenase (U/L) was also done. A significant increase in the biochemical parameters of blood was seen following

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8 hours of ischemia. However, creatinine, did not reveal any significant changes after 8 hours of ischemia. A significant increase could be seen following 8 hours of ischemia in peritoneal fluid alkaline phosphatase and lactate dehydrogenase. Creatinine was not a good indicator of ischemia as it did not reveal any significant change at both the ischemic intervals. The significant increase seen in these biochemical markers of blood and peritoneal fluid marked the severity of the ischemia following 8 hours of ischemic insult. Thus, it can be concluded that these biochemical markers cannot reveal the fate of an ischemic bowel but can help in the diagnosis of ischemia.

# **The Efficacy of Pectin-Honey Hydrogel and Olive Oil–Vitamin E Preparation in Prevention of Post-Operative Intraoperative Adhesions in Rabbits**

*Fulmoni Kalita*

The present study was conducted to investigate the efficacy and comparative evaluation of Pectin-Honey Hydrogel and Olive oil-vitamin E preparation in prevention of experimentally created post-operative intraoperative adhesions in rabbits (*Oryctolagus cuniculus*).

The experiment was conducted in eighteen (18) numbers of adult healthy rabbits of either sex weighing 1.0-2.0 kg and maintained under same managerial and environmental condition. The animals were randomly divided into three groups, i.e. Group A, Group B and Group C consisting of six (6) animals in each. Pectin-Honey Hydrogel and Olive oil-vitamin E were prepared by using methods described by Giusto *et al.* (2016) and Portilla *et al.* (2004) respectively. Standardized caecal/peritoneal abrasion (Giusto *et al.*, 2017) was created following caudal midline laparotomy under Xylazine and Ketamine anaesthesia in each animal. Before closing the laparotomy wound, all the animals of Group A, Group B and Group C were treated with intraoperative application of normal saline, Pectin-Honey Hydrogel and Olive oil-vitamin E preparation respectively.

Clinical parameters were checked on 0 (before surgery), 2<sup>nd</sup>, 4<sup>th</sup>, 6<sup>th</sup>, 8<sup>th</sup> and 10<sup>th</sup> post operative days. Post operative haematological changes were recorded on 0<sup>th</sup> (before surgery), 5<sup>th</sup>, 10<sup>th</sup>, 15<sup>th</sup> and 20<sup>th</sup> day of operation. Peritoneal fluid was collected on 0<sup>th</sup>, 10<sup>th</sup>, 20<sup>th</sup> and 30<sup>th</sup> post-operative days for evaluation of biochemical parameters. The wounds were reopened on 10<sup>th</sup>, 20<sup>th</sup> and 30<sup>th</sup> day for macroscopic assessment of adhesions and histopathological examination.

Clinical parameters were found to be significantly elevated on 2<sup>nd</sup> post-surgical day in all the animals followed by returning to normalcy in subsequent observation; however, elevation was non-significant in case of rectal temperature. The changes in all the groups were within the physiological limit.

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There were initial haematological changes following surgical defects in all the groups with slight variation among the groups. Post-surgical elevation of total protein concentration of peritoneal fluid was significantly higher in Group A followed by Group C and Group B. Significantly lower catalase activity of peritoneal fluid was found in Group B post-surgically.

Macroscopic peritoneal and visceral adhesion score was recorded highest in Group A and lowest in Group B. Histopathological view of tissue sample revealed more and long lasting inflammatory reaction in Group A, followed by Group C and Group B respectively.

## **Effects of Certain Anaesthetic Combinations in Goat**

*Gyandeep Choudhury*

Fifteen clinical cases of goats (apparently healthy) of either sex and having body weight of 8-20 kg were divided into three groups consisting of five animals in each group. The goats in group I received (midazolam @ 0.4 mg/kg and ketamine @ 4 mg/kg body weight i.m); goats in group II received (tiletamine-zolazepam @ 3 mg/ kg body weight i.m) while goats in group III received (medetomidine @ 20 µg/kg and ketamine 5 mg/kg body weight i.m).

Induction time of  $3.2\pm 0.58$ ,  $3.8\pm 0.32$  and  $5.12\pm 0.15$  minutes; duration of anaesthesia of  $21.2\pm 1.71$ ,  $25.4\pm 2.14$  and  $110\pm 5.14$  minutes and recovery time of  $44.80\pm 2.35$ ,  $60\pm 3.32$  and  $123.40\pm 4.63$  minutes were recorded in group I,II and III respectively. Cessation of palpebral and pupillary reflex alongwith downward rotation of the eyeball was observed in the animals of all the three groups. Muscle relaxation and analgesia was found to be moderate in group I, poor in group II and excellent in group III. The animals in all the three groups exhibited mild to moderate salivation. During recovery, the animals in group I exhibited tympany and shivering while animals in group III exhibited mild tympany with urination.

Significant ( $p<0.01$ ) change in heart rate, respiration rate, rectal temperature, tidal volume, minute volume, MAP and  $SpO_2$  were recorded in all the three groups. Significant ( $p<0.01$ ) decrease was recorded in the haematological parameters,i.e, Hb, PCV and TEC. The biochemical parameters, i.e, GGT, blood glucose, blood creatinine and total protein also recorded significant ( $p<0.05$ ) change in the animals of all the three groups. Cortisol levels exhibited a significant ( $p<0.01$ ) increase.

All the three combinations exhibited transient changes in the physiological, haematological, biochemical and stress hormone parameters and hence are suitable for clinical use in goats. The combinations, midazolam-ketamine and tiletamine-zolazepam are suitable for short surgical procedures like castration while the combination medetomidine-ketamine is more suited for surgical procedures of longer duration.

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# **Investigation of Ocular Maladies and their Therapeutic Management in Veterinary Patients**

*Iftikar Islam*

Animal well-being and quality of life are affected by different kinds of disease conditions, among which one of the most important affections is ocular maladies. In the present scenario, scientific studies on ocular diseases in veterinary patients and their therapeutic management in our region is not adequate. Therefore, the present study was undertaken to fill up the void of information. The study was undertaken at six different establishments, segregating the survey work into a retrospective survey and research period survey as well as therapeutic management of the presented cases.

183499 cases were surveyed for the retrospective period of 5 years (31 March 2015-31 March 2020), out of which 843 (0.46%) were ocular disorders. 8784 cases were surveyed for the research period of 20 months (01 April 2020-30 November 2021), out of which 198 (2.25%) were ocular affections. In the retrospective study, the highest prevalence (5.15%) was observed at VCCL and the lowest prevalence (0.049%) at SVHNL. The highest incidence (4.52%) was recorded at VCCL and the lowest incidence (1.83%) at TVCC. High prevalence and incidence were noted in canine species at DSR and TVCC. High prevalence and incidence were recorded in caprine and bovine species at VCCL. High prevalence was observed for canines at SVHC and bovines at SVHNL. High prevalence and incidence of ocular affections were recorded for adult animals at all research establishments. High prevalence and incidence were observed in the Local/Mongrel breed of canines at DSR and TVCC. High prevalence and incidence were observed in the Assam hill goat and Lakhimi breed of bovine species at VCCL and Assam hill goat at GRS. High prevalence was noted for the Local/Mongrel breed of canines at SVHC and the Lakhimi breed of bovines at SVHNL. High prevalence and incidence of Cherry eye were observed in canines at DSR; conjunctivitis in canines at TVCC and SVHC. High prevalence and incidence of corneal opacity were recorded in caprine and bovine species at VCCL and corneal opacity in caprine at GRS. High prevalence of conjunctivitis was observed in bovines at SVHNL. High prevalence and incidence of ocular affections were recorded in males of canines at DSR, TVCC and SVHC. High prevalence and incidence of ocular affections

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were noted for females of caprine and bovine species in VCCL and females of caprine at GRS. High prevalence was observed in bovine females at SVHNL. High prevalence and incidence of ocular affections were recorded during summer, monsoon and post-monsoon seasons at all research establishments. During both periods, pet animals constituted the most affected animals surveyed at DSR, TVCC and SVHC. Farm animals constituted the most affected animals surveyed at VCCL and SVHNL. Therapeutically, both surgical and medicinal treatment methods were found to be effective depending on the nature of the presented cases. Haematological studies revealed no significant difference in haemoglobin (Hb), TLC, TEC, lymphocyte (Lym), monocyte (Mon) and granulocytes (Gra) between the normal and affected animals in all of the three species. However, biochemical studies (oxidative stress) revealed significant differences for all the parameters in all three species.

The present research work represents a small fraction of the vast arena of veterinary ophthalmology. The results and findings recorded leave a trail of possible connecting dots with earlier research, which was lacking earlier. The pile of data extracted in the present research work may be considered as the base work in its field which might open future research opportunities.

# **Comparative Study of Surgical Affections of Lakhimi and Cross-Bred Cattle of Assam with Their Therapeutic Management**

*Milton Engti*

The present investigation was conducted for comparative study of various surgical affections in Lakhimi and cross-bred cattle of Assam along with their therapeutic management. A total of 3137 cattle were surveyed during the period from (1<sup>st</sup> march 2019 to 30<sup>th</sup> November 2020), out of which 683 (21.77%) cattle were found to be affected with various surgical affections. During the survey Cross-bred cattle (21.81%) was found to be more affected with surgical affections as compared with Lakhimi cattle (20.88%). Maximum incidence of surgical affections was observed in summer season (64.12%) followed by winter (35.87%). Highest incidences of surgical affections were recorded in hoof affections (59%), which were followed by wounds (13.32%), bursitis (8.49%), fracture (3.80%), myiasis (3.36%), horn affections (3.07%), abscess (1.90%), umbilical hernia (1.75%), tail affections (1.46%), corneal opacity (1.02%), knuckling (0.87%), upward fixation of patella (0.58%), atresia ani (0.43%), corneal dermoid (0.43%), tumours (0.29%) and meningocoele (0.14%) respectively. Highest incidence of surgical affections was seen in the age group of 3-6 years (40.84%), followed by 6 and above years (30.30%), 1-3 years (19.91%) and 0-1 years (8.93%). Haematological investigations showed that the mean values of Hb, TEC, TLC and PCV of affected animals have decreased insignificantly as compared to healthy animals. The mean values of Neutrophil and Basophil percentages in affected animals were increased insignificantly as compared to healthy animals. The mean values of Lymphocyte and Monocyte percentage of the affected animals were decreased insignificantly as compared to the healthy animals. The mean values of Eosinophil percentage of the affected animals was increased significantly as compared to the mean values of the healthy animals. Biochemical tests revealed the mean values of serum Creatinine, Creatine Kinase and Phosphorus of the affected animals were increased insignificantly as compared to the mean value of the healthy animals. The mean value of serum Aspartate Aminotransferase (AST) in affected animals showed significant increase and Calcium in affected animals showed significant fall as compared to the mean values of the healthy animals.

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## **Tiletamine-Zolazepam Anaesthesia in Cat**

*Monalisa Ahmed*

In this study, ten clinically healthy cases of domestic cat (*Felis catus*), requiring surgical intervention for various conditions were considered. The cats were of either sex, weighing 3 to 4 kg, and of 2 to 4 years of age. They were randomly divided into 2 (two) equal groups with five animals in each group. The cats of group I received tiletamine - zolazepam (Zoletil 100 vet.) @ 5 mg/kg body weight and the cats of group II were administered the same anaesthetic combination @ 10 mg/kg body weight intramuscularly. The mean induction time of  $2.40 \pm 0.24$  minutes and  $1.60 \pm 0.24$  minutes, duration of anaesthesia of  $24.40 \pm 1.69$  minutes and  $43.60 \pm 5.87$  minutes, and the recovery time of  $34.20 \pm 3.00$  minutes and  $57.00 \pm 4.84$  minutes were recorded in the cats of group I and group II, respectively. Group I and II showed significant difference ( $p < 0.05$ ) in induction time and duration of anaesthesia; and high significant difference ( $p < 0.01$ ) in recovery time between the groups. Animals of both the groups showed initial pawing, unconsciousness, eyes remained open throughout the duration of anaesthesia, mydriasis, presence of corneal and pupillary reflexes, smacking of lips, and protrusion of tongue without salivation. Animals of group I exhibited moderate analgesia and muscle relaxation; but in case of animals of group II, good analgesia as well as muscle relaxation were ascertained. No unwanted effects like salivation, catalepsy, vomiting, urination, or defaecation were observed in any of the groups.

In both the groups, heart rate increased significantly ( $p < 0.01$ ), whereas, nonsignificant ( $p > 0.05$ ) decrease of respiration rate was seen. The rectal temperature and SpO<sub>2</sub> for both the groups showed significant ( $p < 0.01$ ) decrease with time. Moreover, the MAP increased significantly ( $p < 0.01$ ) in both the groups. Haematological parameters like Hb, PCV and TEC revealed significant ( $p < 0.01$ ) decrease in both the groups. In case of biochemical parameters, there was non-significant ( $p > 0.05$ ) increase of GGT, blood glucose and cortisol but non-significant ( $p > 0.05$ ) decrease of total protein and creatinine levels in both the groups. All the changes were transient in nature.

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From the above studies, it can be concluded that tiletamine – zolazepam @ 5 mg/kg body weight produced moderate anaesthesia of shorter duration allowing minor surgical interventions like castration, removal of external growths, aural haematoma operations, etc., and tiletamine – zolazepam @ 10 mg/kg body weight intramuscularly produced balanced anaesthesia permitting major surgical procedures like spaying, gastrotomy, cystotomy, etc. in domestic cats.

## **Dental Affections and their Management in Dogs**

*Pinku Talukdar*

A total of 143 dental affections were recorded with incidence rate of 6.45% among the cases presented to Department of Veterinary Surgery and Radiology and Veterinary Clinical Complex, College of Veterinary Science, AAU, Guwahati-781022 over a period of one year w.e.f. 28<sup>th</sup> February 2020 to 1<sup>st</sup> March 2021. The highest incidence was recorded in males and in German spitz breed within an age group of 5 to 7 years. The common affection recorded was dental tartar with gingivitis and mostly 4<sup>th</sup> maxillary premolar teeth were involved. Dietary involvement showed disease affinity towards mixed homemade diet. Concurrent diseases occupied 33.56% involvement with dental affections moreover, majority of the dogs (90.21%) were deprived from oral health practices.

The common lesions for various dental affections were recorded in the form of inflamed gingiva, bleeding gum and light to heavy tartar deposition etc. The alkaline nature of salivary pH was found ideal for the diseases incidence with mean salivary pH of  $8.08 \pm 0.245$ . The periodontal score index revealed high score of stage III (41.66%) for periodontal diseases and calculus score revealed high score of II (48.95%) for dental tartar with the composition of 91.66% calcium on tartar analysis. Dental radiography provided good diagnostic tool for detecting the abnormalities of various forms of periodontal diseases and all the tooth associated structures were easily evaluated for presence of diseases. There study revealed no significant changes ( $P > 0.05$ ) in haematological and biochemical parameters. However, few parameters showed high level on 0 day indicating local or systemic dysfunction. Salivary enzymes like Creatine kinase, Serum glutamate oxaloacetate transaminase and Lactate dehydrogenase were proven to be good biomarkers for periodontal diseases as their levels were higher than normal range. Oral cavity harbored pathogens like *Staphylococcus* spp. as predominant genus which showed sensitivity for Amoxicillin drugs. Dental scaling along with polishing was effective in long term management of dental tartar and also acted as a preventive therapy in periodontal diseases. Specific antibiotics and metrinidazole oral gel along with use of anti tartar sticks were some of the additional managerial practices which gave satisfactory results. Although, in advance stages of periodontal disease tooth extraction brought good outcome. Dental tumours appear mostly in benign forms which were effectively managed with surgical excision and electrocautery.

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**Major Advisor : Dr. Bitupona Deuri**

# **Diagnosis, Treatment and Rehabilitation of Coxofemoral Joint Affections in Dogs**

*Pracheer Budhwar*

The present study was undertaken to diagnose, treat and manage the affections of coxofemoral joints in dogs. A total of 2214 cases of dogs were presented in the Department of Veterinary Surgery and Radiology and Veterinary Clinical Complex (Surgery Unit), College of Veterinary Science, A.A.U., Khanapara during the period from 1<sup>st</sup> August 2019 to 31<sup>st</sup> July, 2020. Total number of dogs with coxofemoral joint affections was 24 (1.08%). Age of the dogs affected with coxofemoral joint affections varied from 1 month old to 11 years of age. Among seven breeds of dogs presented, the Labrador was the highest affected with hip dysplasia and osteoarthritis/ degenerative joint disease (DJD) and Mongrel dogs were most affected with trauma. Hip joint affections were recorded in 16 males and 8 females. Affections of coxofemoral joints were recorded and classified as developmental, acquired and traumatic, based upon origin/ etiology. Incidence of all three types were equal.

Sixteen out of twenty-four cases turned up for clinical examination and treatment. Clinical assessment included physical, orthopedic and neurological examinations before and after treatment. Radiographic evaluation and haemato-biochemical estimation of Hb, TEC, TLC, ESR, PCV, serum ALP, serum calcium and serum phosphorus were recorded before and after rendering the treatment. The haemato-biochemical parameters had no significant alterations before and after the treatment.

Treatment of the diagnosed cases included conservative and rehabilitation therapy and surgical treatment for the cases necessary.

Following standard anesthetic protocol, surgical procedures followed were femoral head (and neck) ostectomy (FHO) in cases of Canine Hip Dysplasia followed by Degenerative Joint Disease (DJD) and cross-sectional pinning with Kirschner wire in femoral head or neck fracture (epiphyseal/ capital).

Medicinal treatment alone was not effective in alleviating the painful condition in affected cases. Post-surgical examination turned out to be satisfactory with normal radiographic findings. Animals were not reluctant to bear weight on the hind limbs and had almost normal gait without any symptoms of pain.

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## **Diagnosis of Canine Heart Diseases with Special Reference to Transthoracic Echocardiography**

*Rimjhim Das*

A total of 14050 dogs were registered; out of which 88 dogs were suspected for heart diseases based on clinical manifestations and 38 dogs with overall incidence rate of 0.27% were diagnosed with various heart diseases based on thoracic radiography, electrocardiography and two-dimensional, M-mode and colour-flow Doppler echocardiography. The incidence of cardiac affections were found to be highest in Labrador Retriever (39.47%), male dogs (63.15%), age group of >6-9 years (31.57%).

Radiographically 20 dogs were diagnosed with cardiac affections and found Pleural effusion with highest occurrence (23.68%), followed by left sided cardiomegaly (21.05%) and right sided cardiomegaly (7.89%).

Electrocardiographically 30 dogs were diagnosed positive for cardiac affections with highest occurrence of Sinus bradycardia (23.68%) followed by P-mitrale (18.42%), ventricular hypertrophy and pericardial effusion (7.89% each), 1st degree AV block, Ppulmonale and myocardial disease (5.26% each), ventricular septal enlargement and atrial fibrillation (2.63% each). However, transthoracic echocardiography was taken as gold standard diagnostic modality with which 38 dogs were diagnosed positive for heart diseases.

The most frequently diagnosed cardiac disease using 2D-mode, M-mode were Dilated Cardiomyopathy (DCM) (47.36%), Left atrial (LA) enlargement (15.78%), Pericardial effusion, Left ventricular posterior wall (LVPW) hypertrophy (7.89%) and Right ventricular (RV) hypertrophy(5.26%). With Doppler mode echocardiography the occurrence of Mitral valve insufficiency was found to be highest (65.78%) followed by Tricuspid valve insufficiency (52.63%) and aortic valve insufficiency (10.52%).

The haematological parameters i.e. TEC, TLC, thrombocytes, lymphocytes, granulocytes, monocytes and Hb and biochemical parameters i.e. SGPT, SGOT, BUN, Creatinine, Total protein, albumin, sodium and potassium revealed non-significant ( $p>0.05$ ) role in diagnosis of cardiac affections in dogs. However, serum calcium and non-specific LDH appeared to be significantly ( $p\leq 0.05$ ) influenced by occurrence of heart disease and both the parameters were found reliable for diagnosis of heart

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diseases. The serum Ca and non specific LDH can be used together in combination to improve the efficacy of diagnosis for cardiac affections.

The sensitivity, specificity and accuracy of thoracic radiography was found to be 58.82%, 76.19% and 65.45% respectively upon taking echocardiography as gold standard diagnostic method. Whereas, the sensitivity, specificity and accuracy of electrocardiography was found to be 81.08 %, 60% and 76.60% respectively.

Based on the present study electrocardiography was found to be more efficient in diagnosis of heart diseases for dogs in comparison to thoracic radiography. However, transthoracic echocardiography using two-dimensional, m-mode and colour-doppler has been found to be the most efficient diagnostic modality in diagnosis of heart diseases in dogs as 43.18% (n=38) were diagnosed positive out of 88 suspected cases for heart disease presented during the study period.



# **Diagnosis and Treatment of Alimentary Tract Disorders in Dogs with Special Reference to Surgical Affections**

*Ritu Raj Saikia*

The present investigation was undertaken to study various affections of alimentary tract disorders in the canine patients presented in the OPD of VCC and Department of Surgery & Radiology, CVSc, AAU, Khanapara. The study conducted with the objectives to elucidate the incidence of alimentary tract disorders, diagnosis of alimentary tract disorders cases with the help of history, radiography, ultrasonography, haematobiochemical changes and to treat and assess the outcome of those cases.

Highest incidence was observed in anal sac affection (23.58%) followed by gingivitis/stomatitis (15.45%), gastrointestinal foreign bodies (11.38%), rectal prolapse (10.57%), oral tumour (8.94%), intussusception (6.50%), perianal tumour (5.69%), oesophageal/pharyngeal foreign bodies (4.88%), Gastric dilatation (4.07%), Paralytic ileus (3.25%), fecolith (2.44%), gastric dilatation and volvulus (1.63%) and megaesophagus (1.63%). Highest incidence of alimentary tract disorder was found in the age group of  $\leq 0-1$  years (30.89%) and least incidence was found in the age group of  $>10$  years. Breed wise incidence of present study revealed alimentary tract disorders are mostly prevalent in non-descript (32.52%) dogs, followed by Labrador (21.97%) and least prevalent in bull dog (0.81%). Sex wise incidence of the present study revealed 65.04% affected dogs were males and only 34.96% were females. The animals were categorized into four groups. Most common clinical symptoms exhibited by the dogs with oral cavity disorders included anorexia, plaque and calculus formation, halitosis, salivation. Disorders of oesophagus exhibited clinical signs such as hypersalivation, retching, dysphagia, cough reflex in oesophageal foreign body and persistent regurgitation just after feeding, weight loss, stiff gait, generalized weakness and emaciation in megaesophagus. Gastrointestinal disorders exhibited clinical signs such as vomiting, diarrhoea, dehydration, haematochezia and haematemesis. Anorectal disorders exhibited clinical signs such as scooting, anal licking, haematochezia, dyschezia and swollen anal sac. Both radiography and ultrasonography were helpful for

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diagnosis of alimentary tract disorders. Radiopaque foreign bodies and fecolith were confirmed with the help of conventional radiograph while radiolucent foreign bodies were confirmed with contrast radiography. Dilated oesophagus was seen in megaesophagus in both conventional and contrast radiographs. Paralytic ileus cases confirmed with dilated intestinal loops and availability of contrast agent in the intestine even after 24 hours. Intussusception cases confirmed with concentric hypoechoic and hyperechoic area on USG. Foreign bodies and fecolith confirmed by hyperechoic structures with distal acoustic shadowing on USG. There was no significant difference observed in Hb, TEC, TLC, DLC count in all the dogs of all the groups affected with various alimentary tract disorders compared to healthy animals except in anorectal disorders where there was significant increase in TLC and granulocyte and significant decrease in lymphocyte were observed and in oral cavity disorders there was significant increase in granulocyte count. There was no significant difference observed SGPT, SGOT, BUN and Creatinine values of affected animals compared to healthy animals except in Oral cavity disorders where there was significant increase in BUN and creatinine value. Sodium, potassium, chloride all decreased significantly in gastrointestinal disorders when compared to healthy animals. Cases were treated with both medicinally and surgically. Various surgical methods were used such as gastrotomy, enterotomy, intestinal resection and anastomosis, colopexy depending upon the type of affections.

# **Sevoflurane Anaesthesia in Butorphanol-Midazolam Premedicated Dogs Induced with Propofol and Ketamine**

*Sarahna Taufiq*

Twelve clinical cases of female Mongrel dogs of 1-5 years, weighing 10-15 kg were considered for the study. The animals were randomly divided into two groups with the following anaesthetic regime: premedication with butorphanol @ 0.3 mg/kg, IM and midazolam @ 0.3 mg/kg, IM followed by induction of anaesthesia with ketamine @ 7.5 mg/kg, IV (Gr A) and propofol @ 4.0 mg/kg, IV (Gr B) and maintenance of anaesthesia with sevoflurane in oxygen in both the groups.

Time of sedation was recorded  $5.00 \pm 0.29$  mins in Gr A and  $5.17 \pm 0.31$  mins in Gr B. Four (66.67%) animals showed excellent quality of sedation and two animals (33.33%) showed light sedation in both the groups. Time of induction was recorded  $2.43 \pm 0.13$  mins in Gr A and  $2.32 \pm 0.08$  mins in Gr B. Quality of induction was smooth without any adverse signs, although apneustic respiration in two (Gr A) and apnoea in four animals (Gr B) was observed after induction. Intubation score was graded as excellent in four (66.67%) and good in two (33.33%) animals in Gr A whereas excellent in all the animals (100%) in Gr B. Quality of analgesia was found to be excellent in Gr A and good in Gr B. Muscle relaxation was graded as excellent in four (66.67%) and moderate in two (33.33%) animals in Gr A, while all the animals (100%) showed excellent muscle relaxation in Gr B. Time for return of swallowing reflex was shorter in Gr B ( $13.83 \pm 0.60$  mins) than Gr A ( $14.83 \pm 0.48$  mins). The time required for head raise was significantly ( $p < 0.05$ ) shorter in Gr B ( $23.42 \pm 0.52$  mins) than Gr A ( $25.67 \pm 0.84$  mins). The time required for standing was  $33.00 \pm 0.93$  mins in Gr A and  $33.17 \pm 0.70$  mins in Gr B. The time for complete recovery was shorter in Gr B ( $51.50 \pm 1.52$  mins) than Gr A ( $53.50 \pm 1.57$  mins). Quality of recovery was excellent in both the groups however, two animals in Gr A showed signs of shivering, salivation and urination. Also, two animals in Gr B showed slight whimpering, salivation and urination during recovery. Heart rate increased significantly, respiration rate and rectal temperature were reduced significantly ( $p < 0.05$ ) in both the groups. Oxygen saturation

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was well maintained and not less than 88% at various time intervals in both the groups. CRT at various time intervals was less than 2 seconds in all the animals. Hb, PCV, TEC and TLC decreased significantly ( $p < 0.05$ ) and total platelet count decreased non-significantly for both the groups throughout the period of study. Total protein decreased significantly ( $p < 0.05$ ) while total albumin and total globulin decreased non-significantly in both groups. ALP, GGT increased non-significantly in both groups. Creatinine increased in both Gr A ( $p > 0.05$ ) and Gr B ( $p < 0.05$ ). The value of BUN was found to increase in both Gr A ( $p < 0.05$ ) and Gr B ( $p > 0.05$ ). In conclusion, both the anaesthetic combinations was found to produce balanced anaesthesia in dogs and could be recommended for clinical use. However, Gr B was observed to be better among the two groups in terms of smooth induction, ease of intubation, good degree of analgesia, excellent muscle relaxation and an overall smooth recovery.

## **Diagnosis and Treatment of Spinal Affections in Dogs and Cats**

*Shantishree Das*

A total of 3130 dogs and 533 cats were presented in the Department of Veterinary Surgery and Radiology and Surgery Out Patient Department (SOPD), Veterinary Clinical Complex, College of Veterinary Science, Assam Agricultural University, Khanapara during the period from 1st November 2021 to 31st July 2022. Overall incidence of spinal affections 0.73 percentage and 1.68 percentage was recorded in dogs and cats respectively. Incidence of spinal affections in male dogs (65.22 percentage) and in female cats (66.66 percentage) was highest. Non-descript dogs (30.43 percentage) and cats (88.88 percentage) were found to highly prone to spinal affections. Motor vehicle accident (30.43 percentage) and dog bites (44.44 percentage) was found to be the prime cause of spinal trauma in dogs and cats respectively. Thoracolumbar region was found to be at highest risk.

Out of the total spinal affection cases presented, 13 dogs and 5 cats were taken under current study. The animals were evaluated clinically on the basis of physiological, Orthopedic and neurological examination. Survey and contrast radiography was taken for confirmation of the spinal affections. After confirmation, 7 dogs and 2 cats were treated conservatively out of which 2 dogs (28.57 percentage) and 1 cat (50 percentage) showed neurological recovery, whereas, 6 dogs and 3 cats were treated surgically (with pedicle screws, spinal stapling and hemilaminectomy) out of which 1 dog (16.66 percentage) and 2 cats (66.67 percentage) showed neurological recovery followed by physiotherapy using TENS, infrared light and hot fomentation.

At 20th day post-treatment there was an insignificant rise in ALP concentration of dogs and cats which could be due to inflammatory phase of healing, osteoblastic activity and administration of the steroids. The mean value of LDH concentration was found to be highly significant. CSF was collected via cisternal tap and evaluated chemically, macroscopically and microscopically. Neutrophils were observed in high number at the reporting time.

Animals reported within 24 hours of affection with intact deep pain reflex showed better recovery. So, earlier the case presented, better is the recovery.

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**Major Advisor : Dr. Chandan Kumar Singh**

# **Platelet Rich Plasma (PRP) with B-Tri Calcium Phosphate (B-TCP) and Demineralised Bone Matrix (DBM) in Healing of Bone Tissue in Rabbit**

*Suman Kalita*

The present study was carried out with the aim of assessing the efficacy of Platelet Rich Plasma +  $\beta$ - Tricalcium Phosphate and Demineralised Bone Matrix in bone reconstruction experimentally created full thickness radial osteotomy in New Zealand White rabbits (*Oryctolagus cuniculus*).

The experiment was conducted in eighteen (18) numbers of adult healthy rabbits of either sex maintained under ideal and same managerial condition. The animals were randomly divided into three groups, i.e., Group I, Group II and Group III consisting of six (6) animals in each. Full thickness radial bone osteotomy of 1 cm length was created on the mid-shaft of the radial bone in all the animals and the bone defect gap was filled with normal saline in Group I, Platelet Rich Plasma +  $\beta$ - Tricalcium Phosphate and Demineralised Bone Matrix in Group II, and Group III respectively. Prior to surgical procedure in the animals of Group II, the Platelet Rich Plasma (PRP) was prepared from the same rabbit by double centrifugation protocol, with lid closed and 1600 revolutions per minute (rpm) for 10 minutes, resulting in the separation of red blood cells, plasma with platelets and leucocytes. Plasma was centrifuged again at 2000 rpm for 10 minutes; as a result, Platelet Rich Plasma was separated.

Clinical parameters were recorded on 0, 3<sup>rd</sup>, 7<sup>th</sup> and 10<sup>th</sup> post-operative days. Post-operative haemato-biochemical changes were recorded on 0, 5<sup>th</sup>, 10<sup>th</sup>, 15<sup>th</sup> and 30<sup>th</sup> days of operation. The wounds were reopened on 20<sup>th</sup>, 40<sup>th</sup> and 60<sup>th</sup> day for histopathological examination of the implanted biomaterials and radiographical evaluation of defected bone.

Clinical parameters were significantly increased in all groups on 3<sup>rd</sup> post-operative days and decreased subsequently. Mild to moderate degree of swelling, exudation and warmth was there in all the groups; however, the degree of pain showed moderate to severe score on 3<sup>rd</sup> day of operation which were more pronounced in Group I as compared to Group II and III.

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There was non-significant variation of haematological parameters within physiological limit in all the groups. Serum ALP and Phosphorus in all the groups increased significantly till 30<sup>th</sup> day of observation. Serum creatine kinase level was significantly increased on 5<sup>th</sup> day followed by significant decrease till 30<sup>th</sup> day of observation in all the groups. The serum calcium level was significantly decreased from 0<sup>th</sup> day to 15<sup>th</sup> day and then subsequently significant increase on 30<sup>th</sup> day in all the groups.

Radiological examination revealed incomplete bridging of the proximal and distal ends of the radius in Group I and III but in Group II, the proximal and distal end of fracture fragments appears to be united towards the 60<sup>th</sup> post-operative days.

Histopathological examination showed fibrous connective tissue accumulation in Group I whereas osteoblastic activity and mineralization is quite prominent in Group II rather than Group III on 60<sup>th</sup> day. Angiogenesis and formation of osteoblasts were noticed on 40<sup>th</sup> day of observation particularly in Group II and III.

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