Centre of Excellence for Value Addition

Uva Wellassa University

6th Research Symposium

# RESEARCH SYMPOSIUM

JANUARY 28-29

# 2016

## Towards Emerging Trends In Value Addition

# Uva Wellassa University of Sri Lanka


# 6th Research Symposium

## "Towards Emerging Trends in Value Addition"

## January 28 & 29, 2016

## Uva Wellassa University of Sri Lanka

**ISBN 978-955-0481-09-5**

Price: Rs. 2000.00
US$ 100.00

Published by:
Uva Wellassa University of Sri Lanka
Passara Road
Badulla
Sri Lanka

Printed at:
Indesign Advertising
Cocowaththa Road
Badulla
Sri Lanka.

# Chancellor's Message

It is with great pleasure that I send this message and good wishes to the 6th Research Symposium organized by Uva Wellassa University. As the Chancellor of the university I'm privileged and glad to participate in this conference being its chief guest and I extend my profound gratitude to the Vice Chancellor and his staff for inviting me to join this academic forum.

Uva Wellassa University which is focused to add value to the local resources is an exemplary academic milieu in the Sri Lankan higher education system as it emphasizes knowledge, skills, attitudes as well as the values, discipline and ethics of tomorrow's graduates who are responsible for country's future. Further, it is true that UWU undergraduates are guided to be entrepreneurial experts by cultivating innovative ideas in them from the inception. Therefore, this 6th Research Symposium has provided them an ideal platform to exhibit their new innovative knowledge in research activities by selecting the apt theme "Towards Emerging Trends in Value Addition."

I trust that this research symposium will give an immense opportunity to researchers of all the fields to discuss, debate and exchange interactive views on their novel research findings. Eventually, their scholarly knowledge will contribute to elevate the social wellbeing and the socio economic development of our country, Sri Lanka.

As a university, it is our utmost duty to contribute to the country's growth by producing skilled graduates and conducting new research activities which will create new paths to country's development. Thus, organizing and holding this kind of symposia will undoubtedly invite the scholars to identify the gaps of development and bridge them with their timely findings.

Thus, I would like to convey my wishes to all the presenters, eminent scholars and other keen participants who have joined our 6th Symposium. Finally, I congratulate and thank the Vice Chancellor and the organizing committee of this event for your commitment, dedication and love towards the university and the country's development.

May Triple Gems Bless You.

**Most Venarable Bengamuwe Sri Dammadinna Nayaka Thero**
**Chancellor**
**Uva Wellassa University of Sri Lanka**

# Vice Chancellor's Message

I deem it a great privilege to convey my message and earnest greetings to the 6th Research Symposium, organized by Uva Wellassa University. Being the center of excellence for value addition and continuing its unique theme of value addition, Uva Wellassa University is in the journey of producing well capable graduates who are ready to win the world of work.

Thus, I do believe that this 6th Research Symposium which leads the theme "Towards Emerging Trends in Value Addition" will provide an irreplaceable platform to showcase especially our young undergraduates' knowledge and skills by presenting, discussing and sharing their innovative research findings. Further, Uva Wellassa University has openly invited researchers of many fields to attend this forum and disseminate their novel knowledge by forming 15 research tracks which represent the sectors such as Science, Technology, Management, Agriculture and Humanities.

I believe that publishing a successful research paper and presenting its results is not a single day's effort, yet it is the fruitful outcome of wise problem identification, careful observation and exploration, apposite analysis and timely recommendations which need a considerable time, patience, courage as well as enthusiasm. Therefore, I congratulate all such esteemed researchers who are going to share their invaluable research experience in our 6th Research Symposium. Moreover, as the Vice Chancellor of the hosting university I am pleased to be among young researchers, eminent scholars, chairpersons, panelists and to share the novel knowledge and views that they are about to disseminate.

Further, I wish to express my sincere gratitude to whole Uva Wellassa University family for rendering their untiring assistance to make the 6th Research Symposium a success.

I look forward to witness a symposium par excellence which will contribute to the socio economic development of the country.

**Dr. G. Chandrasena**
**Vice Chancellor**
**Uva Wellassa University of Sri Lanka**

# Symposium Coordinator's Message

It is indeed a great pleasure to deliver the note of appreciation for the 6th Research Symposium. Being the Coordinator, I am personally pleased to witness another successful Research Symposium at the University premises. I trust with an innovative theme "Towards Emerging Trends in Value Addition", symposium attempts to fill the gap which has been long awaited by the industry. The successful blend of various researches carried out in different specialization areas will allow the industry to view value addition concept through various arenas. As academics, we highly focus towards teaching as well as disseminating the knowledge through inculcating research atmosphere within the Higher Education. Over the past five research symposia, knowledge dissemination through research outputs has been considerably grown up, as today we are holding our 6th Research Symposium. We highly appreciates the academic community who has contributed by sending their research findings as around 215 research paper presenters are expected to make presentations through parallel technical sessions. It will create a platform to disseminate the knowledge, exchange the ideas and discuss on emerging trends towards the value addition that ultimately leads the Socio-Economic Development.

I wish to express my deepest gratitude to the Chancellor of Uva Wellassa University, Most Venarable Bengamuwe Sri Dammadinna Nayaka Thero, for generous endowments to make the Symposium a success. Further I wish to extend my sincere appreciation to Vice Chancellor, Dr.Gamani Chandrasena, for being a guiding light to us from the beginning. I wish to extend my sincere gratitude to the management of Bank of Ceylon, Badulla, and all sponsors for enormous support. I take this opportunity to thank all my collogues of the Organizing Committee, specially Dr. Thusitha Kumara , Secretary of the 6th Research Symposium, Faculty, Degree and Activity Coordinators, Reviewers and members who dedicated to make this event a great success. Last but not least, wish to extend heartfelt gratitude to Registrar, Bursar and all Academic and Administrative staff for invaluable support and well wishes.I wish the symposium will mark a remarkable footprint within the research and publications in Sri Lanka.

**Dr. (Ms) P.I.N. Fernando**
**Coordinator – 6th Research Symposium**
**Dean, Faculty of Management**
**Uva Wellassa University of Sri Lanka**

# Keynote Speech

## Failure of Conventional Social System to Make Businesses Socially Responsible: Rationale for Alternative Entrepreneurial Institutions

Economic and management theory suggest two broad strategic options, including 'private/market actions' and 'public/statutory and regulatory approaches' can drive a business to carry out its "job"; yet, there exists a significant gap in literature, or in other words, neither good "theory" nor good "evidence" is available, that tells us which approach is "working best" for a business to perform it "duties" without much failure.

Conventional wisdom has been to place more faith in government than in the market to look after concerns on the society. The principle justification for public policy intervention lies, thus, in the shortcomings of market outcomes. Yet, the rationale is only a necessary but not a sufficient condition for government policy. The shortcomings of market outcomes should, therefore, be compared properly with the shortcomings of non-market efforts to provide appropriate remedies.

Economic literature identifies a "system of economic incentives" that consists of market and non-market components have an impact on firms to behave socially and environmentally responsible manner, including: '*Market forces'* such as businesses risk losing reputation, market share & sales revenue, and major customers, if the society becomes concerned about the conduct of the businesses; '*Public laws and regulations'* characterized by various penalties imposed by courts or government agencies in terms of fines, product recalls, and temporary or permanent closure, and '*Product liability laws'* by way of 'criminal sanctions' and / or 'civil sanctions' are associated with financial compensation and punitive damages.

Given that, the question remains whether market would, in this fashion, always be capable of developing a sound environment for businesses. Two broad criteria have commonly been used in the economic literature to judge the 'success' or 'failure' of market outcomes in this regard, i.e. *efficiency* and *distributional equity*. According to Wolf (1986; 1979), an outcome of the market deemed to be efficient, if the same level of total benefits that it generates cannot be obtained at lower cost or, alternatively, if greater benefits cannot be generated at the same level of costs. In either case, the resulting total benefits must exceed total costs if the outcomes are to be deemed efficient. However, if other institutional arrangements can accomplish the same task at lower cost, or can do it better for the same cost, then the market is, in this respect, relatively inefficient.

Market failure is defined in economic theory, in more general contexts, as "departures from the optimum" with respect to an operating price system. It is thought to occur, when the 'markets fail to produce public goods', or 'inadvertently produces externalities', or 'gives rise to natural monopolies', or disenfranchises parties through 'information asymmetries', or 'creates undesirable income distributions'. The major assumption used in this respect is that the 'price system is costless'. However, this creates a fundamental problem with the concept of market failure, as it "describes a situation that exists everywhere because in the real world price system can never be costless". As these situations suggest analysts in search of externalities and market failures can find them 'anywhere they look', providing a "universal justification" for any sort of government intervention that one might want to undertake. Supporters of the market failure concept avoid this problem by focusing on failures that are 'big'.

Economic literature identifies several characteristics that "demand" government intervention to mitigate the failures in the market, including, amongst the others: '*Public awareness of market shortcomings'* – this has been increased in the recent past as a result of increased frequency and magnitude of instances of market failure associated and/or reported with respect to expanded economic activities (e.g. growth of toxic waste and use of pollutants, visible exercise of monopoly power by both business and labor); '*Influenced by the political organization and enfranchisement of many groups'* – who were formerly less informed and less active in the political process are now pressed for governmental legislation, regulation, and other programs to remedy the failures in the market (e.g. women's groups, consumer affiliations, minorities and environmentalists); '*Structure of political rewards'* – this is often accrue to legislators and governmental officials who articulate and publicize problems and legislate proposed solutions, without assuming responsibility for implementing them; '*High time-discount of political actor*s' – where the future costs and future benefits tend to be heavily discounted or ignored, while current or near-term benefits and costs are magnified to satisfy short terms associated with elected office of the political actors, and '*Decoupling between burdens and benefits'* – this may contribute to 'excess' demand for government activities in the sense that they entail greater social costs than benefits, or that they are not sustainable because they diminish incentives for productivity and growth in the economy.

Supply of non-market activities/outputs may also be characterized by a number of distinguishing features such as: they are often hard to define in principle, ill defined in practice, and 'extremely difficult to measure' as to quantity, or to evaluate as to quality (e.g. a public regulation on noise) and consequently, those are 'measured in the national accounts as the value of the inputs used in producing them'; those are usually 'produced by a single source of production' whose exclusive cognizance in a particular field is legislative mandated, administratively accepted, or both, and an absence of a sustained competition for which contributes to the difficulty of evaluating the quality of the output; the 'technology of producing non-market

output is frequently unknown' or, if known, is associated with considerable uncertainty and ambiguity; and, it is generally not 'connected with any bottom-line for evaluating performance' comparable to the profit-and-loss statement of market output, and closely related to which is the absence of a reliable mechanism for terminating such activities when they are unsuccessful.

*We may, therefore, contend that neither market nor government alone is capable of directing a business to develop a sound environment to cater into their clients through its own action, and as a result, an appropriate institutional arrangement should be designed that joins all social institutions to augment the individual incentives possess by these firms to work with such institutions. My view is that this would be the 'point of rationale' for moving into alternative institutions where the notion of entrepreneurship has a role to play at everywhere possible level, including the market, government and judiciary.*

**Professor. U. K. J. Mudalige**
**Professor (Chair) - Dept. of Agribusiness Management**
**Wayamba University of Sri Lanka**

# Members of the Research Committee

| | |
|---|---|
| Dr. A.R. Kumarasinghe | - Chairman |
| Dr. S.C. Jayamanne | - Dean, Faculty of Animal Science and Export Agriculture |
| Dr. P.I.N. Fernando | - Dean, Faculty of Management |
| Dr. E.P.S.K. Ediriweera | - Dean, Faculty of Science and Technology |
| Dr. K.B. Wijesekara | - Head, Department of Science & Technology |
| Dr. L.M.H.R. Alwis | - Head, Department of Export Agriculture |
| Dr. H.R.N. Peiris | - Head, Department of Public Administration |
| Mr. G.H. Abeyweera | - Head, Department of Management Science |
| Dr. D.K.D.D. Jayasena | - Head, Department of Animal Science |
| Mr. A.J.M.D.N.B Nawela | - Secretary, Senior Assistant Registrar |

# Symposium Organizing Committee

***Coordinator:***

Dr. P.I.N. Frenando

***Secretary:***

Dr. P.H.T. Kumara

***Faculty Coordinators:***

Ms. P.E. Kaliyadasa
Ms. J. Sutha
Dr. M.M.S.N. Premathilake

***Track Coordinators:***

**Genetics and Biotechnology**
Dr. H.M.S.K. Herath

**Food Science Technology**
Dr. W.A.J.P. Wijesinghe

**Bio Process Technology**
Dr. P.B. Ratnaweera

**Sustainable Crop and Animal Production**
Dr. E.D.N.S. Abeyrathne
Dr. S.R.W.M.C.J.K. Ranawana

**Aquaculture and Fisheries**
Mr. N.P.P. Liyanage

**Water Science and Technology**
Dr. N.P. Premachandra

**Environmental Science**
Dr. I. D. Singhalage

**Entrepreneurship and Management**
Mr. K.M.M.C.B. Kulathunga

**Entrepreneurial Agriculture**
Mr. R.A.P.I.S. Dharmadasa

**Hospitality and Tourism Management**
Ms. A.K.A. Damunupola

**Material Science and Engineering**
Dr. H.M.J.C. Pitawala

**Mineral Science and Technology**
Ms. T.H.N.G. Amaraweera

**Digital Electronics and Embedded Systems**
Mr. K.P.P.S. Pathirana

**Computing and Information Science**
Mr. T. Katheeswaran

**Humanities and Social Development**
Ms. K.M.R. Siriwardhana

**Poster Sessions**
Dr. K.G. Prematthilake
Mr. C.J.P. Kulathilake
Dr. K.W.S.N. Kumari

## *Activitiy Coordinators:*

**Hall Arrangement**
Ms. N.S. Withanage

**Fund Raising**
Dr. R.R.M.K.K. Wijesundara
Mr. M.G.W.K. Rajapaksha

**Logistic Activities**
Mr. A.J.M.D.N.B. Nawela

**Invitations**
Dr. A.P. Henagamage

**Media and Publicity Activities**
Mr. C.J.P. Kulathilake

**Symposium Proceedings**
Dr. P.H.T. Kumara

**Symposium Kit**
Dr. D.D.C. Wanniarachi

**Printing Works**
Mr. R.A.P.I.S. Dharmadasa

**Hospitality Activities**
Mr. T.M.P.S.I. Tennakoon

**Preparation of Budget**
Mr. A.P.U.K. Abeysooriya

**Souvenirs**
Ms. K.M.D.C. Mudannayake

**Poster Preparation**
Dr. E.D.N.S. Abeyrathne

## *Office Assistance:*

Mr. S.M.C.P. Samarakoon
Mr. W.M.C. Salinda
Mr. U.K. Srinath

## *Review Panel*

Professor. D.N.B. Gunewardena
Professor. R.L. R. Chandrajith
Dr. A. Wijayasinghe
Dr. A.L.A. Rauf
Dr. A.M.A.N.B. Attanayake
Dr. A.P. Henagamage
Dr. A.R. Kumarasinghe
Dr. D.C. Mudannayake
Dr. D.D.C. Wanniarachchi
Dr. D.K.D.D. Jayasena
Dr. E.D.N.S. Abeyrathne
Dr. E.P.S.K. Ediriweera
Dr. G. Chandrasena
Dr. G. Tilakarathna
Dr. H.M.J.C. Pitawala
Dr. H.M.S.K. Herath
Dr. H.R.N. Peiris
Dr. I. D. Singhalage
Dr. K.B. Wijesekera
Dr. K.G. Premathilake
Dr. K.M.A. Bandara
Dr. L.K. Naragammana
Dr. L.M.H.R. Alwis
Dr. M. Aslam
Dr. M.B.F. Mafasiya
Dr. M.I.M. Hilal
Dr. M.K. Wanniarachchige
Dr. M.M.S.N. Premetilake
Dr. N.P. Premachandra
Dr. N.W.B. Balasooriya
Dr. P. Kailasapathy
Dr. P.H.T. Kumara
Dr. P.I.N. Fernando
Dr. P.M. Sirimanne
Dr. P.N. Ranasinghe
Dr. R. Jayathilake
Dr. R.R.M.K.K. Wijesundra
Dr. S.C. Jayamanne
Dr. S.M. Young
Dr. S.R.W.M.C.J.K. Ranawana
Dr. T.L.S.W. Gunawardana
Dr. T.N.B. Etampawala
Dr. W.A.J.P. Wijesinghe
Dr. W.K.A.C. Gnanapala
Mr. G.H. Abeyweera
Mr. H.M.S.N. Ariyadasa
Mr. J.A. Athula
Mr. K.M.M.C.B. Kulatunga
Mr. K.P.P.S. Pathirana
Mr. N.A.D. Jayasinghe
Mr. N.P. Premachandra
Mr. N.P.P. Liyanage
Mr. P.I.N. Tennakoon
Mr. R.A.P.I.S. Dharmadasa
Mr. S.T.C.I. Wimaladharma
Mr. T. Kartheeswaran
Mr. T. Paranthaman
Mr. T.M.P.S.I. Tennakoon
Mr. V. Kanagasingam
Ms. A.M. Samaraweera
Ms. A.M.I. Jariya
Ms. J. Sutha
Ms. P.E. Kaliyadasa
Ms. R.M.C.W.M. Rathnayake
Ms. S.H.D. Senanayake
Ms. T.H.N.G. Amaraweera
Ms. V.R. Ragel

# About Symposium

Uva Wellassa University of Sri Lanka (UWU) established primarily focusing on Value Addition to teaching, learning and research is going to have its 06th Research Symposium with a view to provide a platform to present, discuss, debate and agreed upon and disseminate the recent research on value addition. The theme of the symposium named "Towards Emerging Trends in Value Addition" as the innovative perspectives towards value addition significantly plays a pivotal role in uplifting the social wellbeing whilst improving the proficiency to capture globe with a crystal clear vision of achieving the set goals: stimulating the research on value addition to enhance the socio-economic development, providing a forum for exchanging constructing views on research findings among scholars and exploring the every possible opportunities for interactions and collaborations with industries, researchers and stakeholders as well.

The 06th Research Symposium is undoubtedly going to reach its zenith of adding value to diversified areas of research as this year Symposium is comprised of areas of research such as Agriculture, Management, Science and Humanities paving way for a multitude of research on myriad disciplines coming under the areas stated above. The researchers , academicians, professional, practitioners and undergraduates were enthusiastic in contributing to this year's Symposium that we received around three hundred and fifty (350) research papers out which two hundred and fifteen (215) research papers have been selected to be presented respectively at;

- Genetics and Biotechnology
- Food Science Technology
- Bio Process Technology
- Sustainable Crop and Animal Production
- Aquaculture and Fisheries
- Water Science and Technology
- Environmental Science
- Entrepreneurship and Business Management
- Entrepreneurial Agriculture
- Hospitality and Tourism Management
- Material Science and Engineering
- Mineral Science and Technology
- Digital Electronics and Embedded Systems
- Computing and Information Science, and
- Humanities and Social Development

The Chancellor of the University shall reside as the Chief Guest of the Symposium whilst Professor Kapila Gunasekera, the former Vice Chancellor of the University of Peradeniya shall grace the occasion as the Guest of Honor. Professor U.K.J. Mudalige will deliver the Keynote speech while Dr. G. Chandrasena, Vice Chancellor, Uva Wellassa University taking lead as the Chairperson of the Symposium.

**Technical Session I**

# Genetics and Biotechnology

## Oral Presentations

# Optimization of a Polymerase Chain Reaction Based Technique to Detect Genetically Modified Foods

T.G.V.N. Thalwatta[1], W.W.P. Rodrigo, H.H.K. Achala[2], W.T.G.S.L. Withana[2], A.M.M.H. Athapaththu[2], P.B.A.I.K. Bulumulla[1]

[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka.*
[2] *Biotechnology Unit, Industrial Technology Institute, Colombo 07, Sri Lanka.*

Genetically Modified foods are an important outcome in the genetic improvement procedures in plants. Nowadays it has become a significant problem regarding authentication of such foods since non-labelled genetically modified foods are existing in the market. The aim of this study was to optimize a Polymerase Chain Reaction (PCR) based technique to detect Cauliflower Mossaic Virus 35S promoter and Nopaline Synthase terminator, which are intentionally introduced to various crops to create genetically modified foods. Three pairs of primers were used for PCR amplification. Chloroplast tRNA primers were used to amplify chloroplast DNA with 571bp amplicon length to prove the presence of plant origin DNA. Cauliflower Mossaic Virus 35S and Nopaline Synthase forward and reverse primers with 243 and 118 bp amplicon length were respectively used to detect promoter and terminator regions. PCR optimized condition for CaMV 35S promoter (annealing condition- 56 °C, 40 sec.) and NOS terminator (annealing condition- 62 °C, 30 sec.) was carried out in 30 cycles each. Fresh and processed food samples (10 each) were collected from super markets and were analyzed in triplicates. During the analysis of post PCR products using 1% agarose gel, four food samples including corn, biscuit, corn flakes and processed potato samples were detected positive for promoter and terminator regions while a processed cereal mixture was detected as positive only for the terminator region. None of the foods were labelled as GM and it indicates that non labelled genetically modified foods are presence in the market. Therefore, this method could be used as simple and reliable assay for screening of unauthorized genetically modified crops and the processed food products.

**Keywords**: Genetically modified foods, Cauliflower mossaic virus 35S promoter, Nopaline synthase terminator, Polymerase chain reaction

# Optimization of a Ribonucleic Acid (RNA) Extraction Protocol for Viruses in Clinical Samples for Disease Diagnosis

S.A. Kumar[1], P.A.D.H.N. Gunathilaka[2], W.W.P. Rodrigo[2], A.M.M.H. Athapaththu[2]

[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Biotechnology Unit, Industrial Technology Institute, Colombo 07, Sri Lanka.*

Ribonucleic acid (RNA) is a polymeric molecule. It is implicated in coding and gene expression. Some medically important organisms such as viruses have only RNAs as their inherent material. To detect the viral diseases using molecular biological methods, it needs extraction of RNA from body fluids. There are several methods of RNA extraction, which require costly reagents and kits. Hence, the objective of this study was to optimize a low cost, in-house protocol for RNA extraction of viruses in clinical samples in order to facilitate disease diagnosis. Clinically confirmed blood samples, which were positive for Dengue Virus by NS1 antigen test, were taken for optimization of the two protocols. Two different RNA extraction protocols were used for the study to identify the most appropriate and reliable method with high efficiency. Trizol reagent, which was prepared in house was used in both protocols. Extracted RNA from both the protocols were quantified at 260 nm using a spectrophotometer. The RNA amount quantified from the spectrophotometer showed a result of 64 and 72 ng/ul from first and second protocols, respectively. In the first protocol, all the procedures were undertaken at room temperature (27-35 °C) but generally RNA is not stable at the room temperature. Therefore, RNA might have degraded due to lack of optimum conditions during the incubation, centrifugation and storage periods. In addition, if the RNA pellets were air dried completely, it becomes insoluble in RNase free water. Therefore, extracted RNA might not have been re-suspended completely in the solution. Those identified drawbacks were adjusted in the second protocol. Further, incubation temperature and time period (4 °C and 30 minutes) and centrifugation time (15 minutes), were modified to achieve stabilization, complete precipitation of RNA molecules and to prevent degradation by RNases. According to the above discussed facts, this study reveals that the second protocol is more suitable for RNA extraction of viruses in clinical samples.

**Keywords**: Ribonucleic Acid (RNA), Virus, Extraction

# Development of micropropagation protocols for two different *Cryptocoryne* species in Sri Lanka (*Cryptocoryne parva* and *Cryptocoryne xwillisii*)

D.T.K. Boyagoda[1], S.C. Jayamanne[1], H.M.I. Herath[3]
[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*
[3]*Royal Botanic Gardens, Peradeniya, Sri Lanka*

An efficient protocol was developed for the micropropagation of *Cryptocoryne parva* and *Cryptocoryne xwillisiii*, two endemic threatened aquatic herbs of Sri Lanka, which considered as highly valued aquarium plants. Rhizomes and leaves of two species were surface sterilized using Sodium Hypochlorite and 0.1 % Mercuric Chloride successfully and they were established on full strength Murashige and Skoog (MS) medium. Experiment was arranged in factorial Complete Randomized Design (CRD). Effects of basal MS medium supplementation with factorial combinations of BAP 6-benzylaminopurine (0, 1, 3, 5mg $l^{-1}$) and NAA-Naphthalene Acetic Acid (0, 0.1, 0.3 mg $l^{-1}$) on shoot initiation from rhizome and leaf explants were determined after 42 days. Data were analyzed using ANOVA and Tukey's Test incorporated in MINITAB 16 software. The presence of growth regulators in MS medium had a significant ($p<0.05$) effect on shoot initiation in rhizomes of both species. Highest mean number of shoots initiated per single rhizome explant was observed in the combination of 5.0 mg $l^{-1}$ BAP with 0.1 mg $l^{-1}$ NAA in both species (*C. parva* 4.3, 3.7; *C. xwillisii* 4.1). Regenerated shoots of rhizome explants were cultured on MS medium supplemented with BAP 0, 1, 3 mg $l^{-1}$ for shoot multiplication. The presence of growth regulators in MS medium had a highly significant ($p<0.05$) effect on shoot proliferation of both species. Highest mean number of shoots proliferated per shoot (*C. parva*7 and *C. xwillisii* 5.6) was observed in 3 mg $l^{-1}$ of BAP. Presence of growth regulators in MS medium had a highly significant ($P<0.05$) effect on embossing leaves of both species as a positive response. Best explant source for both species was rhizome. Optimum hormone combination for shoot initiation of both species is 5 mg $l^{-1}$ of BAP with 0.1 mg $l^{-1}$ of NAA and for shoot multiplication optimum hormone concentration is 3 mg $l^{-1}$ of BAP.

**Keywords**: *Cryptocoryne parva*, *Cryptocoryne xwillisii,* BAP, NAA, Rhizomes and leaves, Shoot initiation, Shoot multiplication

# Legal Regulation of Biotechnology: Problems and Opportunities for Reform

K.K. Madugalla
*Department of Law, University of Peradeniya, Peradeniya, Sri Lanka*

The implications of developments taking place in the field of genetics and biotechnology towards human rights could be considered as a critical issue, which has given rise to many controversies in the modern context. In view of the issues perceived regarding legal regulation of genetics and biotechnology, there is a pressing need to revisit the legal framework in this regard, examine the human rights implications of such legal provisions and consider alternative approaches, which would ensure sufficient consideration of human rights in this area. The research problem was whether the legal responses that have been made to address the developments in genetics and biotechnology have been successful in ensuring consideration for human rights in jurisdictions such as the European Union and United States of America, where there are developed regimes of intellectual property law. The research objective is to analyse the extent to which the legal frameworks regarding genetics and biotechnology in the European Union and United States of America have been receptive towards human rights considerations, analyse the problematic aspects of these laws and identify other mechanisms, which would pave way for adequate consideration of human rights concerns in this field. Qualitative research methodology was adopted in the research. The research revealed that legislative instruments and judicial decisions in the European Union and United States of America have been responsive towards ethical concerns involved with regard to genetics and biotechnology. Yet it was also revealed that significant issues persist in giving due regard to human rights considerations in this field. In this context, the emergence of bioethics, which consider human rights concerns in the field of genetics and biotechnology assume significance. In view of the importance of considering human rights concerns in this area, it is recommended that further initiatives whereby issues encountered in ensuring consideration of human rights concerns could be solved in the field of genetics and biotechnology should be explored in detail.

**Keywords**: Genetics, Biotechnology, Human rights, Bioethics

# Characterization of Conserved Germplasm of Pungent Chilli Landraces (*Capsicum chinense* Jacq)

K.A.M.Y.C Jayathissa[1], L.M.H.R Alwis[1], K.N. Kannangara[2]
[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Regional Agricultural Research and Development Centre, Makandura*

Morphological and agronomical traits are widely used to study the diversity in *Capsicum* species, to determine the relationship between various species and to develop an identification key. *Capsicum chinense* Jacq ("Nai Miris") species are still not properly characterized as the attention has been directed to *Capsicum annum* species. Hence present study was undertaken to explore the morphological and agronomical diversity of *Capsicum chinense* Jacq at Regional Agricultural Research and Development Centre, Makandura, low country intermidiate zone ($IL_{1a}$). Thirty three morphological traits and fourteen agronomical traits considered for 48 accessions germinated from 112 *Capsicum* accessions. Accessions were collected from Plant Genetic Resource Centre and chilli breeder, Mr. K.N. Kannangara. Characterization was based on descriptor for *Capsicum* produced by PGRC. Based on the results of 48 *Capsicum* accessions, there were no duplicated accessions within the studied accessions. The traits that largely contributed to the variability within and between the accessions included corolla colour, anther colour, fruit colour at intermediate stage, fruit colour at mature stage, fruit shape, mature leaf length, mature leaf width, number of days for flowering, number of days for fruiting, fruit length, fruit wall thickness, fruit weight and 1000 seeds weight. Cluster analysis showed that there are three major clusters in germplasm collection of *Capsicum.* One major cluster consisted with 23 accessions of pungent chilli having useful and most common characteristics such as: annular constriction of calyx and clusters of flowers or fruits at node, which are exclusively found in the *Capsicum chinense* Jacq accessions. The twenty three accessions divided in to seven sub clusters and showed wide genetic diversity that exists in *Capsicum chinense* germplasm.

**Keywords**: Morphological traits, Agronomical traits, *Capsicum chinense* Jacq, Cluster analysis, Genetic diversity

# Development of *In-vitro* and Conventional Propagation Protocols for Two Different Endemic Species of *Aponogeton* (*Aponogeton rigidifolius and Aponogeton jacobsenii*)

W.N.V. Weerasekara[1], B.V.A.S.M. Bambaranda[2],
S.C. Jayamanne[1], S.A. Krishnarajah[2]
[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Royal Botanic Gardens, Peradeniya, Sri Lanka*

This research was focused on the development of successful propagation protocols for two different endangered and threaten aquatic plant species of *A. rigidifolius* and *A. jacobsenii*. Due to lack of effective propagation methods, *Aponogeton* species indiscriminately harvested from wild and leads to extinct. To overcome the problem of species loss and inadequate supply to the local and foreign market, *in vitro* and conventional propagation protocols were developed for both species. Rhizomes, seeds and leaf explants of both species were sterilized using NaOCl and 0.1 % $HgCl_2$ and established on full strength MS medium supplemented with combination of 6-benzylaminopurine (BAP) 2, 3, 5 mg/L with or without 0.1 mg/L indole acetic acid (IAA) for initiation. For shoot multiplication 2, 3, 5 mg/L BAP were used. Rhizome cuttings and seeds of both species were planted in pots, which contain sand, sand: top soil, top soil and boggy soil with water as conventional propagation method. Experiment was arranged in Complete Randomized Design method and data were analyzed using ANOVA and Tukey's Test. The presence of growth regulators had significant effect ($p<0.05$) on shoot initiation of *A. rigidifolus* rhizome. The highest shoots per replicate (2.4) were proliferated in 2 mg/L BAP medium. Application of hormones had a significant effect on number of leaves and seedling height of seed explants of both species. Maximum number of leaves (5) and seedling height (5.8cm) in *A.rigidifolius* obtained from the treatment which supplemented both 5 mg $l^{-1}$ BAP and 0.1 mg $l^{-1}$ IAA while the highest leaves (3.43) and height (1.92 cm) shown in 5 BAP alone medium in *A. jacobsenii* seedlings. The highest shoots per seedling (4.2) obtained from 2 mg $l^{-1}$ BAP contain multiplication medium in *A. rigidifolius* seedling. Conventional growth media significantly influence on the shoot development from *A. rigidifolius* rhizome cuttings, seed germination, and in other seedling growth parameters of both species. Mean number of leaves, height of seedlings, and number of roots and length of roots were high in both plants which planted in boggy soil medium. The highest shoots of *A. rigidifolius* obtained in sand medium.

**Keywords**: *Aponogeton rigidifolius, Aponogeton jacobsenii, in-vitro,*

# DNA Fingerprinting of *Thunnus obesus* and *Thunnus albacares* Fish Species for Proper Identification in Large Scale Fish Processing Industry

D.R.C. Perera[1], P.A.D.H.N. Gunathilaka[2], W.W.P. Rodrigo[2], A.M.M.H. Athapaththu[2], P.B.A.I.K. Bulumulla[1]

[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Biotechnology Unit, Industrial Technology Institute, Colombo 07, Sri Lanka.*

Detection of species substitution has become an important topic within the food industry and there is a growing need for rapid, reliable, and reproducible tests to verify species in commercial fish and seafood products. The effects of species substitution are far-reaching and include economic fraud, health hazards, and illegal trade of protected species. In Sri Lanka tuna fish industry is a rapid developing field. However, the species identification prior to the processing is achieved through morphological characteristics, which is not a reliable method. Therefore, the aim of this study was to develop a diagnostic method by combining Polymerase Chain Reaction with Restriction digestion to differentiate *Thunnus obesus* (bigeye tuna) and *Thunnus albacares* (yellowfin tuna) species in order to facilitate the fish processing industries and fish exporters by developing the test for species confirmation. Deoxy ribonucleic acid (DNA) extracted from muscle tissues of *T. obesus* and *T. albacares* were analyzed. DNA was amplified using primers flanking a region of cytochrome b gene of 558 bp and digested using two restriction endonucleases, *Eco*NI and *Sca*I. A product having band sizes of 187 bp and 371 bp was observed from *T. albacares* after digesting with *Eco*NI. The digestive product by *Sca*I resulted 215 bp and 343 bp band sizes for both *T. albacares* and *T. obesus*. The polymorphism of DNA profiles obtained by restriction digestion was used to differentiate the *T. albacares* and *T. obesus* species. Therefore, the current study carries a reliable approach to identify and distinguish *T. obesus* and *T. albacares* from the other tuna species.

**Keywords**: Tuna species, DNA extraction, Polymerase chain reaction, Restriction Enzyme digestion

# Detection and Confirmation of Phytoplasma Disease in Different Crop Species by Using Molecular Technology

A.A.I.M. Amarasinghe[1], L.M.H.R. Alwis[1], P.D.P.M.D. Silva[1]
B.M.V.S. Basnayake[2], T.M.N.D. Tennakoon[2], K.D. Nandasena[2]
[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Plant Virus Indexing Centre, Department of Agriculture, Homagama, Sri Lanka*

Phytoplasma disease is caused by plant pathogenic Phytoplasmas, which are cell wall less bacteria that causes devastating losses in yield and quality of crop production in Sri Lanka. Effective control is required to minimize the spread of the disease through identification of the organism. Detection and confirmation of phytoplasma diseases in infected crop species by using molecular technology required to gain rapid accurate results in identification to compete with increment of virulence of the pathogens. However, there are least number of research conducted on phytoplasma diseases in Sri Lankan context. Hence, this study was conducted as a molecular approach for phytoplasma detection, identification and confirmation. The Polymerase Chain Reaction based method was used with universal primers for 16S rRNA gene to detect phytoplasma in fifty different suspected crop species and the amplified DNA fragments in 557 bp were visualized on 2 % agarose gel. Thirty-six crop species gave positive results with producing DNA fragment in 557 bp size. For accurate detection of phytoplasma caused symptoms in Sapota (*Manilkara zapota*) and Petunia (Petunia sp.) two oligonucleotide primers were designed, using sequenced phytoplasma DNA extracted from infected Sapota and Petunia plants. Those designed primers were characterized, optimized and primer specificity was analysed. Primers Mx for Sapota is forward -5'- GCCAGGCAGTCCACTTATCA-3' and reverse 5'- GTGCACGCCCTAAACGAATC-3'. The length of the primer was 20 bases and detectable band in gel profile was 88 bp. with three unstable hairpin loops. Primer Mx best annealing temperature was 50 and showed 90 % specificity. Primers Px for petunia is forward sequence '5-CGGCTTGGCTACCCTTTGTA-3' and reverse sequence 5' - TACCTGGCCTTGACATGCT-3. The length of the primer was 20 bases and detectable band in gel profile was 288 bp. with eight unstable hairpin loops. Primer Mx best annealing temperature was 45 and showed 30 % specificity. Mx and Px primers can be used for specific, sensitive detection of phytoplasma infect to Sapota (*Manilkara zapota*) and Petunia (*Petunia* sp.) plant species.

**Key words**: Phytoplasma, Polymerase chain reaction, Primers, Gene sequencing, Template DNA

# Induction of Embryogenic Callus in Grapes (*Vitis vinifera*)

U.L.D.M.S. Gunasinghe[1], P.E. Kaliyadasa[1], H.A.S.L. Jayasinghe[1]
S.M. Nagahawatta[2]
[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Plant Virus Indexing Centre, Homagama, Sri Lanka*

*In vitro* propagation of Grapes (*Vitis vinifera*) extends opportunities for increasing plant material for cultivation. This experiment was conducted to develop an efficient protocol for surface sterilization and callus induction from different explants of Grapes. Grape peduncle segments and fruit skins were used as explants. Different Clorox® concentrations and different soaking times were used to select the best surface sterilization method. The sterilized explants were cultured on MS medium supplemented with different hormone concentrations and combinations of NAA (Naphthalene Acetic Acid) – BAP (6- Benzyl Amino Purine), NAA – KIN (Kinetin), 2,4 –D (DicholoroPhenoxy Acetic Acid) - BAP and 2,4–D- KIN to investigate the effect on callus induction. Cultures were maintained at 25± 2 °C temperature under dark conditions in a culture room. The best surface sterilization of peduncles was achieved with 25 % Clorox with twenty minutes and the best surface sterilizataion of fruit skins was achieved with 2.5 % Clorox for one second. Peduncles are explants for high frequency callus induction than the fruit skins. Among the NAA and 2, 4 – D hormones, NAA is better for callus induction from peduncles and 2, 4 – D is better for callus induction from the fruit skins. 10 mg $l^{-1}$ NAA + 0.5 mg $l^{-1}$ BAP are best hormone combination for earlier callus formation and obtain higher volume callus from grape peduncles. As a protocol for callus induction of grapes using peduncles and fruit skins above methods of surface sterilization and culture establishment can be used successfully.

**Keywords**: Callus induction, NAA, BAP, KIN, 2, 4-D

# Morphological Characterization of Capsicum Species Conserved in Plant Genetic Resources Centre

A. Wijewickrama[1], L.M.H.R. Alwis[1], S. Wasala[2]
[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Evaluation Division, Plant Genetic Resources Centre, Gannoruwa, Sri Lanka*

Capsicum, which belongs to the family Solanaceae is widely grown field crop in Sri Lanka. There are more than 600 accessions of capsicum conserved at Plant Genetic Resources Centre (PGRC), Gannoruwa. This study was conducted to evaluate the characters of locally collected chilli germplasm and to study the genetic diversity among the germplasm based on the morphological characters. Fifty-four germinated capsicum accessions from PGRC were used for the morphological characterization. Data were collected according to the descriptor, which was developed by PGRC, Gannoruwa. Cluster analysis was carried out to group these accessions according to the morphological traits. There were four major clusters and second major cluster has three sub-clusters. Due to similar phenotypic characters all the capsicum Chinese species came under one cluster and except six accessions of *Capsicum frutescence*, all other *Capsicum frutescence* accessions were clustered in one group. Except three *Capsicum annuum* accessions, others were assembled to one group. Considering qualitative characters, leaf shape, plant growth habit, branching habit, fruit shape, mature fruit colour and intermediate fruit colour highly contrast among three species. Fruit weight, length and fruiting and flowering time period like quantitative characters show the significant difference among accessions. According to the study, there was considerable diversity within and between capsicum accessions conserved at PGRC and can be utilized for chilli crop improvement.

**Keywords**: Capsicum species, Morphological characterization, Cluster analysis, Chilli germplasm, Diversity

# Screening of Tea Germplasm on Suitability for Green Tea Manufacturing

A.H. M. G. I. Abesinghe[1], L.M.H.R. Alwis[1], K.P.M. Kahandage[1], M.A.B. Ranatunga[2]
[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Tea Research Institute, Talawakelle, Sri Lanka*

Demand for green tea consumption has gone up among the local consumers. Thus, tea growers look for cultivars suitable for green tea production. Studies were conducted to screen the suitability of tea germplasm for green tea manufacturing aiming for developing better cultivars in future. Twenty six accessions from the germplasm representing exotic collection, recommended cultivars and estate selections were used. Two leaves and the bud were picked from plants and green tea was prepared using an optimized hand processing method by steaming to deactivate enzymes, hand rolling and pan frying, twisting and drying. Samples were triplicated and sensory evaluation on quality of ungraded green tea was done by professional tea tasters. Taster's comments were transformed into ranks and scores were summed up to get the Total Quality Score (TQS). Ranked data were subjected to cluster analysis using Average Distance Cluster method and resultant dendrogram was constructed using PAST 3 software. Twenty six accessions were grouped based on the average ratings given for individual quality parameters; dry leaf: appearance, aroma, infused leaf: appearance, aroma, liquor: appearance, aroma, colour, taste using average linkage cluster analysis. Resultant dendrogram was clustered in to four major groups. First group comprised of CH13, estate selection and six accessions from the exotic germplasm collection. All those accessions were rated as producing high quality green tea. The second group consisted of TRI 4067 recommended cultivar and six other accessions from the exotic germplasm collection, which are also considered as good accessions for quality green tea. This is the first attempt on screening tea germplasm for developing a Sri Lankan green tea cultivar.

**Keywords**: Green tea, Sensory evaluation, Exotic tea germplasm, Polyphenol, Caffeine

**Technical Session I**

# Genetics and Biotechnology

## Poster Presentations

# Expression of a Rabies Virus Specific Antigen by Cloning the Glycoprotein Gene into *Escherichia coli* Expression System

H.S. Sewwandi[1], W.W.P. Rodrigo[2], A.M.M.H. Athapaththu[2], P.A.D.H.N. Gunathilaka[2], K.G.W.W. Bandara[2], R.R.M.K.K. Wijesundara[1], P.B.A.I.K. Bulumulla[1]

[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka.*

[2]*Biotechnology Unit, Industrial Technology Institute, Colombo 07, Sri Lanka.*

Rabies is an infectious disease characterized by dysfunction of the central nervous system caused by Lyssavirus of family Rhabdoviridae. Detection of rabies antibodies are used to confirm if people have been successfully immunized. Currently, these detection methods require lots of expertise and are generally carried out in reference laboratories at a high cost. Therefore, it is vital to develop and standardize simple techniques such as Enzyme Linked Immunosorbent Assay (ELISA) for determining the level of antibodies against rabies virus at a lower cost. Hence, the aim of the present study was to clone rabies virus specific glycoprotein gene into bacterial expression vector for the production of recombinant protein. Initial attempts were made to isolate plasmid DNA of pET-28a (+) vector and pcDNA3.1-RVG recombinant plasmid containing previously cloned Rabies Virus Glycoprotein gene (RVG). Both plasmids were successfully digested with BamHI and XhoI restriction enzymes. The purified Rabies Virus Glycoprotein gene was cloned into pET-28a (+) bacterial expression vector. The pET-28a (+)-RVG plasmids were successfully transformed into TOP10F' competent cells through electroporation. Transformants were screened by rapid screening method. Out of 20 colonies 8 were identified as recombinants. Further screening of recombinant colonies will be carried out by digesting with restriction enzymes. Putative correct recombinant construct will be transferred into bacterial expression system for the expression.

**Keywords**: Rabies, Rabies virus glycoprotein gene, Cloning

# Development of a Protocol to Extract Quality DNA from Maha Aratta (*Alpinia galangal* (L.) Sw.) and Related Species

R.A.S.N. Ranasinghe, L.M.H.R. Alwis
*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*

*Alpinia galangal* (L.) of family Zingiberaceae is one of the valuable medicinal plants in traditional medicine. There are some morphologically similar plants for *Alpinia galangal*. Therefore, improper identification creates issues in traditional medicine. DNA barcoding provides correct identification of plants at molecular level. Quality DNA extraction from *Alpinia galangal* and other related species is needed for DNA barcoding. Thus, this research focused on development of a protocol to extract quality DNA from *Alpinia galangal* and five related species. *Alpinia galangal*, *Alpinia calcarata*, *Alpinia malaccensis*, *Hedychium flavescens*, *Hedychium coronariuam* and *Hedychium coccineum* leaf samples were used to extract DNA. Extracted DNA was visualized using 0.8 % agarose gel and quantified using UV visible spectrophotometer. The protocol developed to extract genomic DNA of *Alpinia galangal* and other related species consisted with following steps. In developed promising protocol, the first leaves were sterilized, weighed and kept at -200 °C for one hour, cut in to small pieces, ground with liquid $N_2$ and transferred in to preheated buffer 2x CTAB with pinch of PVP. β mercaptoethanol was added. Then chloroform:isoamyl alcohol (24:1) extraction and centrifugation at 13000 rpm were done. After two chloroform: isoamyl alcohol extractions, DNA were left to precipitate at -200 °C for one hour. Then, supernatant was removed and wash buffer was added. Samples were centrifuged at 13000 rpm, and pellets were taken and allowed to dry overnight. Finally, dry pellets were dissolved in TE buffer. This promising protocol confirms that extraction quality DNA is at considerable amount from *Alpinia galangal* and other related species. Pure quality DNA is having absorbance ratio in between 1.8 to 2. It showed that DNA extracted using this developed protocol can be used to extract quality DNA from *Alpinia galangal* and other related species. Concentrations of DNA extracted from six *Alpinia species*, was in range of 150 to 275 ng $\mu l^{-1}$. It also revealed that this developed protocol can extract considerable amount of DNA from *Alpinia galangal* and other related species.

**Keywords**: *Alpinia galangal*, Maha aratta, Identification, DNA barcoding, Adulteration

# Determination of a Suitable Hardening Medium for Micropropagated *Anubias nana*

A.M.S.M. Kumari[1], S.C. Jayamanne[1], W.P.R. Chandrarathna[2]
[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka,*
[2]*Ornamental Fish Breeding and Training Centre, Rambadagalla, Sri Lanka*

Most of aquatic plant varieties are used in aquariums as ornamental plants due to their aesthetic and ecological value. The genus *Anubias* of the family Araceae is considered as one of the highly demanded plant types among other aquatic plant species. Among *Anubias* varieties, *A. barteri* var. *nana* is considered as a most cultivated and commercially important species. Micropropagation is currently applied to this plant as a tool for large scale multiplication of plants since the planting material has a very low multiplication rate. However, the high rate of mortality experienced by micro propagated plants during or following laboratory to outdoor transfer is still existing as a major limitation in large scale applications. Therefore, it is a requirement to develop an effective acclimatization procedure for a successful establishment and survival of plantlets. The present experiment was carried out in order to determine a suitable hardening medium for micropropagated *Anubias nana* using complete randomized design. The study was conducted at the Ornamental Fish Breeding and Training Centre, Rambadagalle. Four weeks old uniform sample of *in vitro* rooted *Anubias nana* plantlets were hardened by using five different potting media. Coir dust, coconut husks, clay brick shards, boggy soil and sand were used as different hardening media/treatments. Each treatment was replicated ten times. Every plantlet was provided with a constant amount (N: P: K-4:2:1) of a commercial fertilizer in once a week. The performances of plantlets were measured by using survival rate and growth in each treatment. The measured growth parameters were number of roots and leaves, length of roots and leaves, fresh weight and dry weight of plantlets after 6 weeks of hardening period. Data were analyzed by using one way ANOVA and Tukey's test. The maximum survival percentage (100%) was obtained in coir dust, clay brick shards and sand. Out of five treatments of media, a significant difference ($p<0.05$) of root growth was shown by plantlets in coconut coir dust and sand. A significant difference ($p<0.05$) of leaf growth and weight was reported in plantlets in clay brick shards media.

**Keywords**: *Anubias nana*, Micropropagation, Hardening

**Technical Session II**

# Food Science and Technology

## Oral Presentations

# A Feasibility Plan for Implementing Food Safety System Certification (FSSC) 22000 Standard, By Gap Analyzing of Existing Hazard Analysis and Critical Control Point (HACCP) System and FSSC 22000 Standard

W.A.S.M. Wirasagoda, D.K.D.D. Jayasena, E.D.N.S. Abeyrathne
*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*

Food safety is a scientific discipline describing handling, preparation, and storage of food to prevent foodborne illness. Food can transmit disease from person to person as well as serve as a growth medium for microorganisms. Over the years, many regional and customized food safety standards have evolved to enhance food safety and address the issues raised by manufacturers, suppliers, retailers and consumers. In 2005, ISO 22000 international food safety standard was developed and it specifies the requirements for a food safety management system. Latest standard for food safety is Food Safety System Certification (FSSC 22000) and it is slightly differ from ISO 22000 food safety standard. This study was carried out to identify the gap between implementing HACCP system and FSSC 22000 standard and check the feasibility to fill the gap in Gills food products (Pvt) Ltd. To analyze the gap, solution selection matrix theory was applied. According to that, the most effective solutions were selected from a suggested list of solutions. 37 solutions were suggested to overcome the requirements in the proposed standard. Then, solutions were ranked from 1 to 37 according to the frequency, implementing feasibility and economic feasibility parameters. Total score was calculated by adding up scores of those three parameters. By considering total scores, solutions were ranked and those scores were considered as effectiveness of solutions. Finally, using the effectiveness value, most effective 25 solutions were selected to implement because it fulfills 96% of requirements. Other than not-established requirements, some solutions were added to solution list to improve already established requirements according to company need. Therefore, solutions were suggested not only for applying FSSC standard, but also improve the company condition to ensure food safety and be capable to apply other standards in future.

**Keywords:** Food safety, HACCP, FSSC 22000, Gap analyzing, Solution selection matrix

# Development of a Fish Paste Incorporated with Mature Flower Buds of *Rhizophora apiculate* as a Nutritional Supplement

T.H.S.Tharaka, E.D.N.S. Abeyrathne
*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*

Indian carps (*Catla catla*) are considered as an excellent source of high proteins, vitamins and minerals and they are low in saturated fats. However, carps have limited consumer acceptability due to presence of intramuscular bones. Recent studies showed that mangroves provide priceless therapeutic agents in both modern and traditional medicines systems. Present study was conducted to develop a value added fish paste incorporating mature flower buds of *Rhizophora apiculata* which can be used as a nutritional and medicinal supplement. Fish paste was prepared mixing with boiled and minced fish with adequate amounts of other ingredients. Finally, it was pasteurized at 85°C for 15 minutes. Preliminary investigations were conducted to determine the suitable levels of all ingredients with 30 untrained panellists. According to the results, 89% (w/w) of catla, 6% (w/w) of mature flower buds of *Rhizophora apiculata*, 1% (w/w) chili, 1% (w/w) salt, 1.5% (w/w) white pepper and 1.5% (w/w) lime juice were determined as the best ($P<0.05$). Proximate analysis showed that final product contained 72.50±0.03%, 20.82±1.49%, 2.81±0.02%, 2.10±0.11% and 1.94±0.01% of moisture, protein, fat, fiber and ash, respectively. Shelf life studies of bread spread were carried out using microbiological and pH tests. In addition pH of the fish paste did not change significantly during the storage period of 30 days under refrigerated condition ($p>0.05$). According to the microbiological observations, total coliform and *Salmonella* were absent while total plate counts were within the acceptable level for 28 days. Therefore the developed fish paste can be considered as a safe food for the consumers up to 28 days which can provide high nutritional and medicinal benefits.

**Keywords:** *Catla catla*, Bread spread, *Rhizophora apiculata*, Sensory evaluations, Shelf life studies

# Comparison of Meat Quality Traits of Scalded and Non-scalded Broiler Chicken Meat

S.T.T. Iromi, D.K.D.D. Jayasena
*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*

The aim of this work was to investigate the physicochemical and sensory characteristics of scalded (SBC) and non-scalded broiler chicken (NSBC) breast meat. Six birds were randomly selected from the processing line of New Anthoney's Farms (Pvt) Ltd before and after scalding process which used as treatments. Proximate composition of breast meat of each bird was determined as outlined by AOAC (1995). Measurement of color was determined by using a colorimeter (CR-410, Konica minolta, NIC., Japan). Measurement of pH was determined by using a pH meter (PH700, Eutech instrument, Singapore). Cooking loss was determined by heating the samples up to 85°C for 30 min in a water bath (LWB-IIID, Daihan labtech Co.LTD., Korea). Analysis of variance was conducted by the (ANOVA) and the General Linear Model using SAS program version 9.1 (SAS, 2002, SAS Institute, Cary, NC, USA). Mean Separation was analyzed by Duncan's multiple range tests at $P<0.05$. SBC contained higher protein but lower fat content than NSBC and no differences in ash and moisture content. Lower fat content in SBC is, dissolve the fat in hot water used in scalding tank. L*, a* and b* values were not significantly difference ($p<0.05$) between NSBC and SBC. Higher pH values were shown by NSBC and no any significant difference of cooking loss in NSBC and SBC. In higher temperature, glycolytic potential will increase and more lactic acid will produce. That can be the reason for the high pH value in NSBC. It will reduce the ultimate pH of the carcass. Based on the results of the sensory analysis, there was a significant difference ($p<0.05$) in overall acceptability. Reason for this difference can be, a niche market (Buhari Hotel) existing for NSBC.

**Keywords:** Scalded, Broiler, Non-scalded, Physicochemical, Sensory

# Formulation, Preparation and Preservation of Palmyrah Fruit (*Borassus Flabellifer* L.) Jelly

M. Jeyarajasingam[1], W.A.J.P. Wijesinghe[1], S.M.I.P.G. Bandara[1], A.M. Nilushiny[2], S. Sirivijendren[2]

[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Palmyrah Research Institute, Jaffna, Sri Lanka*

Palmyrah fruit has high nutritive value but it has received less attention from palmyrah industry. It could be utilized to prepare jelly from fruit pulp. The study was carried out at Palmyrah Research Institute to develop a fruit jelly from the Palmyrah fruit pulp. Several preliminary experiments were carried out to find out the optimum amount of each ingredient which could be added in Palmyrah Fruit Jelly (PFJ) production. In each experiment one ingredient was changed in different amounts keeping the others constant in weigh basis. Then, all ingredients were interpreted in percentage. A sensory evaluation was performed and results were analysed using Minitab17.0 software. Freidman's test and Turkey's pairwise comparison were used to find the optimum level of each ingredient for PFJ. Nutritional composition of developed PFJ and Preserved Palmyrah Fruit Pulp (PPFP) were determined. Yeast and mould count of PFJ packed in three different packing materials such as transparent polypropylene cup, high impact polystyrene white cup and low density polythene cup were determined in 15 days interval to find out shelf life of PFJ under normal atmospheric condition. According to sensory evaluation results 40g of PPFP, 50g of sugar, 0.5g of citric acid and 0.5g of seaweed extract were selected as most acceptable formula to develop the PFJ. Developed PFJ contained 29.40% moisture, 1.67% protein, 6.48% reducing sugar, 56.05% total sugar and 0.89% ash contents, 0.65% titrtable acidity, 3.50 pH, 65.51% TSS, Ca (25.6 mg/100g), P (5.06 mg/100g) , Fe (20.67 mg/100g) and vitamin C (0.86 mg/100g). Used PPFP for jelly preparation contained 0.41% protein, 0.89% ash, and 5.92% reducing sugar, 8.72% total sugar, 0.34% titrtable acidity, Ca (30.67 mg/100g), P (11.11 mg/100g), Fe (13.85 mg/100g) and vitamin C (1.47 mg/100g). The acidity, pH and TSS were in recommended range and microbial colony was not observed up to two months. One cup of jelly in polypropylene cup can be sold for Rs. 30.00 while one cup of jelly in HIPS and LDPE at Rs. 25.00

**Keywords:** Palmyrah fruit pulp, Fruit jelly, Value addition, Preservation, Packaging

# Estimation of Quality of Black Tea Grades by Different Brewing Methods and Their Chemical Composition

S. Shivanth[1], A.G.A.W. Allakolanga[1], P.D.P.M.D. Silva[1], A. Anil Cooke
[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Asia Siyaka Commodities PLC, Sri Lanka*

The objective of the present study was to determine the optimal brewing methods and their contribution to the in-cup chemical composition as well as to correlate the chemical composition of tea infusions to their sensorial properties. BOP, PF1, FBOPF grades are obtained by different manufacturing methods. The fixed brewing temperature and time in preparation of tea for all grades were not effective for the extraction of full liquor characters to the brew. Black tea samples were brewed at different temperature levels (75 °C, 85 °C, and 95 °C) for 2, 5, 7, and 9 min using three different high grown black tea grades. Highly trained seven panellists evaluated different tea grades using a seven –point hedonic scale. The data were analyzed through the Kruscal-Wallis non parametric ANOVA method. Conover-Inman method was used for the selection of the best treatment combinations. Two factor factorial design was used for chemical analysis in each type and to determine the polyphenol content, correlation between tea quality attributes and in-cup chemical composition. Across all three black tea samples at 12 different brewing temperatures and time combinations, 95 °C for 9 minis the best temperature and time combination for brewing all the black tea grades. Also the extraction of polyphenol was increased by prolonging the infusion time for 5, 7, and 9 minutes.

**Keywords:** Black Tea, Quality attributes, Brewing methods, In-cup chemical composition

# Effect of Gammalu (*Pterocarpus marsupium*) Latex Coating on Internal and Sensory Qualities of Chicken Eggs Stored at Room Temperature

E.D.M.T. Edirisinghe[1], S.M.C. Himali[2], E.D.N.S. Abeyrathne[1]
[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Department of Animal Science, University of Peradeniya, Peradeniya, Sri Lanka*

Coating of eggs is one of the methods used to preserve egg quality and extend the shelf-life. Objective of this research was to check the suitability of *Gammalu* (*Pterocarpus marsupium*) latex as a coating material on eggs to control egg quality and sensory attributes over an extended time duration. Total of 369 eggs from 38 weeks old ISA-Shaver Brown were purchased from a government livestock farm. Eggs were individually weighed and assigned as completely randomized design to five different coating treatments as three *Gammalu* latex solutions, mineral oil (positive control) and uncoated (negative control) and stored at room temperature($27\pm2^{O}C$). The weight loss, internal quality parameters such as Haugh unit, yolk index, albumen and yolk pH values and sensory qualities of eggs were determined. Microbiological analysis was done to identify *Salmonella* in the internal contents of eggs. Only mineral oil coated eggs had significantly lower weight losses during the storage period ($p<0.05$). No significant differences in all internal quality parameters evaluated among non-coated and *Gammalu* latex coated eggs were observed ($p>0.05$). Haugh unit and yolk index decreased whereas weight loss and albumen and yolk pH values increased during the storage. Non-coated eggs changed from grade AA to C within 3 weeks. However, *Gammalu* latex maintained B grade up to 4 weeks and mineral oil maintained B grade during 6 weeks of storage periods. No significant difference in overall acceptability of hard boiled eggs after 4 weeks was observed. All coated eggs were negative for *Salmonella* indicating that eggs were microbiologically safe throughout the storage. This study demonstratedthat *Gammalu* latex coatings cannot preserve the internal quality of eggs and extend the shelf life of eggs compared to mineral oils but it has the potential for shelf-life extension for several weeks compared with non-coated eggs.

**Keywords:** *Gammalu*, Internal quality, Sensory, Chicken egg, Shelf-life

***Acknowledgement:*** *This research was supported by the International Foundation for Science (IFS) under grant E/5559-1.*

# Effect of Enrobing on Quality Traits of Chicken Nuggets Produced Using Steam Cooking and Without Steam Cooking

W.M.S. Samudini[1], D.K.D.D Jayasena[1], T.S.R. Fernando[1], W.M.N.M. Wijesundera[1], D.L.K. Athula[2], P.F.S. Pemasiri[2]

[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*

[2]*Ceylon Agro Industries, Seeduwa, Sri Lanka*

The aim of this study was to examine the effect of enrobing on quality traits of chicken nuggets produced using steam cooking and without steam cooking. Nuggets were manufactured, based on nuggets preparation procedure of Ceylon Agro Industries (pvt) Ltd, with four treatments Tr1 (initial product), Tr2 (steam cooked nugget without enrobed), Tr3 (enrobed fried nugget produced without steam cooking) and Tr4 (enrobed, fried steam cooked nugget). Nuggets were evaluated for microbiological counts, pH, colour, breading pickup and sensory properties during storage. Higher initial aerobic plate counts were recorded in uncoated nuggets same as *Staphylococcus aureus*. After 21 days, uncoated nuggets were resulted highest aerobic plate counts and *Staphylococcus aureus.* Tr4 recorded zero initial *Staphylococcus aureus* counts during storage time. The pH of the control samples in respect to the enrobed, diminished during first fourteen days of storage and then in 21 day of storage it showed an increment. Same pattern was exhibited in enrobed samples but the increment was less than the control samples. The L*, a*and b* values changed significantly ($p<0.05$) with the enrobing. Enrobed samples with their respective control ones showed an increase in redness (a* value) reduction in lightness (L* value). Moreover there was an increase in between Tr1 and Tr3 but there was a reduction in Tr2 and Tr3 in relation to yellowness (b* value). Breading pickup of the two enrobed, fried products significantly differ and Tr4 recorded significantly low ($p<0.05$) breading pickup. All the sensory characteristics were improved by enrobing in both locations, and same scores were reported in both places, except overall acceptability. These results indicate that enrobing could be used as a method of value addition for better utilization of low value meat without quality defects. In relation to steam cooking there are significant differences with quality defects but not with sensory attributes.

**Keywords:** Chicken nuggets, Enrobing, Steam cooking, Quality traits, Value addition

# Development of Ready to Serve Beverage by Using Ginger (*Zingiber officinale*) with Lime (*Citrus aurantifolia*)

R.M.M.K. Wijerathna[1], W.A.J.P. Wijesinghe[1], C.R. Gunawardhana[2]
[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Institute of Postharvest Technology, Anuradhapura, Sri Lanka*

Beverage industries always search for fruits to produce juices, blends and cordials. Producing ready-to-serve beverages now move to new concepts such as using vegetables, herbal plants and spices. People expect the easiness in every aspects of their living style. Ready-to-serve beverage is the best solution for those people. There is no any preparation after buying the ready serve product and it can be consumed as such. Ginger (*Zingiber officinale*) is an important spice as well as an important herbal plant which have many medicinal properties. Lime (*Citrus aurantifolia*) is widely grown and serving as one of the most abundant source of vitamin C and antioxidants which are beneficial to human health. Objective of this investigation was to develop a lime added ginger ready-to-serve beverage. Three preliminary trials were carried out to find out preferable level of ginger, best level of lime and best combination of lime and ginger. Best ginger and lime combination was determined by sensory evaluation using 20 semi trained panellists and five point hedonic scale. Ginger 120 mL (6%), lime 43.75 mL (2.2%), sugar 250 g (12.5%), and water 1750 mL (87.5%) was the best recipe out of three recipes. Physico-chemical properties and microbial properties were determined for the selected product. Shelf life studies of final product was carried out by analysing pH, total soluble solids, and titratable acidity at 7 days intervals for 1 and half months period and microbial analysis at 14 days interval for 1 and half month. $P^H$, total soluble solids, titratable acidity shows significant different with the storage time. Microbial amount was less than the standard limits. All the data were analysed by using MINITAB 17 statistical software. Based on the results, it can be concluded that ginger 6%, lime 2.2%, sugar 12.5% recipe has the highest sensory attributes with 1 and half months of storage period.

**Key words:** Ginger, Lime, Ready-to-serve, Sensory Evaluation

# Development of a Fruit Leather by Using Underutilized Bael (*Aegle marmelos* L.) Fruit

T.A.D.D.L. Thanaweera, W.A.J.P. Wijesinghe
*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*

Fruit leather, a dehydrated snack, has the potential to increase fruit solids consumption especially in the young. When consider about underutilized fruits, bael fruit is one of them which is highly nutritious, medically important and seasonably available fruit in Sri Lanka. A product developed through such a valuable fruit will give a great potential to be popularized among the health concerned consumers in the present world. Hence, the study was carried out to develop bael fruit (*Aegle marmelos* L.) pulp based leather using sugar, citric acid and a thickening agent as ingredients, with the aim of improving the palatability and increasing the utilization of bael fruit. The proximate composition of the final product was analyzed. The product was evaluated for quality by using its microbial, physicochemical and sensory properties. Data of sensory evaluations were statistically analyzed using Friedman non parametric test and the shelf life evaluation data were analyzed using by using one way ANOVA test with 95% confidence level. The results were revealed that the best thickening agent was corn flour and its best concentration was 2.5%. Proximate analysis of the fruit leather showed that the finally developed product contained 2% ash, 2.3% crude protein, 0.1% fat, 3.9% fiber and 8.9% moisture. According to the results the developed bael fruit leather packed in low density polypropylene (gauge 300) can be safely stored under room temperature for six weeks.

**Keywords:** Bael fruit, Fruit leather, Sensory evaluation, Shelf life

# Preparation of Set Yoghurt using Plant Originated Stabilizer as a Substitute for Gelatine

N. Thillainathan[1], M.G.C.S. Madakumbura[2], A.M.N.L. Abesinghe[1]
[1]*Department of Animal Science, Uva Wellassa University, Badulla*
[2]*Pelwatte Dairy Industries Limited, Pelwatte, Sri Lanka*

The purpose of this research is to select plant originated stabilizer for lacto-ova-vegetarian. Plant originated stabilizer was fully replaced for gelatine through that select best stabilizer from agar-agar, carrageenan and combination of agar and carrageenan. Rheological, microbiological, chemical and sensory properties of set yogurt were determined. For this study agar-agar, carrageenan and combination of agar and carrageenan were used in different concentration (0.225, 0.0725 and 80/20 with a 2% of total concentrations respectively). Agar-agar, carrageenan were extracted by using hot water extraction method. Complete randomized design was used for analysing purpose. The viscosity of samples containing agar-agar increased compared to the carrageenan and combination of carrageenan agar and carrageenan containing samples. However agar containing sample was contained low viscosity compare to the control sample (gelatine containing sample). There was a significant different between syneresis and different plant originated stabilizer contain yoghurt samples ($P < 0.05$) at $4^0$C and $25^0$C. Control samples were contained lowest syneresis at $4^0$C and $25^0$C. Yogurt treated with agar- agar gained the highest sensory score compared to the other treatments.According to the rheological andsensory properties agar- agar containing sample was selected as best sample from plant originated stabilizer containing samples. pH, total solids and titratable acidity were not big influence on agar-agar containing yogurt samples and control sample. Viscosity of control sample was increased with storage time. However viscosity of agar containing sample was not showed significant changes. pH and total solid values were drastically decreased with storage period at $4^0$C. As well as titratable acidity values were slightly increased with storage period at $4^0$C. In addition, mould, yeasts and coliform groups were not detected in samples at day 1. Coliform was not identified at the end of storage period. Yeast population was detected with storage period.

**Keywords:** Agar-agar, Carrageenan, Gelatin

# Comparison of Quality Characteristics of Leg Meat Between Sri Lankan Indigenous Chickens and Commercial Broilers at Retail

R.B.G.S.K. Rajapaksha[1], O.D. Senarathne[1], G.L.L.P. Silva[2], D.K.D.D. Jayasena[1]
[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Department of Animal Science, Faculty of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka*

With the aim of investigating the differences in the meat quality traits between Sri Lankan village chickens (VC) and commercial broilers (CB) physicochemical and sensory properties of leg (thigh and drumstick) meat from the two chicken types were assessed at their market age. Ten carcasses each from VC and CB were purchased directly from farmers who are rearing VC and from retail market, respectively. Leg meat from left half of each carcass was deboned separately, and then visible skin, fat, and connective tissues were trimmed off. Deboned meat was minced and used for analysis of proximate composition, pH, and cooking loss. The right leg of each carcass was used for analysis of color, water holding capacity, fatty acid composition, and for sensory evaluation. The results revealed that the leg meat of VC had a higher crude protein content and a lower crude fat content than CB ($p<0.05$). However, there was no significant difference in moisture and crude ash contents between the two breeds ($p>0.05$). Though VC showed lower pH and cooking loss compared to CB ($p<0.05$), the water holding capacity was not differed significantly ($p>0.05$) between the two types. The a* value was higher while L* value was lower in VC Compared to CB ($p<0.05$). This may contribute to the darker colour of leg meat from VC. The content of polyunsaturated fatty acids including linoleic acid (C18:2), eicosapentaenoic acid (C20:5), docosatetraenoic acid (C22:4), docosapentaenoic acid (C22:5), anddocosahexaenoic acid (C22:6) was higher in the leg meat of VC than that in CB ($p<0.05$). Additionally, VC had higher levels of n-3 and n-6 fatty acids ($p<0.05$). Moreover, higher taste was recorded for VC compared to CB in sensory evaluation ($p<0.05$). In conclusion, VC showed better taste and physicochemical properties compared to CB. Thus, the consumer preference for VC meat may be partially explained by these distinctive quality characteristics.

**Keywords:** Commercial broiler, Polyunsaturated fatty acids, Meat quality, Sri Lankan village chicken

# Effect of Frying in Different Cooking Oils on the Fatty Acid Profile and Sensory Characteristics of Tilapia (*Oreochromis niloticus*) Fillets

N.F.K.R. Fernando, G.G.N. Thushari, D.K.D.D. Jayasena
*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*

Fish is one of the most abundant sources of essential fatty acids. Among many fish species, Nile tilapia (*Oreochromis niloticus*) is a popular culture species in aquaculture industry and they heavily contribute to the worldwide fish consumption. Fish is mainly consumed in fried forms in many countries and the alterations in the fatty acid composition during frying process may have significant effects to human health. This study was performed to determine the effects of frying with three different cooking oils (soybean, sunflower and coconut oil) on the fatty acid profiles and sensory characteristics of tilapia fillets. Fish were purchased from local fish shop in Badulla and transported to the university laboratory under chilled condition. Tilapia fillets were deep fried in the three different cooking oils separately and the fatty acid composition of each group was evaluated using gas chromatography. The fat content of the fillets increased after frying in all evaluated samples ($P<0.05$). Mean saturated (SFA), monounsaturated (MUFA), polyunsaturated (PUFA) fatty acids, Total (∑) -3 and ∑-6 contents of raw fillets were 43.26±0.55, 29.90±1.26, 26.31±1.65, 15.43±1.17 and 10.88±0.53%, respectively. Frying led to exchange of fatty acids between the tilapia fillets and cooking oils. As a result of interactions, PUFA, ∑-6 and PUFA/SFA ratio of samples fried in soybean and sunflower oil significantly increased while the amounts of SFA decreased ($P<0.05$). Frying had a negative effect on the ∑-3, EPA and DHA amounts in all fried samples. ∑-6/-3 ratio was optimum in soybean oil fried samples while sunflower and coconut oil fried samples values were not in the recommended level to health. Frying with coconut oil showed high SFA, MUFA and low PUFA levels among all samples. In concern to sensory results, both sunflower and soybean oil-fried samples obtained positive results. By considering all the facts, soybean oil can be considered as the best cooking oil to fry tilapia fillets.

**Keywords:** Tilapia, Deep frying, Soybean oil, Coconut oil, Fatty acids

# Study on Milk Composition and Adulterants in Kandy District

A.L.Y.H Aruppala[1], U.L.P.Mangalika[2]
A.M.N.L.Abesinghe[1], M.K. Ranasinghe[1], R.R.M.K.K Wijesundara[1]
[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Veterinary Research Institute, Gannoruwa, Sri Lanka*

Dairy farmers appear to have found four ways to increase their profit margin; (i) dilution (ii) extraction of valuable components, (iii) addition of harmful preservatives (iv) a combination of (i) and (ii) with addition of bulk additives.The adulteration of milk affects the constituents in milk. Hence knowledge on these specific constituents of milk would indeed help to safeguard against adulteration of milk with various adulterants. There are few published literature regarding the milk composition and quality in Kandy district over past two decades, this survey study was carried out around Kandy district to understand milk composition, screen and determine extent of various milkadulterants. Ten chilling centres associated with collecting points were selected for the study. A total of 300 samples were collected from chilling centres. Composition and adulterants (sugar, salt, starch, formalin, neutralizers, urea, and hydrogen peroxide) were analysed following AOAC procedures and laboratory manual at Dairy Technology Laboratory of Veterinary Research Institute, Gannoruwa. Accumulating evidence has shown that average composition of milk at significance ($P<0.01$), fat percentage (4.47±0.057), protein (3.19±0.012), lactose (4.14±0.019), solid non-fat (8.14±0.046) and total solid (12.61±0.063). Minimum and maximum ranges were varied considerably in all constituents. Potassium was the highest mineral in milk with average value of 151.4±6.62mg/100ml followed by calcium (130.9±4.31 mg/100ml), phosphorus (90.52±2.85mg/100ml), sodium (55.19±2.36mg/100ml) and magnesium (13.87±1.44 mg/100ml). Among the other adulterants only water was found in majority of samples (91.60%) followed by sugar (13.7%) and salt (8.7%).

**Keywords:** Milk, Adulteration, Composition

# Quality Attributes of Selected Ginger (*Zingiber officinale*) Varieties and their Potential to Formulatea Ready-To-Serve (RTS) Functional Beverage with Lime (*Citrus aurantifolia*)

G. Hariharan, T. Mahendran
*Department of Agricultural Chemistry, Faculty of Agriculture, Eastern University of Sri Lanka*

Nutritional enhancing, health promoting and disease preventing characteristics of functional beverages are thought to boon health against degenerative diseases. Incorporation of phyto-chemicals to formulate Ready-To-Serve (RTS) functional beverage is one of the ways of value addition since the ingredients have functional properties. An experiment was conducted to select the superior ginger variety among the available ginger varieties such as Local, Chinese and Rangoon for formulation of RTS functional beverage and to select the most suitable blending ratio of ginger juice and lime juice. Different blends were prepared by mixing various proportions of ginger juice extract from 10 to 20% and lime juice extract from 2 to 10% sweetened by Palmyra sugar candy. Average weight of rhizomes was higher in Chinese variety (46.81g) than Rangoon (35.23g) and Local (27.56g) varieties. The juice percentage of Chinese variety was comparatively higher (88.39%) than Rangoon (73.24%) and Local (61.52%) varieties. Ginger juice extract of Local ginger variety had a higher mean score for Total Soluble Solids (2.81°Brix) than Rangoon (2.54°Brix) and Chinese (2.32°Brix) varieties. On a 7-point hedonic scale, Local variety was found to be superior in sensory scores for colour (5.7), aroma (5.6) and overall acceptability (5.7). Chinese ginger variety had a higher mean score for pungency (4.2) compared to other tested varieties. The results indicated that Local variety was superior to Chinese and Rangoon varieties to formulate RTS beverages. Freshly made formulations showed a gradual increase in titratable acidity from 0.22 to 0.52% (as % of citric acid), Total Soluble Solids from 12.6 to 16.8°Brix, ascorbic acid from 12.4 to 56.9 mg/100 ml and total sugar from 16.6 to 20.39% and gradual decrease in pH from 6.63 to 3.11 with increase in lime juice extract from 2 to 10%. It was concluded that functional beverage with 12% of ginger juice and 8% lime juice, sweetened by Palmyra sugar candy was the best formulation and could be stored at 30±1°C temperature and 70-75% of RH for a period of 12 weeks without any significant variations in quality attributes.

**Keywords:** Functional beverage, Ginger, Lime, Palmyra sugar candy, Phyto-chemicals.

# Prevalence of Pale, Soft, and Exudative (PSE) Condition in Chicken Meat in a Commercial Meat Processing Plant and Its Effect on Roasted Chicken Breast

K.A.D.S. Karunanayaka[1], J.M.P. Jayasinghe[1], B. Liyanarachchi[2], D.K.D.D. Jayasena[1]
[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Gills Food Products (Pvt) Ltd, Wattala, Sri Lanka*

Pale, soft, exudative (PSE) condition is a growing problem in the broiler industry and it results in PSE meat with pale color, low water holding capacity, and softer texture. Pre slaughter handling, post mortem factors, and genetics are the main predisposing factors contributing to PSE condition in meat. This condition affects the product yield and quality. The objectives of this study were to determine the incidence of PSE chicken meat in a commercial meat processing plant and to find out its consequences on the meat quality traits of roasted chicken breast. A total of sixty breast fillets were randomly selected and evaluated based on color and placed into one of two categories, PSE or normal. A total of 20 breast fillets (10 PSE and 10 normal) were analyzed for color, pH, and water holding capacity. After processing them into roasted chicken breast, cooking loss, color, pH, water holding capacity and texture of samples were evaluated. Sensory evaluation was done using 30 untrained panellists. The incidence of PSE meat was 70% in the experiment. The PSE fillets were significantly ($p<0.05$) lighter and had a lower pH compared to normal fillets. The negative correlation between the lightness and pH was significant. There was no significant difference in color, texture and water holding capacity when fillets were processed into roasted chicken breasts. However, results showed an approximately 3% cooking loss in PSE meat. Moreover, cooking loss and lightness values showed a significant positive correlation. Nevertheless there were no significant differences in sensory parameters among normal and PSE chicken meat. These results indicated that although significant color differences were not detected between PSE and normal meat after roasting, it may cause economic losses due to significantly higher cooking losses.

**Keywords:** Color, pH, Water holding capacity, Cooking loss, PSE

# A Comparative Study of Phytochemical, Proximate and Mineral Compositions of Different Selections of Dried Goraka (*Garcinia quaesita*) Fruit Rinds in Sri Lanka

K.K.I. Jayasundara[1], W.A.J.P. Wijesinghe[1], T. Liyanage[2]
[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Department of Export Agriculture, Central Research Station, Matale, Sri Lanka*

Goraka (*Garcinia quaesita*) is a multi- purpose and endemic tree species bearing economical important edible fruits. Objective of this study was to investigate the comparative phytochemical, mineral and proximate contents between four *Garcinia quaesita* selections namely Ovilikanda I, Ovilikanda II, Gasnawa and Aranayaka I that were cultivated under similar agro climatic conditions in the nursery farm of Department of Export Agriculture, Gasnawa. Standard Analytical procedures were followed to analyze phytochemical, mineral and proximate compositions. The phytochemical analysis suggested a quantitatively higher percentage of hydroxycitric acid content in Aranayaka I selection than other selections. Flavonoid content was significantly ($p < 0.05$) higher in Ovilikanda I than other selections. The results of proximate analysis revealed that Ovilikanda I was richer in acid insoluble ash and dry matter while Gasnawa selection exhibited greater amounts of crude fat and crude protein. Significantly ($p < 0.05$) higher amounts of crude protein and nitrogen contents were found in Aranayaka I selection while Ovilikanda II selection exhibited the highest total ash content. In mineral analysis, significantly higher amount of magnesium was observed in Ovilikanda I, while Ovilikanda II contained highest amount of phosphorous. Gasnawa selection contained significantly ($p < 0.05$) higher amount of potassium and Aranayaka I contained higher amount of sodium than the other selections.

**Keywords:** Goraka, *Garcinia quaesita*, Phytochemical analysis, Fruit rind, Mineral

# Development of a Wine from Water Melon (*Citrullus lanatus*): A Value Added Product from a Tropical Fruit Crop in Sri Lanka

G.H. Jayawardana, A.P. Henagamage
*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*

Wine is generally produced by the fermentation of fruit juice with yeast (*Saccharomyces cerevisiae*). Ripened fruits have natural sugar, natural acids and pectinase enzyme which ultimately enhance the quality of the product. The quality and the type of commodity dictate the final quality of the fruit- based wine. Hence, the selection of correct fruit commodity is critical in wine making. It has been found that the Jambola (*Citrus grandis)* peels have high amount of pectinase content which has the potential to enhance quality of fruit beverages. Thus, this study was focused to develop a wine from watermelon using baker's yeast and to evaluate the effect of Jambola peels to enhance the quality of the wine. Fruit juice was extracted by crushing the flesh from completely ripened water melon. Quality parameters such as Total Soluble Solid (TSS) and Titratable Acidity (TA) were adjusted by adding 250g sugar and 2.8g of Citric acid for 6litre of solution to prepare for the fermentation. The prepared fruit juices were allowed for fermentation for four weeks with and without treating Jambola peels and by adding baker's yeast. Quality attributes such as pH, TA, TSS and alcohol content were measured using standard protocols. Sensory attributes were evaluated and analyzed using Friedman Test (MINITAB, version 16). Mean TSS and mean TA values of the wine treated with jambola peels were significantly higher ($P < 0.05$) than that of the wine without treating jambola peels. Wine sample treated with Jambola peels was the best with respect to aroma ($p = 0.000$), taste ($p = 0.006$), colour ($p = 0.006$), and overall acceptance ($p = 0.025$) except texture ($p = 0.72$). Further, final mean alcohol percentage of the selected water melon wine sample treated with jambola peels (10.32 %) was in the acceptable range compared to standard wine (9.0- 13.50%). Therefore, water melon wine developed with jambola peels can be recommended as the best wine since it has high quality attributes and high sensory attributes compared to the standard wine and has a potential to improve as a commercial wine.

**Keywords:** Watermelon, Baker's yeast, Sensory evaluation, Citrus

# Determination of Residual Nitrite Levels in Chicken Sausage for Safe Consumption

K. Sivarajah[1], N. Edirisinghe[2], H. Ariyasena[2], D.K.D.D. Jayasena[1]
[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Cargills Quality Foods (Pvt) Ltd, Ja-Ela, Sri Lanka*

Nitrite is a precursor of carcinogenic N-nitrosamines during processing of meat products or under human stomach conditions, as well as having its own toxicity. The factors affecting purchasing and consumption of meat and meat products are diverse and complex. The objective of this study was to determine the addition of minimum residual nitrite salt to chicken sausage and determine the safe consumption by analysing microbial count including *Clostridium botulinum*. During this study, different amount of nitrite salt (90 ppm, 112.5 ppm, 125 ppm and 175 ppm) and nitrate salt (90 ppm, 112.5 ppm, 125 ppm and 175 ppm) were added for chicken sausage samples and stored at $-5^0$ C. Residual nitrite level was tested at day 1, day 15 and day 30 at $-5^0$ C by photo electro colourimeter to determine the minimum effective residual nitrite level for causing food borne disease by *Clostridium botulinum*. Ingoing nitrite level and nitrate level as 90 ppm was considered as a control in this study. Total plate count, *Staphylococcus aureus*, Total coliforms and *Escherichia coli* were checked weekly. Colour analysis, Lightness (L*), redness (a*) and yellowness (b*) values were analysed at day 1 and day 30. pH was analysed at day 1 and day 30. Sensory analysis was done by using 7-point hedonic scale for 30 untrained panellists. Highest score was gone to 112.5 ppm nitrite and nitrate salt added for all the sensory parameters. Data was subjected to analysis of variance (ANOVA) with $P<0.05$ significant level by SAS. Duncan Multiple Range Test was performed to compare the mean value. The results revealed that residual nitrite level range from 4.55 ppm to 12.7 ppm was free from *Clostridium botulinum.* The results of the Total plate count, *Staphylococcus aureus*, Total coliforms and *Escherichia coli* revealed an acceptable limit of microbiological situation.

**Keywords**: Residual nitrite, *Clostridium botulinum*, *Staphylococcus aureus*, *Escherichia coli*

# Effect of Melting on Flavor Granules Used in Flavored Tea Bags

A.B.K. Chandrasir[1], S.M I.P.G. Bandara[1], P.D.P.M.D. Silva[1],
K.D.K. Wanasinghe[2]
[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka,*
[2]*BPL Teas Privet Limited, Colombo 05, Sri Lanka*

Flavored tea highly contributes to the value added exports and causes high revenue to the county. Sri Lankan value added tea in total tea exports increased slightly from 39%to 42% in 2014.Although flavors play a big role in the value addition process, hygroscopic property of black tea, hot and humid environment may cause a deleterious effect for the final products. The main quality problem found in flavored tea is melting of flavor granules during the storage and transportation, leading to quality failure and the final product, therefore, is not in compliance with the expected standard. This research was focused to determine the effect of temperature, relative humidity and the storage time of the product on melting of three types of flavor granules such as strawberry, forest fruit and honey. The melting effect on flavor granules was assessed under three levels of temperature ($28 \pm 2\ ^{o}C$, $33 \pm 2\ ^{o}C$, $38 \pm 2\ ^{o}C$) and three levels of relative humidity ($58 \pm 2\%$, $68 \pm 2\%$ , $78 \pm 2\%$), altogether as nine treatments. The physical state of flavor granules was observed during the six weeks for three months. Binary logistic regression is used to identify the relationship between the predictors and the prediction. Results revealed that temperature, relative humidity affected significantly on melting of flavor granules. Storage time also had a significant effect on melting of strawberry flavor granules and honey flavor granules. Flavor melting indicated a significant increase with the increase of temperature and relative humidity. Keeping relative humidity at 58±2 % and temperature at $28 \pm 2^{o}C$ is the best level in order to mitigate the amount of melting of flavor granules used in black tea.

***Keywords***: Black tea, Flavor granule, Liquid flavor, Relative humidity, Temperature

# Developing a Spectroscopy Technique to Determine Nitrate in Milk, which can be used as Confirmatory Test for Water Adulteration

P.N.K. Herath[1], U.L.P. Mangalika[2], R.R.M.K.K. Wijesundara[1]
[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Veterinary Research Institute, Gannaoruwa, Sri Lanka*

Cow milk contains numerous nutrients, therefore, it is identified as one of the most important food nutrient source besides breast feeding for infants and babies. Additionally, it is a good source to fulfill the nutrients for adults to meet their body requirements. However, farmers augment milk with water to surge the quantum of yield to get a better income. To mitigate the issue and to maintain the quality of milk, a simple spectrophotometric method was developed to assess the nitrates in milk and to use as a confirmatory test for water adulteration. Preliminary test was conducted at Veterinary Research Institute, Gannoruwa with thirty total milk samples (n=30) from Kandy district. It was observed that in15 ordinary milk samples,nitrate concentration ranged from 10ppm – 40ppm. Whereas, pre identified water adulterated 15 samples gave nitrate concentration more than 40ppm. The concentrations were statistically analyzed using paired *t*-test with a hypothesis to identify the nitrate difference of ordinary milk and water adulterated milk, this gave a *p* value of 0.000 which is less than 95% significance level and can conclude that with the water adulteration nitrate concentration in milk samples increase. Correlation between water adulteration and nitrate concentration was identified using Pearson Correlation. As a preliminary step Jaffna deep well water (130.0ppm) and Anuradhapura deep well water (20.18ppm) were added to a nitrate concentration known milk sample (28.96ppm). For Jaffna well water there was a strong positively correlation (R= 0.995). However for Anuradhapura well water, there was a negative correlation (R= -0.898). According to the present study, we were able to identify that, nitrate concentration in milk changes with water adulteration. Therefore, this method can be used as an accurately and prompt method to determine water adulteration in milk. Nitrate has an impact on human health as it is carcinogenic and also can cause bluebaby syndrome in babies. Therefore this technique can be used to determine nitrate in milk throughout the country, with that the government can make a Sri Lankan standard for the nitrate amount in fresh milk.

**Keywords:** Nitrate, Cow Milk, Spectrophotometer, Water adulteration

# Comparison of Quality Characteristics of Breast Meat between Sri Lankan Indigenous Chickens and Commercial Broilers at Retail

O.D. Senarathne[1], R.B.G.S.K. Rajapaksha[1], G.L.L.P. Silva[2], D.K.D.D. Jayasena[1]
[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Department of Animal Science, Faculty of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka*

With the aim of investigating the differences in the meat quality traits between Sri Lankan Village Chickens (VC) and Commercial Broilers (CB), physicochemical and sensory properties of breast meat from the two chicken types were assessed at their market age. Ten carcasses of VC were directly purchased from farmers rearing VC at Karuwalagaswewa and ten carcasses of CB were purchased from local market. Breast meat from each carcass was dissected. After trimming off visible skin, fat, and connective tissues, left half of each breast was minced separately and used for analysis of proximate composition, pH, and cooking loss. The remaining half of each breast was used for analysis of colour, water holding capacity, fatty acid composition and for sensory evaluation. Data analysis was done using SAS programme version 9.1. Breast meat of Sri Lankan VC had a higher crude protein content and a lower crude fat content than CB($p<0.05$). However, no significant differences were observed in moisture and crude ash contents between the two types ($p>0.05$). Sri Lankan VC showed lower pH values in breast meat than CB, however the cooking loss and water holding capacity of breast meat were not differ significantly ($p>0.05$) between the two type. The L* values of breast meat from Sri Lankan VC were higher ($p<0.05$) while a* and b* values were lower ($p<0.05$) than those of CB. The content of polyunsaturated fatty acids in the breast meat including linoleic acid (C18:2), eicosapentaenoic acid (C20:5), docosapentaenoic acid (C22:5), anddocosahexaenoic acid (C22:6) was higher ($p<0.05$) in Sri Lankan VC than that in CB. Additionally, Sri Lankan VC had higher ($p<0.05$) levels of n-3 and n-6 fatty acids. Results of sensory analysis revealed that breast meat of Sri Lankan VC had higher scores for taste, tenderness, and overall acceptability($p<0.05$). In conclusion, Sri Lankan VC showed better physicochemical and sensory attributes than CB. Thus, the consumer preference for Sri Lankan VC may be partially explained by these distinctive quality characteristics.

**Keywords:** Commercial broiler, Polyunsaturated fatty acids, Meat quality, Sri Lankan village chicken

**Technical Session II**

# Food Science and Technology

## Poster Presentations

# Development of A Fish Burger Incorporating Sea Lettuce (*Ulva lactuca*) and Catla (*Catla catla*)

R. N. C. Kumarathunge, E.D.N.S. Abeyrathne
*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*

Catla fish has limited scope for consumption due to presence of intermuscular bones. This investigation was carried out to develop high protein and fiber containing ready to eat catla fish burger, incorporating seaweed (*Ulva lactuca*). Control fish burger was prepared without adding seaweed. Recipe development was carried out with different levels of spices. Suitable amount of spices were determined by preliminary trials. Four different levels (0.5%, 1%, 1.5% and 2%) of *Ulva lactuca* powder were tested. On the basis of sensory evaluation results; 0.5% (w/w) incorporated seaweed sample was found suitable due to significance difference ($p<0.05$) in taste, color, flavor, appearance and overall acceptability. Cooked burgers were packed in polyethylene bags in safety manner for further use. Proximate analysis revealed that seaweed incorporated fish burger contains higher amount of protein and fiber compared to regular fish burgers. Color of the burgers treated with seaweed (*Ulva lactuca*) showed significant difference for a* value compared with control. Shelf life studies were carried out by using microbiology and pH tests. The present study of seaweed incorporated fish burger showed slightly increased in pH from 5.47-6.47 up to 14th day where no significant increase observed ($p>0.05$). When pH of the control burger ranging from 6.16-6.6 stored at freeze temperature ($-18^0$C). E.*coli* and *Salmonella* they did not present in the both seaweed incorporated and control burgers which were negative in samples because of the hygienic preparation, handling of product and it is not subjected to cross contamination. Proximate composition of seaweed incorporated catla fish burger recorded as 62.83%, 16.25%, 2%, 12.43%, and 7.21% respectively for crude moisture, protein, fiber, fat and ash. It can be concluded that 0.5% (w/w) *Ulva lactuca* incorporated fish burger increase not only the protein and fiber content but also it fulfil the nutritional requirement of consumer.

**Keywords:** Fish burger, *Catlacatla*, Seaweed powder; *Ulva lactuca*

# Development of a Ready to Eat Breakfast Cereal with Incorporating Ovalbumin from Chicken Egg White

R.D.I.P. Randeniya, E.D.N.S. Abeyrathne
*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*

Ovalbumin incorporated breakfast cereal is a good source of protein with several functional properties. Shrinking the daily protein intake through breakfast associate with daily cognitive functions and obesity in long term. Formulation of breakfast cereal carried out several preliminary trials with different percentages of rice flour, chickpea, mung, cowpea, maize, skim milk powder and ovalbumin. Breakfast cereal was achieved by mixing 20 % rice, 6.67 % maize, mung pea, cowpea and sugar, 12 % chickpea, 3.34 % skim milk powder and ovalbumin, 0.67 % salt and vanilla with 33.3 % water. Protein content of the formula was reported as 15.12±0.53 % and protein calories reported high value of 17.34 % from total energy. Moisture and ash contents were noted to be high and low in fat (4.32±0.65%) content. High value of Bulk Density of 0.67±0.03 g/ml reported with desirable packing abilities. Lower water absorption capacity (WAC) 144.58±0.16 g/100g, of the product is desirable for nutrient uptake. High lightness and yellowness with low redness was reported (a*-3.96±0.36, b*-35.20±0.56 and L*-69.20±1.12), which results a desirable appearance. Microbiological count (Total Plate Count) was not exceeded the recommended level of ready to eat products up to forth week under room temperature storage condition. There was no *Salmonella* or coliform reported with same storage conditions. pH of the product did not vary with the period measured ($p>0.05$). Based on those facts this ovalbumin incorporated breakfast cereal can recommended as a good protein diet with low fat for adults and adolescent.

**Keywords**: Breakfast cereal, Ovalbumin

# Drying of Green Mango Pulp: Effects of Processing Methods on Product Quality and Shelf Life

T. Mahendran, G. Hariharan, V.S. Krishnapillai
*Department of Agricultural Chemistry, Faculty of Agriculture, Eastern University, Sri Lanka*

Mangoes (*Mangifera indica* L.) are consumed as ripe and unripe fresh fruit as well as various processed products. The processing not only adds value to the products, but also makes the products more convenient to the consumers. Green mango powder is used to add sour fruity flavor in stir-fried dishes, soups, curries and add the nutritional benefits of mangoes when the fresh fruit is out of season. The objective of this research was to define the methodologies for the processing of green mangoes into powder and to monitor the products after processing through physico-chemical, microbiological and sensory evaluation. Green mango (*cv: Haden*) powders were produced using tunnel drying, vacuum oven drying and spray drying and the quality characteristics were assessed in 2 weeks interval for a period of 3 months. The moisture content of the green mango powder ranged from 1.41 to 3.94% on dry weight basis. During drying, a significant reduction ($p<0.05$) in titratable acidity of 23% and increase in pH of 0.62 units after vacuum drying of mango indicated that some acids were lost due to evaporation during drying. The oxidative loss of ascorbic acid after vacuum drying was 24.1% which was higher than the tunnel drying (14.6%) and spray drying (7.2%) with 80% mango pulp + 20% maltodextrin additive. The maltodextrin formed a film around the mango solids that facilitated the production of non-hygroscopic and fine flowing powder. Microbiological studies revealed that there was no total plate count observed in the dried samples following storage. Ready-to-serve (RTS) green mango beverages were prepared from dried powders and were compared with those prepared from fresh mangoes.The sensory evaluation revealed that there were significant differences ($P < 0.05$)in colour, sweetness, flavour, consistency and overall acceptability between the treatments. Reduction in maltodextrin concentration improved the solubility of the mango powder, when 20% maltodextrin was added to mango pulp, the solubility of powder was 95% whereas adding 40% maltodextrin decreased the solubility to 86%. Based on the results, the spray drying is the best method for producing green mango powder with good nutritional quality and high storage stability.

**Keywords**: Green mango powder, Maltodextrin, Nutritional quality, Sensory analysis, Spray drying.

# Development of a Prawn Flavored Spicy Cracker with Prawn Waste and Drumstick Leaves

A.M.L.K. Martyn, E.D.N.S. Abeyrathne
*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*

Prawns are very important aquatic products in Sri Lanka. Prawn industry wastes are used as value-added human food, fish feed or to extract chitin. This research intended to produce high protein spicy prawn cracker with prawn waste and drumstick leaves. Prawn industry wastes (head, appendages, carapaces, and shell) were thoroughly washed, dried in hot air oven at 80°C for 4 hours and ground by a blender. Fine prawn head waste powder thus obtained was used for producing prawn crackers. Drumstick leaves were wilted for 5 days at the room temperature and finely ground. Wheat flour, rice flour, vegetable oil, salt, dry yeast, pepper, water were mixed to make a dough. According to the sensory results 2% (w/w) prawn head waste powder and 1% (w/w) drumstick leaves powder was selected as the best. The dough was cut into pieces of square shapes and put into the oven at 180°C - 200°C for 8-10 minutes. Nutrition evaluation of prawn cracker was total carbohydrate 62.34%, crude protein 13.06%, crude fat 15.8%, ash 2.40% and crude fiber 2.50%. pH of the product did not significantly vary within the measured period (around pH 7). Microbiological analysis reveals that the product is within the SLSI limits in room temperature up to 14 days. Hygienic handling practices and proper packaging will increase the shelf life. This research revealed that high quality protein fortified prawn crackers could be manufactured from unutilized prawn wastes. Finally the development procedure can be scale up and can increase the shelf life with introducing proper packaging materials.

**Keywords:** Prawn head waste powder, Drumstick leaves powder, Prawn cracker

# Comparative Study of Proximate Composition of Palmyrah *Pinattu* and Flour (*Odiyal, Boiled odiyal*)

S. Srikantharasa[1], S. Mahilrajan[2], W.A.J.P. Wijesinghe[1], S.M.I.P.G. Bandara[1], S. Sri Thayalan[2]

[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Palmyrah Research Institute, Jaffna, Sri Lanka*

Palmyrah (*Borassus flabellifer)* palms can be considered as a gift of nature as they contribute wide range of vital products for human diet and existence. Among palmyrah products fruit and flour are highly utilized by local population. Fruits are mostly used as fresh, because of its perishable nature it is traditionally preserved as dried fruit pulp leather called as *pinattu*. Palm produces two types of flour such as *odiyal* (Dried tuber) and *plukodiyal* (boiled and dried tuber) flour. In this study the proximate composition of palmyrah *pinattu* and flour were evaluated. Samples were collected from the three different branches of Palmyrah Development Board and used for the analysis.There were no significant different between moisture content of the boiled *odiyal*flour [11.66± (0.001)] and *odiyal* flour [10.66± (0.001)] while *pinattu* showed [16.6± (0.008)] %. Protein content of boiled *odiyal* flour [6.51±0.062] and *odiyal* flour [6.7813± (0.06)] were significantly higher when compared with *pinattu* [2.23± (0.062)] %. As well fat content of *odiyal* flour was 0.43±0.013 g/100g and that was significantly higher than boiled *odiyal* flour and *pinattu*. Significantly higher amount of ash was observed in *pinattu* [0.04±(0.001)]when compared with flour. Boiled *odiyal* flour [7.13±(0.18)] contained significantly higher crude fiber content than *odiyal* flour [4.49±(0.15)] and *pinattu* [5.06±(0.01)] g/100g. Carbohydrate content was significantly higher for *odiyal* flour [77.59±(0.5)] when compared with *pinattu* [75.91±(0.61)] and boiled *odiyal* flour [74.37±(0.65)] g/100g. This study was suggested that proximate composition of *pinattu* and flour were varies and which were good source of fiber and protein.

**Keywords:** Boiled *odiyal* flour, Palmyrah, *P*inattu

# Developing a Filling Solution Using Different Filling Media and Spices for Canning Skipjack Tuna (*Katsuwonus pelamis*)

G.L.W.Niroshani, K. Kahaduwa, E.D.N.S. Abeyrathne
*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*

Skipjack tuna is one of the excellent sources of protein, fat, polyunsaturated fatty acids, vitamins, and minerals. Present study was conducted to develop a filling solution for canning skipjack tuna using oil and spices. Preliminary trials were conductedwith 30 untrained panelists to find out the best spice level to adjust the flavor in the canned product. After selecting the correct formula, final canned fish was prepared. Shelf life studies were carried out by using microbiological tests, pH test and lipid oxidation analysis. In order to impart a proper flavor to the skipjack tuna canned in oil, 2% (w/w) salt, 2% (w/w) pepper, 1.5% (w/w) cardamom, and 1% (w/w) cinnamon were selected as the best levels ($P<0.05$). Soya bean oil was selected as the best oil type for the canning skipjack tuna comparing with palm oil, sunflower oil, virgin coconut oil, and corn oil ($P<0.05$). A comparative study was done for the proximate analysis. It revealed that there is a significant ($P<0.05$) difference for all the physico-chemical properties of skipjack tuna canned in water with spices and soya bean oil with spices. Skipjack tuna canned in water with spices had a higher moisture content. Protein, fat, and ash content were high in skipjack tuna canned in soya bean oil media. Total viable counts were generally low. Coliforms and *Salmonella* were absent for all the samples. pH and the lipid oxidation results revealed that the skipjack tuna canned in water with spices and oil with spices were within the standard values. Considering the nutritional properties was recommended to choose skipjack tuna packed in water, not oil since tuna packed in water had less fat and calories. But both products can be used as a ready to eat fish product for consumers.

**Keywords:** Skipjack tuna (*Katsuwonus pelamis*), Soya bean oil, Nutritional benefits

*Acknowledgement : Happy Cook Lanka Food (pvt)Ltd, Magalle, Galle 80000, Sri Lanka.*

# Value Addition to Off Grade Tea by Incorporating Tea Aroma

V.P. Ellepola[1], K.G. Premathilake[1], P.D.P.M.P. De Silva[1], Ajith Chitty[2]
[1]*Departmrnt of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Eastern Brokers (Pvt) Ltd., Sri Lanka*

Considerable amount of volatile compounds which formed up to fermentation process are lost during drying. An experiment was conducted to study how to make use of, amount of volatiles formed during fermentation process of tea to enhance the organoleptic attributes of off grade tea. Experiment was conducted at Rozella tea factory, Watawala. After extracting aromatic volatiles from fermented tea dhools, concentration of the extract, was enhanced. The developed treatment was then used to add value to off grade tea and sensory evaluation was conducted. Then moisture content of the developed teas were recorded. Off grade tea incorporated with 1% of non-concentrated volatile sample and, 0.5 % of concentrated volatile sample were identified as the best treatments. Treatments had a significant impact on the development of aroma, flavour and quality traits. Hence, the study proves that resupplying of volatile compounds to off grade tea is found to be a good approach to add value to off grade tea.

**Keywords:** Tea Aroma, Tea off grades, Volatile compounds, Value addition

# Assessment of Microbiological Quality in Set Yoghurt Production Line at a Commercial Dairy Processing Plant

T.D.W. Ranasinghe[1], M.G.C.S. Madakumbura[2], E.D.N.S. Abeyrathne[1]
[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Pelwatte Dairy Industry Limited, Buttala, Sri Lanka*

A study was conducted to find out microbial contaminations, sources and preventive measures in the set yoghurt production line in Pelwatte Dairy Industry Limited (PDIL) at Buttala. Samples were collected at all the processing steps and from raw ingredients and UV splash water. Swab samples were collected from processing vats, CIP tank and permanent workers' hands. Air samples were taken from Air Condition (A/C) plant, table fans and yoghurt filling area. Quality of samples was assessed using microbiological (total colony count, *Coliform*, yeast and moulds) properties. Pasteurized yoghurt mixture samples (sorbate added mixture, culture inoculated mixture and filling mixture) were detected after an effective pasteurization process (92°C, 5 minutes). Further analysis of contamination points showed the presence of yeast and mouldin the air samples, UV splash water and swabs of the exposed processing vats such as balance tank and CIP tank. However, the enclosed processing vats such as mixing vat and filling vat were free from yeast and mould after CIP cleaning using sterilized UV splash water (100°C, 2 minutes) as final rinsing agent. Balance tank was always exposed to the outer environment during manufacturing process and culture inoculation vat was opened twice after CIP. Yeast and mould were detected in both vats. Yeast and mould were consistently detected in air samples and simultaneously the swabs of permanent workers' hands. Table fans were close to workers and filling area. Hence, it can be concluded that air obtained from A/C plant and fans was the contamination source of yeast and mould. Microbiological quality of set yoghurt can be improved by using clean and proper ventilation, minimizing the exposure of processing area to outer environment and frequent cleaning of air filters in A/C plant, while maintaining the basic manufacturing steps.

**Keywords:** Set yoghurt, Microbial contaminations, Sources, Air

# Determination of the Effect of Water Quality on the Sensory Properties of Tea Liquor

R.N.D.S. Ruwanpura[1], A.G.A.W. Alakolanga[1], M. Wanniarachchi[2]
[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Ceylon Fresh Teas (Pvt) Ltd., Sri Lanka*

Tea is an aromatic beverage which is demanded by consumers because of its unique taste, color and aroma also known as sensory properties of tea liquor which are influenced by several factors. The major ingredient of beverage tea is water and therefore water used to brew tea can be on sensory properties. This study was therefore, conducted to find out whether there is an effect of water quality on tea liquor properties by analysing most important water quality parameters to develop a profile of suitable water for brewing of tea comprised with optimum ranges of these water quality parameters. In this view, ten water samples were obtained from ten DS divisions of each Matara, Colombo, Ratnapura, Puttalam, Anuradhapra and Kandy districts were analyzed. This study was conducted in two steps; a sensory evaluation of teas of DUST 1 grade prepared with different water was conducted by trained panellists and a water analysis to determine the pH, Total hardness, total alkalinity, phenolphthalein alkalinity, EC andTDS. Results of water analysis showed, values for all the selected water quality parameters within districts as well as among districts were varied significantly. Therefore, it is evident that the water quality in terms of these parameters is varied within a district as well as among districts substantially. Average ranks obtained from sensory evaluation data varied pertainingto thearea hence, concluded that the area used to obtain water for brewing of tea has a significant effect on the sensory properties of tea liquor.Teas prepared from the water obtained from Deniyaya, Devinuwara, Mulatiyana, Rathnapura, Godakawela, Pelmadulla,Moratuwa, Kotte, Thimbirigasyaya, Kesbewa, Nattandiya, Dankotuwa, Rajanganaya, Thalawa, Mihinthale, Ganga IhalaKorale, Panwila, Yatinuwaraareas showed highest average ranks hence can be concluded as good in quality. Results shows a negative relationship between total hardness, electrical conductivity and total dissolved solids contents of water and tea liquor properties, yet the relationship between pH and total alkalinity parameters with tea liquor properties is insignificant. Results of the study concludes, liquor properties of tea are affected by water quality in terms of water hardness, conductivity and total dissolved solids. Approximately, total hardness of 25-218 ppm, electrical conductivity of 5.45-86 µs/cm and total dissolved solids of 3.27-51.6 ppm ranges are preferable for brewing of tea.

**Keywords:** Water quality, Tea liquor Properties, Water quality parameters

# Study of Egg External Quality Traits in Five Korean Native Chicken Strains Reared Under Controlled Environment

S.S. Wickramasuriya[1, 2], H.I. Wijayananda[2], J.M. Heo[1]

[1]*Division of Animal and Dairy Science, Chungnam National University, Daejeon 34134, Republic of Korea*

[2]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*

A total of 240 Korean native chickens in five different (GS-08, GS-10, GS-12, GS-17 and GS-21) strains were used to evaluate strain effect on external quality parameters of egg. Birds were allocated in a completely randomized design (60 cages: 12 replicates with 4 chickens per cage) in their respective controlled environment. All birds were subjected to the same commercial feeding and standard management practices during the rearing period. At the 32 weeks of age, randomly selected 150 eggs (30 eggs per each strain) from total egg collection were used to analyze external quality parameters. The results indicated that significant difference ($P<0.05$) in egg weight, egg shell color, egg shell strength and shell density among the five Korean native chicken strains. No differences were found ($P>0.05$) egg length, egg width, egg shape index and egg shell thickness of the five Korean native chicken strains. Our results indicated that the five Korean native chicken strains would have an interconnection with their external quality parameters of egg.

**Keywords:** Egg, External quality parameters, Korean native chickens

***Acknowledgement:*** *This study was funded by grants from the Golden Seed Project (No 213005043SBD30, Korea Institute of Planning & Evaluation for Technology in Food, Agriculture Forestry & Fisheries), Republic of Korea.*

# Comparison of Quality Traits of Breast Meat from Spent Hen and Broiler Chicken

J.A.P.P. Lakshani, D.K.D.D. Jayasena
*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*

Meat is the edible post-mortem component originating from live animals. It contains high biological value protein, iron, essential fatty acids and vitamins. Broiler chicken is the commercial chicken, which are raised because of fast growing rate and has high valuable market demand and price. Spent hens are the birds which finished the productive first laying cycle. Farms have problems in selling these birds in considerable price and used for different processing. The objective of this study was determined the differences in physical, chemical and sensory properties of breast meat of spent hen and broiler chicken. Carcasses of broiler chicken were purchased from local market in Badulla and spent hen from Seven Hills farm in Maskeliya. Collected and dissected breast fillets were stored under refrigeration condition (-20 $^0$C) and excess fat and connective tissues were trimmed off before mincing. The results indicate that broiler breast fillet contained higher moisture content ($p<0.05$) compared to spent hen chicken, but higher protein ($p<0.05$) content was observed in breast fillet of spent hen chicken. Monounsaturated Fatty acids (MUFA) content was higher ($p<0.05$) in broiler chicken compared to the spent hen chicken, while Polyunsaturated Fatty acids (PUFA) content was lower ($p<0.05$) compared to the breast fillet of spent hen chicken. Myristic acid, eicosapentaenoic acid, docosatetraenoic acid and docosahexaenoic acid contents were higher ($p<0.05$) in spent hen chicken compared to the broiler chicken, although palmitoleic acid, vaccenic acid, oleic acid and linolenic acid contents were higher ($p<0.05$) in broiler chicken than spent hen chicken. Omega 6 to omega 3 ratio was higher ($p<0.05$) in broiler chicken. Higher ($p<0.05$) colour value (L*) and cooking loss value was found in spent hen chicken and breast fillet of broiler chicken contained higher ($p<0.05$) pH value compared to the spent hen chicken. In sensory evaluation there is no significance difference ($p>0.05$) between sensory parameters of breast fillets of two chicken species. In conclusion broiler chicken contained higher pH, moisture, MUFA and good to be consume because of SFA content is low. Spent hen chicken meat also good to be consume because of good source of protein and PUFA content is low.

**Keywords:** Broiler, Fatty acids profile, Physiochemical properties, Sensory characters, Spent hen

# Evaluation of the Quality Traits of Pork from Cross Bred Local Pigs under Free Range and Semi Intensive Systems

R.H.A.K.N. Ranasinghe, D.K.D.D. Jayasena
*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*

This study was done to evaluate the meat quality, composition and sensory parameters of pork obtained from two different rearing systems. Four semi-intensively reared and four extensively reared finishing pigs were used to determine the meat quality parameters. The extensively reared pigs were subjected to walk around the day time and also during night. Swill feeding was done for both rearing systems. *Longissimus dorsi* muscle from each animal was taken just after slaughtering. Quality traits of pork (pH, colour, water holding capacity, cooking loss) and proximate composition (protein, fat, moisture, ash) were evaluated using standard methods while fatty acid profile was measured using Gas Chromatography. A sensory evaluation was done using 30 untrained panellists. Data were analysed using Statistical Analysis System, version 9.1. The rearing system had no influence on water holding capacity, colour, pH and cooking loss ($P>0.05$). The redness (a* value) of meat from extensively reared pigs were not significantly different from that from semi-intensively reared pigs. This is due to the less amount of difference in exercise gained in two rearing systems. The amount of exercise is not enough to increase the myoglobin content in pork from extensive rearing system. The protein, fat, moisture and ash contents were not significantly different between the pork taken from semi-intensive and extensive rearing systems. There was a significant difference in vaccenic acid and total monounsaturated fatty acids between the two groups. There was no significant difference between unsaturated to saturated fatty acid and between the contents of omega-six to omega-three fatty acids. The unsaturated fatty acids are more important in sensory attributes such as taste. There was no significant difference in unsaturated fatty acids between the two pork types. All the above quality traits affect consumer acceptance and the sensory attributes. Sensory analysis also showed that there is no significant difference in seven parameters including taste, odour, colour, juiciness, tenderness and overall acceptability.

**Keywords:** Semi-intensive, Crossbred, Local pigs, Meat quality, Extensive

## Technical Session III

# Bio Process Technology

## Oral Presentations

# Antifungal Activity of Endophytic Fungal Species Isolated from Apple (*Malus domestica*)

M.A. Naseefa[1], A.G.A.W. Alakolanga[2]
[1]*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*

Novel natural metabolites with a microbial origin are one of the most interested areas in Natural Product Chemistry. This study was aimed to investigate the antifungal activity of endophytic fungal species isolated from apple (*Malus domestica*). Endophytes, which have a microbial origin, reside inside tissue without causing apparent disease to host. Fresh apple samples from local supermarket, Badulla, were first surface sterilized to limit epiphytic fungi. Potato Dextrose Agar (PDA), supplemented with chloramphenicol (100 mg $mL^{-1}$) was used to isolate a *Penicilium* sp. and a *Chrysosporium* sp. at pH 5.6. Isolated endophytes were cultured in potato dextrose broth for 14 days and extracted with hexane and ethyl acetate successively. Diluted (10 %) diethyl sulfoxide was used to prepare solutions of extracts and inhibition of fungal growth was determined using disc diffusion method at five different concentrations (1000, 2000, 3000, 4000 and 5000 ppm) against *Alternaria* sp. and *Aspergillus* sp. with 100 mg $mL^{-1}$ flucanazole as positive control. Effective concentrations ($EC_{50}$ and $EC_{90}$) were calculated for mean inhibition percentage. *Aspergillus* sp. growth was highly inhibited compared to *Alternaria* sp. by *Penicllium* extract. EtOAc extract of *Penicllium* showed high inhibition against (Minimum Inhibitory Concentration < 1000 ppm) *Alternaria* sp. than *Crysosporium* extracts (MIC 4572.2 ppm). Brine Srimp Lethality Assay (BSLA) was also carried out with 48h old naupali. Results were noted after 24 h. *Penicllium* sp. extract showed a high lethal toxicity (LC50 402.078 ppm) as they may produce excess of metabolites than *Crysosporium* sp. The observation of different antifungal activity of the two types of endophytic fungal extracts revealed the variations in chances and rates of producing secondary metabolites. With these results, it can be concluded that, apple endophytic fungal extracts can be used to control selected phytopathogenic fungal species, but the toxicity of extracts should be considered in case of food commodity.

**Keywords:** Endophytic fungi, Fungal extract, Bioactivities, *Malus domestica*, Antifungal compounds

# Development of Polyphenol Incorporated Herbal Hair Shampoo by Using Tea Fluff

D.M.N.H. Peduruarachchi[1], P.D.P.M.D. Silva[1], H.K.S.G. Gunadasa[1], H.G.H. Samaranayake[2]

[1]*Depatrment of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*

[2]*Imperial Tea Exports (Pvt) Ltd, Kelaniya, Sri Lanka*

Usage of cost effective herbal cosmetic products have become a new trend among the people. Tea polyphenol is one of the food derived active ingredients which has potential of hair growth. Since tea fluff is a cost effective polyphenol rich wastage, can be used to produce several natural cosmetic products with lower side effects and higher safeness. Therefore the major objective of this study was, development of polyphenol incorporated herbal hair shampoo by using tea fluff as a value added product which is effective towards hair growth and safeness. This study was used to determine the best polyphenol incorporation level to the shampoo based on its sensory properties, show the potential of used tea fluff as a cost effective polyphenol rich source for new product development, show the potential of value addition to the wastages and effectively utilize the wastages for the purpose of cost effective waste management method. Polyphenol extract of tea fluff was appended into shampoo base with varied concentrations i.e. 2.1%, 2.3%, 2.5%, 2.7% and 2.9%. Further sieved tea fluff was appended into shampoo base with varied proportions i.e. 0.021%, 0.023%, 0.025%, 0.027% and 0.029%. A sensory evaluation test was carried out with 30 panelists to reveal the best treatment. A shelf life analysis was performed at the storage of room temperature for the selected best treatments for period of two months at two weeks of interval. Results revealed that hair shampoo was stable in room temperature. According to the results of the sensory evaluation and statistical analysis, it can be concluded that 2.1% of polyphenol extract with 97.9% shampoo base (most preferable formula) and 0.025% of tea fluff with 99.975% shampoo (contains the highest polyphenol level) base are the two best formula among the two series.

**Keywords:** Tea fluff, Polyphenol, Shampoo, Hair growth, Sensory evaluation

# Development of Natural Mosquito Repellent Coil Using Tea Fluff as a Filler Material

R.M.D.C.S. Ranasinghe[1], A.G.A.W. Alakolanga[1], A.N.R. Weerawansha[1], H.G.H. Samaranayaka[2]

[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*

[2]*Imperial Tea Exports (PVT) Limited, Kelaniya, Sri Lanka*

Control of mosquitoes is of extreme importance at the present day, with increasing number of mosquito borne illnesses. Therefore specialty products like mosquito repellents are used to combat mosquitoes. Chemical mosquito repellents have a remarkable safety profile, but they are toxic. Due to its high health risk researchers are making attempts to find out new filler materials and active ingredients derived from natural plants. Tea fluff has the required properties of the filler material. Hence tea fluff as a waste product produced during the secondary manufacturing process of the *Camellia sinensis,* can be utilized as a filler material for the production of the natural mosquito repellent coil. Citronella (*Cymbopogon* sp.) oil was used as the natural repellent. The preliminary trials were conducted with seven different tea fluff and binder ratios to find out the suitable tea fluff and binder range. Ratios were selected based on the sensory evaluations which were breakability, width, color, appearance and overall acceptability as sensory parameters based on 5-point hedonic scale. The effectiveness of the mosquito coils were evaluated on flammability, burning time and mosquito repellency level. 3% repellent level was identified as the best effective mosquito repellency level without causing human toxicities. Mosquito repellency level tests were conducted according to the World Health Organization reference and as the test arena model of Peet Grady chamber. The final product was determined through another sensory evaluation on breakability, color, aroma, appearance and overall acceptability as sensory parameters based on 5 point Hedonic scale. Data were statistically analyzed using Freidman test at 5% level of significance using MINITAB 16 statistical software. The finally developed new coil had five and half hours of burning time.

**Keywords:** Natural mosquito repellent, Tea fluff, Filler material, Citronella, Mosquitoes

# Development of a Simple and Economical Method for Chitin Extraction from Prawn (*Penaeus monodon)* Shell Waste

M.N. Wehella[1], A.G.A.W. Alakolanga[2], E.D.N.S. Abeyrathne[1]
[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*

Chitin is the second most important biopolymer on earth and found mainly in invertebrates and several other organisms. It exhibits a wide range of applications in biotechnology, medicine, agriculture, food processing, environmental protection and textile industry. Disposal of shell waste is a major problem in relevant processing plants. Objective of this research was to develop a simple, economical, high yielding, non-toxic and cost effective method for chitin extraction from prawn (*Penaeus monodon*) shell waste. Samples were collected from a local prawn processing plant and crude chitin was obtained through deproteinization, decolourization and demineralization using NaOH, butanol and citric acid respectively. Crude chitin was then converted in to chitosan by deacetylation. Purity analysis, yield analysis, physiochemical and functional properties analysis such as moisture content, Water Binding Capacity (WBC), Fat Binding Capacity (FBC) and $Cu^{2+}$ chelating activity were measured. Control was prepared using 5% (w/v) NaOH, 100% (v/v) Acetone and 1% (v/v) HCl solution. FBC and WBC of the present study showed significantly higher values ($539.20 \pm 0.40^{a}$, $560.00 \pm 0.23^{a}$) than those of control ($304.66 \pm 0.23^{b}$, $285.06 \pm 0.40^{b}$), respectively ($p<0.05$). However, results of the yield analysis did not show a significant difference between the developed method ($32.40 \pm 0.01$) and the control ($24.80 \pm 0.08$). A low purity value (10%) for crude chitin was showed by the developed method compared to prepared control (25%). However, $Cu^{2+}$ chelating activity was significantly higher in the developed method (51%) compared to prepared control (-16%). Observations obtained in the 3 step extraction process suggested that butanol and citric acid were the most suitable chemicals compared to acetone and HCl. WBC, FBC and chelating activity of chitosan extracted by the present method can be involved in many applications. In contrast to previous studies, the present research showed that the suggested method is a simple way to extract chitin.

**Keywords:** Chitin, Prawn shell, Demineralization, Decolourization, $Cu^{2+}$ Chelating activity

# Development of a Simple and an Economical Method for Extraction of Edible Crude Fish Oil from *Catla catla*

D.R.C. Dahanayaka[1], A.G.A.W Alakolanga[2], E.D.N.S Abeyrathne[1]
[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*

Fish oil is a rich source of nutrition and it provides benefits on human health. It is considered to be an important natural source of polyunsaturated fatty acids (PUFA).When considering of existing edible fish oil extraction methods, several draw backs can be identified. The objective of this study was to develop a simple, rapid, cheap, nontoxic and scale up method to extract edible crude fish oil from *Catla catla*. In the present study, preliminary investigations were conducted to determine the suitable solvent for fish oil extraction. According to that ethanol, acetone, propanol and hexane were selected for sequential solvent extraction since they were recommended as the food grade solvents. The results of the sequential solvent extraction showed acetone and ethanol have an excellent capacity to extract fish oil. According to yield study, separated crude lipids, high yield was resulted from 50% acetone ($p < 0.05$). Therefore fish skin was treated with five volumes of 50% (v/v) acetone and homogenized. The homogenate samples were kept in refrigerator at 4°C for 24 hours. Then samples were filtered through filter paper and solvents were removed through dialysis, and separated lipids were freeze dried. In the present study, physicochemical properties were obtained as iodine value (131.13 ± 7.33), peroxide value (15.53 ± 0.38) and free fatty acid value (4.48 ± 0.22) in final extracted fish oil and it was in the acceptable range. According to the results, the extracted oil has good quality and high stability. Therefore, this method is considered as simple, rapid, cheap and non-toxic. This can also be incorporated to solvent extraction of fish oil from fish which can be scaled up.

**Keywords:** *Catla catla*, Ethanol, Acetone, Lipids, Nontoxic

# Investigation on Suitability of Banana Fiber as a Filler Material in Natural Rubber Latex-Based Household Gloves

T. Kirushanthi[1], D.G. Edirisinghe[2], C.K. Jayasuriya[3]
[1]*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Rubber Research Institute, Ratmalana, Sri Lanka*
[3]*Department of Chemistry, University of Kelaniya, Sri Lanka*

With increasing demand for polymer based household items, waste disposal has become an environmental issue. Thus, researchers are concerned on producing cost effective products, which are also biodegradable. The objective of this study is to investigate the possible use of banana fiber as a filler material in making natural rubber based household gloves with improved biodegradability and cost effectiveness while retaining the desired properties. In this study, long banana fibers were extracted mechanically and ground using a blender. Then, they were sieved and size less than 400 μm particles were selected. These were chemically treated using 4% sodium hydroxide and 2% of sodium sulfite. Natural rubber latex compounds were prepared changing banana fiber content. The films were made using casting method. The physico-mechanical properties of films, including tensile, tear and accelerated aging properties were analyzed and compared with the control sample in which no banana fiber was added. Tensile and tear strength have decreased with increasing fiber percentage compared to the control sample. This may be due to the poor interaction between rubber matrix and banana fiber. Banana fiber added natural rubber latex films exhibited, in comparison, a higher Young's modulus at 100% elongation than the control sample. Results also showed that the elongation at break has decreased steadily with the increasing of the fiber loading. Increase in the modulus and the decrease in percentage elongation may be attributed to the restriction of molecular chain movements resulting from the presence of fiber in the rubber matrix. Significant increase in retention value can be seen when higher amounts of fiber was incorporated suggesting enhanced durability in the condition of heat, oxygen and ozone. Use of nano-sized fiber particles, better coupling agent and an alternative fiber dispersing method may improve the mechanical properties.

**Keywords:** Biodegradable, Natural rubber, Latex gloves

# Optimization of Sulfur: Zinc Oxide: Accelerator Ratio for Natural Rubber Latex Unsupported Gloves

N.C.Y. Kithmini[1], A.G.A.W. Alakolanga[1], P. Ariyananda[2]
[1]*Department of Export Agriculture, Faculty of Animal Science and Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Research and Development Division, Industrial Clothing (Pvt) Ltd (Prime Polymer Division), Avissawella , Sri Lanka*

Glove is one of most important export product which holds a significant place in rubber latex dipping industry in Sri Lanka. Different chemical ingredients are incorporated with centrifuge latex in compounding for glove production. Among them, the ratio of S, ZnO and accelerator plays an important role on vulcanization rate and the properties of the end product. The existing ratio which used in the glove industry is identified as having some wastage of above ingredients. Therefore, an investigation was carried out to optimize the S, ZnO and accelerator ratio while maintaining same physical properties in natural rubber latex unsupported gloves. The dispersions of 50 % Zinc Oxide, 50 % Sulfur and 50 % Accelerator were prepared successfully. Nine compounds including the control were prepared by changing the ZnO, Sulfur and accelerator ratio within the selected minimum and maximum limits while all the other ingredients are constant. The existing compound was used as the control and the physical properties of finished gloves; tensile strength, elongation, force at peak were measured. The results indicated a significant effect of different amount of dispersions on the physical properties. The treatment 4 (ZnO 0.1: Sulfur 0.3: Accelerator 1.0) was identified as the best treatment which resulted the best tensile strength (>17 $Nmm^{-2}$), elongation (>700 %) and force at peak (>7 N) compared to the specifications of the properties of natural rubber latex disposable gloves. The cost of glove production was successfully reduced by eliminating the excess amount of ingredients in the selected compound while maintaining the properties as well.

**Keywords:** Vulcanization rate, Unsupported gloves, Tensile strength, Elongation, Force at peak

# Determination of Factors Affecting to the Tensile Strength of Tread Compound of Pneumatic Rubber Tyre Used in Industrial Application

H.M.L.P. Herath[1], A.G.A.W. Alakolanga[1], P.K. Wickramaarchchi[2], A.N.R. Weerawansha[1]

[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Camso loadstar, Central Mixing Plant, Minuwangoda Road, Kotugoda, Sri Lanka*

There are many factors which affect the tensile strength of pneumatic tyre tread compound. In this experiment, it is focused on mixing process parameters which affect to the tensile strength. The mixing parameters were investigated on an intermesh mixer for selected tyre tread compound. It was identified that the dumping temperature, mastication time, carbon black and silica incorporation temperature and carbon black silica feeding sequence influence the tensile strength of particular compound. The study was conducted to find out the effect of above factors to the tensile strength of tread compound and to identify their appropriate value. For that 1st stage mixing was done under three different dumping temperatures (155 °C, 160 °C, 165 °C) and three different mastication times (0 s, 20 s, 40 s) using the best combination of mastication time and dumping temperature changed carbon black silica incorporation temperature (120 °C, 140 °C) and carbon silica feeding sequence. According to the two factor factorial analysis dumping temperature significantly affect to the tensile strength. Experimental results showed that higher and lower dumping temperatures retard the strength but moderate temperature of 160 °C is the optimum. Mastication time also affect to the tensile strength but not significantly. Considering the interaction between mastication time and dumping temperature, we can conclude that it significantly affects to the tensile strength. Best combination of those factors is 40 s and 160 °C. Carbon black and silica dispersion also influence to the tensile strength of tread compound. A minimum temperature of 140 °C is necessary to gain efficient reaction between silica and silane. Feeding silica and carbon black separately avoids the restriction of carbon black against silica - silane reaction.

**Keywords:** Tread compound, Tensile strength, Dumping temperature, Mastication time, Carbon black

# The Use of Buffing Dust in Enhancing the Mechanical Properties of Vulcanized Natural Rubber in Tyre Industry

A. Niroshan[1], U. Jayalath[2], J.K. Premachandra[3]
[1]*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Ceat Kelani Holdings (PLC) Ltd., Sri Lanka*
[3]*Department of Chemical and Process Engineering, University of Moratuwa, Sri Lanka*

Before the used tyres are completely worn out, at a certain stage, some can be made to be reused by rebuilding. At the starting point of rebuilding process, the surface of the used tyres are scratched off by tyre polishing which generates a waste called buffing dust. Buffing dust contains different sizes of vulcanized rubber particles and it can be used as a filler material in various rubber products reducing the cost of raw materials. In the current research, it was expected to do value addition for buffing dust using as a filler and cost reduction in pneumatic tyre manufacturing. Buffing dust with the particle size ranges from 150 μm to 180 μm was used for the study. The pneumatic tyre compound formulation is used in rubber compounding. A series of compounds containing 5, 10, 15, 20, 25 and 30 parts per hundred rubber (phr) by weight of buffing dust was prepared. A rubber compound in the absence of buffing dust was also prepared to be used as the reference for the comparison of results. Required samples for the investigation of mechanical properties were prepared by vulcanizing the rubber compounds at 160 °C for 20 minutes. Mechanical properties such as tensile strength, tear strength, hardness and abrasive resistance of the resulting vulcanizates were investigated. The use of the buffing dust as a filler with 10 phr or lower in vulcanized natural rubber compounds enhanced the mechanical properties such as modulus at 100% elongation and hardness of the rubber compound. The samples having 15 phr or more of buffing dust showed significantly low hardness. Tear strength of the samples gradually decreased with increasing the amount of buffing dust incorporated. However, there was no drastic reduction in the tear strength of buffing dust filled samples compared with the tear strength of the reference sample. The incorporation of buffing dust into vulcanized natural rubber compounds has significantly lowered their tensile strength.

**Keywords:** Fillers, Natural rubber, Mechanical properties, Buffing dust

# Expansion of Storage Time of Tread Compound of Fork Lift Tyres without Sulphur Blooming

D.M.A. Udeshika[1], A.G.A.W. Alakolanga[1], M.H.L. Wasantha[2], A.N.R. Weerawansha[1]
[1]*Department of Export Agriculture, Faculty of Animal Science and Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Department of Research and Development, Samson Rubber Products (Pvt) Ltd, Galle*

With rapid industrialization and agricultural advancement, road transportation is one of the most promising and potent means for existence of everything. Both solid and pneumatic tyres involved in this process. Solid tyres are used primarily for light commercial applications and personal use vehicles like forklifts. Sulphur blooming is one of the major problems encountered with them. It will cause to loss of tackiness. Therefore, solid tyres are significantly more prone to roll-over than pneumatic tyres. This study was conducted to develop a suitable chemical compound for the tread component of fork lift tyre to have a significantly high storage time without sulphur blooming. Five different compounds including soluble sulphur, insoluble sulphur, silane coupling agent and phenolic resin (bakelite) were prepared and kept for six storage time levels (12 hours, 24 hours, 36 hours, 48 hours, 60 hours and 72 hours). They were tested for cure characteristics and physical properties with respect to product specifications of fork lift tyres. The visual observations revealed that, chemical compound prepared by using soluble sulphur, silane coupling agent and phenolic resin has maximum storage of 60 hrs which did not have sulphur blooms on finished tyre surfaces. The soluble sulphur along with silane coupling agent and phenolic resin (bakelite) is more suitable for fork lift tyre compounding whereas added chemicals have significantly a favorable effect on improvement of cure characteristics and physical properties within the specifications.

**Keywords:** Fork lift tyres, Sulphur blooming, Cure characteristics, Physical properties

**Technical Session III**

# Bio Process Technology

## Poster Presentations

# Antimicrobial Effect of Seed Extraction of Cardamom (*Elettaria cardamomum*) on Mouth Odor Forming Bacteria

E.M.D.D. Ekanayake[1], G. Panagoda[2], S.N. Premathilake[1]
[1]*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Faculty of Dental Sciences, University of Peradeniya, Sri Lanka*

Halitosis is an unpleasant odor that emanates from the oral cavity and Chlorhexidine included mouthwashes are a generally well accepted and popular way of dealing with halitosis. However most of these mouth washes merely provide a competing and temporary smell that is capable of masking the unfavorable malodor and may contain harmful chemicals such as alcohol and phenols. *Elettaria cardamomum* is used as a spice and ayurvedic medicine since ancient times and could be used in mouthwashes due to their pleasant aroma. In the present study, the antimicrobial effect of *E. cardamomum* seed extraction on mouth odor forming bacteria was investigated. Hot water extracts of *E. cardamomum* were obtained and concentration series (10000 ppm, 5000 ppm, 2500 ppm, 1250 ppm, 0 ppm) were prepared. Bacteria samples were obtained from pockets of oral cavity and posterior region of tongue and cultured on blood agar under anaerobic conditions. Antimicrobial activity test and odor test were carried out for the prepared concentration series. Ten replicates were used for one concentration in antimicrobial test and two replicates for odor test. This experiment was carried out using well diffusion technique and mean inhibition concentration (MIC) was determined based on the inhibition zones on the blood agar plates. Odor test was carried out using test panel of 8 members and a 0 ppm solution (blood agar broth) was used as a control for comparison after growing anaerobic bacteria. Cardamom seed extraction was added to other solutions according to the concentration and anaerobic conditions were given. A significant inhibition was observed on oral anaerobes and the effect was significantly increased with the increment of the concentration (Pearson correlation, 0.934, $p = 0.000$). A significant odor change was observed when compared with the control ($p = 0.000$) and 10000 ppm and 5000 ppm did not show any significant odor (One way ANOVA, Tukey Multiple Comparison Test). According to the results it can be concluded that *E. cardamomum* has antimicrobial effect on odor forming anaerobic bacteria and 5000 ppm could be identified as the MIC of cardamom extraction for the inhibition of anaerobes which form halitosis.

**Keywords:** *Elettaria cardamomum*, Odor forming bacteria, Antimicrobial activity

# Antimicrobial Activity and Toxicity Effect of *Adiantum Capillus-Veneris*

J.M.I.K. Abesingha, S.N. Premathilake
*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*

Medicinal herbs are important natural resources that can be used against various infections. *Adiantum capillus-veneris* has been used in traditional medicine for centuries against various infections. The objectives of the present study were to study the antibacterial activity against *Staphylococcus aureus* and the toxicity effect of *A. capillus-veneris.* Leaf extraction of *A. capillus-veneris* was prepared using the Soxhlet apparatus with absolute methanol as solvent and then concentrated using a rotary vacuumed evaporator. Using a stock solution of 100 mg/mL four different concentrations of crude extracts were prepared (50 mg/mL, 25 mg/mL, 12.5 mg/mL, and 6.25 mg/mL) for the antibacterial test. Well diffusion method was employed to study the antimicrobial activity and inhibitory zone diameter was also measured. Absolute methanol was used as negative control. For the toxicity test crude extract was reconstituted using distilled water. A stock solution of 1000 µg/mL was prepared and 500 µg/mL, 100 µg/mL, 10 µg/mL and 1 µg/mL solutions were prepared using this solution. Zebrafish (*Danio rerio*) embryos were used as toxicological model and their coagulation, lack of somite formation, lack of detachment of the tail and lack of heart beat was used as the lethality indicators. The results indicated that methanol extract of the *A. capillus-veneris* have antibacterial activity against *S. aureus* and the Minimum Inhibitory Concentration (MIC) was 12.5 mg/mL (One way ANOVA, $p<0.05$ and Dunnett's test by 95% confident level). According to the Probit analysis the lowest LD 50 value received for toxicity test was 102 µg/mL after 96 hours by 95% confident level. According to the results it could be concluded that leaf extracts of the *A. capillus-veneris* shows antibacterial activity against *S. aureus* at a very low concentration and they could be toxic with the increasing time duration.

**Keywords:** *Adiantum capillus veneris, Staphylococcus aureus*, MIC, Zebrafish embryo, LD 50

**Technical Session IV**

# Sustainable Crop and Animal Production

**Oral Presentations**

# Effects of Salinity on the Growth and Yield of Selected Rice (*Oryza sativa*) Cultivars at Different Growth Stages

S. Puvanitha, S. Mahendran, N. Sujirtha

*Department of Agricultural Biology, Faculty of Agriculture, Eastern University, Sri Lanka.*

Salinity is a limiting environmental factor for plant production and is becoming more prevalent as the intensity of agriculture increases. Limited water and hot dry climates frequently increases the salinity levels that limit crop production in arid and semi-arid regions. It is estimated that 2% of the rain-fed agricultural area is affected by salinity globally. In agriculture, a soil having a salt concentration exceeding an electrical conductivity value of 4 $dSm^{-1}$ is classified as saline. This experiment was conducted to assess the effects of salinity on the growth and yield of selected rice cultivars. The growth of three rice cultivars namely; "Pachaiperumal", "At 307" and "At 308" were evaluated under saline (6.52 $dSm^{-1}$) and non-saline (1.76 $dSm^{-1}$) conditions. This experiment was laid out in the Completely Randomized Design with two factors in a factorial arrangement. There were six treatments and each one was replicated four times. Root and shoot dry weights and yield of the tested rice cultivars were significantly reduced by salinity. Rice cultivar "At 307" showed the highest root dry weights at all three growth stages, vegetative, reproductive and ripening (0.21, 10.1 and 26.4 g) respectively when exposed to salinity and the lowest root dry weights (0.03, 5.7 and 19.0 g) were found in "Pachaiperumal". The % reduction in root dry weights of "At 307" and "Pachaiperumal" were 19.2, 66.7; 30.3, 51.7 and 36.2, 46.3 during the vegetative, reproductive and ripening stages respectively. Cultivar "At 307" showed the highest shoot dry weights when exposed to salinity during all the three growth stages and the lowest weights were found in "Pachaiperumal". The % reduction in shoot dry weights of "At 307" and "Pachaiperumal" were 25.7, 55.6; 36.7, 52.4 and 29.6, 62.7 during the vegetative, reproductive and ripening stages respectively. Salinity significantly reduced the yield of all the tested rice cultivars. The highest (2.0 t $ha^{-1}$) and the lowest yields (0.44 t $ha^{-1}$) were recorded by "At 307" and "Pachaiperumal" respectively. Hence, "At 307" was identified as the most salt tolerant rice cultivar among the three rice cultivars tested which could be grown in the saline tracts of Batticaloa district.

**Keywords**: Growth attributes, Rice cultivars, Salt tolerant, Yield

# Developing a Calibration Curve to Quantify Chlorophyll Content in Rubber (*Hevea brasiliensis*)

L.K.I. Madushani[1], P.E. Kaliyadasa[1], U.G.A.T. Prematilake[1], K.V.V.S. Kudaligama[2]
[1] Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka.
[2] Department of Biochemistry and Physiology, Rubber Research Institute, Dartonfield, Agalawatta, Sri Lanka.

Chlorophyll meter, SPAD-502 is widely used in determining leaf chlorophyll content in field plants as it is non-destructive and less time consuming. Variations in chlorophyll content among varieties of different species have been identified. However, investigations of any genotypic variations related to rubber have not been reported so far. In order to convert relative SPAD meter values into units of absolute chlorophyll concentration, it is necessary to employ a calibration curve. Genotypic variations in leaf characteristics such as leaf thickness, epicuticular wax content, water content and leaf biomass could affect the readings of the SPAD-502 chlorophyll meter. Therefore, this study was carried out to develop a calibration curve to quantify chlorophyll content and effect of leaf thickness, epicuticular wax content, water content and leaf biomass on the readings of SPAD-502 meter. Leaf samples of most commonly used grown rubber genotypes i.e. RRIC 121, RRIC 100, RRISL 203 and RRISL 2001 were selected. Leaf samples of each genotype that in the similar growth stages were collected from the budwood nurseries in Dartonfield estate, Agalawatta. SPAD values of each leaf sample were measured and the actual leaf chlorophyll content (LCC) was analyzed by acetone extraction method. Leaf thickness, water content, epicuticular wax content (EWC) and leaf biomass of each leaf sample were also determined by using standard test methods. Standard calibration curves were developed separately for each genotype on per leaf biomass (mg/g) and per leaf area (mg/cm$^2$) basis by regressing with correspondent SPAD values. The most appropriate calibration model for all tested genotypes was the second order polynomial with above 95 % accuracy ($R^2$= 0.95). Highest leaf thickness and EWC were observed in RRIC 100 genotype whilst RRISL 203 genotype gave the lowest values. The highest water content and leaf biomass were observed in RRIC 121 and RRISL 2001, respectively. LCC of RRIC 121 genotype was comparatively lower with averages of 3.598 mg/g and 0.036 mg/cm$^2$. The highest LCC was observed in RRISL 203 genotype and the average values were 5.238 mg/g and 0.054 mg/cm$^2$. The genotypic averages of leaf EWC, water content, leaf biomass and leaf thickness were 0.079 mg/cm$^2$, 7.998 mg/cm$^2$, 10.889 mg/cm$^2$ and 0.126 mm, respectively. Correlation between leaf thickness, EWC, leaf biomass and water content with the reading of SPAD-502 chlorophyll meter were not significant in all four genotypes. This indicates that these four parameters do not affect the reading of SPAD-502 chlorophyll meter in determining LCC of rubber.

**Keywords:** Chlorophyll content, Epicuticular wax, Leaf biomass, Leaf thickness, SPAD-502 Chlorophyll meter

# Study on Effectiveness of Ascorbic Acid, *DRC+3* and Sodium Nitroprusside (SNP) on Recovery of Tapping Panel Dryness (TPD) of Rubber Trees

W.K.S.W. Watawala[1], A.M.W.K. Senevirathna[1,2], M.P.M. Arachchi[1], H.K.S.G. Gunadasa[1], N.M.C. Nayanakantha[2], R.K. Samarasekara[2]

[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Plant Science Department, Rubber Research Institute, Dartonfiled, Agalawatta.*

Tapping panel dryness (TPD) of rubber is known as a physiological disorder (oxidative stress), which occurs in all rubber clones growing everywhere in the world resulting in severe loss of yield. At present, TPD affected trees are rested for about six months period to reduce stress to the trees in order to minimize TPD. There is no any effective treatment has been found to prevent or cure TPD. Therefore, rubber growers face serious problems due to high economic losses caused by TPD. This experiment was conducted to find the effectiveness of some chemical treatments for trees affected with TPD. Ninety TPD affected trees and 30 healthy trees of clone RRIC 121 that were planted in 1996 were selected. All the trees were being tapped at half spiral, every other day (S/2 d2), downward (↓) tapping system in the first renewed panel (C=BI-1panel). A commercial chemical named, *DRC+3*, Ascorbic acid (AA) and Sodium Nitroprusside (SNP) as a NO (nitric oxide) donor were used for the experiment, which are said to having antioxidant properties. *DRC+3* (1g per tree with 6 days intervals), Ascorbic acid (1mM & 0.5mM with 6 days intervals) and Sodium Nitroprusside (100µM & 50 µM with 2 weeks intervals) were applied on affected TPD trees with an untreated control. In another experiment, *DRC+3* (1g per tree with 10 days intervals) was applied for healthy trees with untreated control. Although data were not statically significant, there is a trend in increasing the yield per tree per tapping (g/t/t/) in TPD affected trees treated with *DRC+3* and, Ascorbic acid, more prominently with 1 mM AA. Higher concentrations of Sodium Nitroprusside might be preferred as there was a positive effect on increasing yield of TPD affected trees with 100 µM SNP compared to 50µM concentration, though the yield increase was not statistically significant. When compared to the pretreatment data and yield increase during the short period of the experiment, further continuation of this experiment is needed to arrive at firm conclusions.

**Key words:** Ascorbic acid, *DRC+3*, Physiological disorder, Sodium Nitroprusside, Tapping panel dryness

# Effect of using Biofilmed Biofertilizer to Control the Tip Burning and Leaf Spot Diseases of *Dracaena sanderiana* and *Cordyline fruticosa*

U.M.C.S. Udagedara[1], P.E. Kaliyadasa[1], U.G.A.T. Premathilake[1], K.A.C.N. Seneviratne[2], G. Seneviratne[3]

[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*

[2]*Royal Botanical Garden, Peradeniya.*

[3]*Institute of Fundamental Studies, Kandy*.

*Draceana sanderiana* and *Cordyline fruticosa* are highly demanding cut foliages in foliage industry. Due to its perishable nature in foliage, it is highly susceptible to pest and pathogens which causes loss of appearance and thereby reduce the ornamental value of the plants. Tip Burning, Leaf Spots, *Fusarium* stem and root rot are some of the major diseases in these plants. High amount of fertilizer and agro chemicals are used to improve the growth of the plants and to control the pest and disease problems. It is an extra cost in floriculture sector and also reduces the quality of the products. Biofilmed Biofertilizer (BFBF) is a cost effective and environmentally friendly bio-fertilizer type. Most importantly it suppresses the pathogens through improved biodiversity and acts as a biological control agent. The research was conducted to identify the possibility of using BFBF to control the Tip Burning and Leaf Spot diseases of *Dracaena sanderiana* "white", *Dracaena sanderiana* "gold" and *Cordyline fruticosa*. Grow More fertilizer was used as the chemical fertilizer in 2.5 g/l concentration and Biofilmed- F was used in 1: 15 ratio by volume. Five treatments were used namely BFBF alone, full strength chemical fertilizer only, half strength chemical fertilizer only, BFBF with half strength chemical fertilizer and Distilled water as control. The study revealed that the application of BFBF alone is more effective in controlling the Tip Burning and Leaf Spot diseases of *Dracaena sanderiana* "gold" and Leaf Spots in *Dracaena sanderiana* "white". Application of BFBF with half strength chemical fertilizer is more effective in controlling both diseases of *Cordyline fruticosa* and controlling Tip Burning of *Dracaena sanderiana* "white" when compared to the use of chemical fertilizer alone. In overall, BFBF with half strength chemical fertilizer is more effective in controlling the Tip Burning and Leaf Spot diseases of *Dracaena sanderiana* and *Cordyline fruticosa* while promoting a better growth.

**Keywords:** *Dracaena sanderiana*, *Cordyline fruticosa*, Biofilmed Biofertilizer, Tip Burning, Leaf Spots

# Screening a Bean Germplasm for Fusarium Wilt Disease, Caused by *Fusarium oxysporum* f. sp. *phaseoli*

G.Y.A.D.D. Perera[1], G. Chandrasena[1], P.D.P.M.D. Silva[1], K.P. Somachandra[2]

[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Regional Agriculture Research and Development Centre, Bandarawela.*

Fusarium wilt or Fusarium yellows is an economically important fungal disease of common bean worldwide. The causal agent of this disease is *Fusarium oxysporum* f. sp. *phaseoli*. The study was conducted to find the suitable medium for the multiplication and to determine the reaction of 30 common bean accessions, including two susceptible controls (Wade and Keppetipola Nil) to the *Fusarium oxysporum* isolates under greenhouse condition. Isolates of the pathogen were collected from the root and stem fragments of common bean plants grown in the production fields of Regional Agricultural Research and Development Center, Bandarawela. Species identity was based on the colony characters, nature of conidiogenous cell, and morphology of microconidia, macroconidia and chlamydospores. It was found that isolates had a relatively high growth in Bean extract Agar (BEA) medium, comparatively to Potato Dextrose Agar (PDA) and Corn Meal Agar (CMA) medium. Screening of the bean germplasm in the greenhouse was done by transplanting inoculated seven day old seedlings into pots filled with pasteurized (1:1) soil: sand medium. At 15 days after inoculation, the primary leaves showed epinasty symptoms and chlorotic areas appeared on leaves followed by necrosis at their margins of most accessions, including two recommended varieties. Disease severity was recorded 21 days after inoculation using a Disease Severity Index and it was observed that disease reactions in the germplasm varied from highly resistant to highly susceptible. Out of the 30 bean accessions including two recommended varieties there were 2 resistant, 19 intermediate and 11 susceptible accessions in the germplasm.

**Keywords:** Common beans, Germplasm, *Fusarium oxysporum* f. sp. *phaseoli,* Fusarium wilt, Greenhouse screening

# Evaluation of the Physiochemical Stability of Different Formulations of Diazinon 50 within Its Shelf-life

H.A.S.P.Kularatne[1], K.G.Premathilake[1], A.N.R.Weerewansha[1], Champa Magamage[2]
[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Office of Registrar of Pesticides, Gatambe, Peradeniya.*

Pesticide formulations can undergo chemical and physical changes on storage. The physiochemical stability of the product has been of exalted concern to the efficacy and safe use of the product within its shelf life. A laboratory evaluation to determine the physiochemical stability of Diazinon emulsifiable concentrate, emulsion oil in water and granule formulations within its shelf-life was conducted. The physical and chemical parameters of the respective formulations were assessed as a function of time at ambient temperature and after storage at 54 °C for 14 days. Analysis was performed as per the Collaborative International Pesticides Analytical Council protocols and in accordance with Food and Agriculture Organization and World Health Organization specifications. The results revealed physiochemical instability in EC formulations was affected by time units and temperature. A marked variation in pH and active ingredient were apparent in EC formulations of 12-18 months old and >24 month old obtained from local manufacturers. A mean active ingredient of 429.34 at mean pH 3.3 was registered with 12-18 month old sample and a mean active ingredient of 249.8 at mean pH 2.2 was registered with >24 month old sample. EW formulations comply with specifications in pH, density, specific gravity and emulsion stability in spite of the slight differences shown. Wettability and persistent foaming of granule samples were in conformity with the WHO specifications. Granule sample of 12-18 months old recorded a decrease in pH recording a mean value of 6.1. Despite the EC samples of time 12-18 months old and >24 month old, stability of the active ingredient content evaluated for all 3 Diazinon formulations used in study were in agreement with the specifications with time units within its shelf-life. However significant difference in active ingredient content was recorded in all formulations used in the study after storage at 54 °C which shows light for the formation of toxic impurities.

**Keywords:** Diazinon, Physiochemical stability, EC formulation, EW formulation, GR formulation

# Effect of Initial Seed Moisture Content on Seed Growth Quality Parameters and Storability of Brinjal (*Solanum melongina* L.)

S. Kayalvizhy[1], P.E. Kaliyadasa[1], U.G.A.T. Premathilake[1], M.G.D.L. Priyantha[2]
[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Seed Health Testing Unit, Gannoruwa.*

Quality seed is the basis in high agricultural productivity and average seed germination in brinjal was reported as below 70% under local conditions. This problem was reported especially in "Lenairi" and "Padagoda" brinjal varieties. Hence this experiment was carried out to compare the effect of Initial Seed Moisture Content (ISMC) on growth quality parameters under non storage and storage conditions in different brinjal varieties. Experiment was designed in Complete Randomized Design with two and three factors having four replicates in each under non storage and storage conditions respectively. Three ISMC, 9%, 8%, 7% and four different varieties, Lenairi, Padagoda, Thinnavelli purple, Amanda were taken for this study. Brinjal seeds were tested initially for growth quality parameters and samples were stored for two months under ambient and refrigerated conditions. Findings revealed that, there was a highly significant effect of ISMC, variety and storage condition on seed germination and vigor. Under non storage condition, highest germination percentage (79.5%) was recorded in Padagoda at 9% initial seed moisture content. Highest vigor index (2147) was recorded in Thinnavelli purple at 9% initial seed moisture content. Under storage condition highest germination percentage (86.5%) was recorded in Padagoda at 8% initial seed moisture content stored in refrigerator. Highest vigor index (2837) was recorded in Amanda at 9% initial seed moisture content stored in refrigerator. Results indicated that highest germination percentage was observed at 9% ISMC under non storage condition. Seeds stored in refrigerator at both 9% and 8% ISMC were superior in storability compared to those stored in ambient condition in growth quality parameters. However, further studies are necessary to identify more suitable ISMC for commercial scale brinjal cultivation.

**Keywords**: Brinjal, Initial seed moisture content, Germination, Vigor

# Assimilation of Phosphate Fertilizer derived from Eppawala Rock Phosphate on the Vegetative Growth of Corn (*Zea mays* L.)

R.M.S.R. Rathnayake, K.B. Wijesekara
*Department of Science and Technology, Uva Wellassa University, Badulla. Sri Lanka.*

Phosphorus is one of the most important macronutrient in plant nutrition and wellbeing. Repeated cultivation has caused drastic depletion of nutrients in agricultural lands necessitating routine addition of costly commercial fertilizers to crops. Rock phosphate deposit at Eppawala Sri Lankan, provides a rich source of phosphorus from which phosphate grade fertilizer could be produced by the acidulation with con. HCl. However, pH of the fertilizer is needed to be adjusted to plant tolerable levels to reduce acid toxicity. This research used CaO to adjust pH of rock phosphate derived fertilizer enabling rapid assimilation by plants. Approximately 100 g of the acidified product was added with a predetermined quantity of 3. 7 g of lime to adjust the final pH value to 6.02. XRF analysis was performed to identify the elements of the final fertilizer mixture before and after CaO addition. A pot experiment was performed to determine the assimilation of newly developed fertilizer by corn plants. The experiment was arranged in a complete randomized block design with five treatments and 180 experimental units. Treatments were: T1- Pants without any amendments, T2-Plants with commercial fertilizers excluding phosphates, T3-Plants with commercial fertilizers including phosphate, T4-Plants with commercial fertilizers+developed fertilizer without pH adjustment, T5-Plants with commercial fertilizers+developed fertilizer with pH adjustment. Plant height, root surface area, biomass at flowering and leaf chlorophyll content were measured to determine the plant performance after fertilization. X-ray fluorescence (XRF) analysis revealed that developed fertilizer contained 11.4% $P_2O_5$, 16.5% MgO, 14.9% $K_2O$ and 24.3% CaO as major constituents while providing plant with some important micronutrients such as, Mn, Fe, and Zn. Addition of lime was not only resulted in increasing the of pH to plant tolerable levels but also eliminated $Cl^-$ and some heavy metal contaminants like As and Rh. Growth performance of T5 plants indicated that phosphate from developed fertilizer had readily assimilated by Corn plants. However, the commercial triple superphosphate used to supplement T3 plants showed significantly higher ($p=0.00$) performance over T5 plants. T4 plants supplemented with fertilizer without pH adjustment died prematurely while T5 plants showed normal growth suggesting pH adjustment with CaO was effective.

**Key words:** Rock phosphate, Phosphat fertilizer, pH adjustment, Plant assimilation

# Effect of Anti-transpirant in Sustaining Rubber Leaf Physiology Under Dry Climatic Condition

P.S.V. Rupasinghe[1], N.S. Withanage[1], E. Munasinghe[2], V.H.L. Rodrigo[2], S.M.M. Iqbal[2], H.A.S.L. Jayasinghe[1]

[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Rubber Research Institute of Sri Lanka, Agalawaththa.*

Protocols have been developed to expand the rubber (*Hevea brasiliensis*) cultivation to Dry and Intermediate Zones of Sri Lanka, where moisture stress is the major climatic constraint. Suitable adaptation techniques are still to be developed to endorse rubber cultivation under such sub-optimal conditions. In this context, introduction of anti-transpirant has been renowned as an agro-management practice to resist crops with drought conditions. Therefore, present study was conducted to assess the benefits of anti-transpirant application in sustaining leaf physiology of rubber plant under dry climatic condition. The experiment was conducted in Padiyathalawa GN Division in Ampara district during 13th May to 22nd July, 2015. The experiment was randomly arranged as two factor factorial design in three blocks. Three concentration levels (0.3 mL/L, 0.45 mL/L and 0.6 mL/L) of anti-transpirant, Green Miracle were tested against three levels of application intervals (2, 3 and 4 weeks) and thus, there were nine treatment combinations over untreated control. Environmental parameters, namely, rainfall, maximum and minimum temperatures, solar radiation, relative humidity, wind speed and soil moisture content; physiological parameters namely, stomatal conductance, chlorophyll content, photosynthesis and relative water content; growth parameters, namely, plant diameter, plant height and total leaf count of the plants were recorded over the study period. A dry period was observed during 7th to 22nd July, 2015 with high temperature (23 °C to 34 °C), low RH (76% to 53%) and with very low rainfall. Rubber plants with the application of anti-transpirant at different concentrations and application intervals outer performed over the untreated control in terms of stomatal conductance, chlorophyll content, photosynthesis and total leaf count of the plant. Application of anti-transpirant with a concentration of 0.45 mL/L at 2 weeks interval contributed to a significant increase in stomatal conductance and chlorophyll content of leaves together with better results for photosynthesis rate, parameters of light response curve and relative water content over control. Application of anti-transpirant with a concentration of 0.6 mL/L at 2 weeks interval contributed to better results for studied growth parameters. Hence, the application of Green Miracle anti-transpirant would be a better attempt to expand the rubber cultivation to non-traditional rubber growing areas of Sri Lanka, while sustaining the leaf physiology of rubber plant under dry climatic condition.

**Keywords**: Anti-transpirant, Leaf physiological parameters, Moisture stress

# Evaluating the Seed Germinability and Growth Performances of Nursery Plants of Alternative Shade Tree Species in Tea Plantations

M. Suman, K.G. Prematilake
*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka.*

Tea is a shade loving plant. Hence, shade trees are necessary to provide shade for tea as well as to add green biomass to soil by regular lopping. There are two species of shade tree species such as *Grevillea robusta*, *Derris mycrophylla* and *Albizzia moluccana* which cultivate as high shade trees in the Uva region and *Dadap (Tithonia diversifolia)* is cultivated as low shade species. Hence, there was a scarcity of shade tree species in tea plantations, but there is a very high demand for alternative shade tree species in all tea growing regions particularly to face to the sudden drought conditions. An experiment was conducted to study the germination and growth performances of three potential tree species such as *Derris mycrophylla, Cassia spectabilis* and *Techoma stance* to provide shade for tea in comparison with recommended shade tree species such as *Albizzia moluccana* and *Grevillea robusta.* Tetrazolium test was used to test the viability of seeds. Germination of seeds was tested after subjecting seeds to different pre-treatments such as pre-soaking in water at ambient temperature, hot water treatment, chemical treatment (98%, $H_2SO_4$) and mechanical damaging. The highest viability percentage was shown by *Cassia spectabilis* followed by *Derris mycrophylla* and *Albizia mollucana*. But, *Techoma stance* seeds did not show any viability. The highest germination percentage was recorded with *Cassia* seeds pre-treated with mechanical damaging of seed coat. Whereas, *Albizia mollucana* and showed the highest germination rate with hot water treatment followed by mechanical damaging. Mean growth rate was also the highest with *Cassia spectabilis* followed by *Derris mycrophylla* and *Derris mycrophylla*. Leaf number per plant was more or less same in all species. Growth rate of *Techoma stance* was relatively lower than that of *Grevillea robusta*, but the leaf number per plant is other way round. *Cassia spectabilis* had the highest viability percentage, highest growth rate compared with other alternative species such as *Techoma stance* and *Derris mycrophylla* as far as pretreatment for the germination and growth rate are concerned *Cassia spectabilis* was the best.

**Keywords:** Pre-treatments, Viability, Germination, Shade trees, Nursery

# Effect of Clone type on Storage Hardening and Gel Content of Raw Natural Rubber

H.W.O.C.Delman[1], P.E. Kaliyadasa[1], M.P. Arachchi[1], A. Attanayake [2]
[1] *Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Department of Raw Rubber and Chemical Analysis, Rubber Research Institute, Rathmalana, Sri Lanka*

Latex is the only non-synthetic elastomer in wide use derived from the milk-like liquid of the Rubber tree. At present the country ranks among the world's top ten largest producers and 7th largest exporter of natural rubber. Even though Sri Lanka is the one of the leading manufacturer of raw rubber, most of the product is carried out in other countries and those rubbers should be kept under storage conditions until use. During transportation or upon storage natural rubber exhibits different storage properties. Hence, rubber industry has increase the requirement for quality and uniformity of natural rubber. The objective of this study was to assess effects of clone type on gel content and storage hardening of natural rubber. Ten different clones rubber were used as samples in this study which are RRISL 201, 202, 203, 205, 206, 211, 216 217, 219 and RRISL 222. Properties of raw rubber were analyzed using standard methods of Gel content, Mooney viscosity, stress relaxation rate, Green strength, Initial plasticity and Hardening plasticity. Minitab 16 statistical software was used to analyze the qualities of nine replicates from ten different clones. Most clones were showed medium and hard viscosities and none of clones reported low viscosities. Correlation between Mooney viscosity and Initial Wallace plasticity were analyzed using regression and identified that there is a relationship among them. The RRISL 203 clone gave relatively high Mooney viscosity, $P_{0,}$ stress relaxation rate and green strength. Therefore it can be concluded that RRISL 203 clone consisted high molecular weight. As all the tested properties of RRISL 217 clone have met the specification requirements for rubber processing, can be successfully used in product manufacturing.

.

**Key Words**: Gel content, Storage hardening, Mooney viscosity, Green strength, Initial plasticity, clones

# Assessing Adoption of Organic Pepper Cultivation in Kandy, Matale and Kegalle Districts

Y.S.M.M.P.Yallarawa[1], L.M.H.R. Alwis[1], Kanchana Wickramasinghe[2]
[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Institute of Policy Studies of Sri Lanka, Colombo-07, Sri Lanka.*

Increased domestic and international demand for organic products, along with environmental and safety issues have stimulated policymakers and governments in some parts of the world to provide incentives for converting from conventional to organic farming. Sri Lankan agriculture industry is developing its potential to address it. The country is trying to be a quality organic supplier to the world market. This study was conducted to investigate the level of the adoption of organic pepper farming and to identify the factors affecting on intension to conversion of conventional cultivation of pepper to organic cultivation of pepper in Kandy, Matale and Kegalle districts. The data used in the study were collected from a sample of both organic and conventional farmers. A total of 126 respondents were selected from the three different cultivated areas to obtain main objective and 72 respondents were selected from the three different cultivated areas to obtain second objective. Probit model was used in this study to categorize the organic farming into adoption and non-adoption. Age of the household head, experience, land area and number of awareness sources have significant effect on the adoption of organic pepper farming. Gender, age of the household head, primary education, attitude on cost of non-organic farming and price per one kilogram of pepper have significant effect on intension to conversion. Forty three percent of farmers in the study area have adopted organic cultivation of pepper. Assessing the intension to conversion, conventional farmers show some potential for converting to organic practices. Seventy eight percent of the farmers in the study areais having an intension to convert their farms into organic. The institutions related to organic farming are very useful in providing information about organic farming. Government agencies, extension and research institution should play a vital role to strengthen the awareness and advantages of organic farming.

**Keywords:** Organic farming, Intension to conversion, Adoption, Probit model

# Effectiveness of Ethno-Veterinary Practice Use in Treatment of Swine Dermatitis

G.M.A.G. Chandrarathne[1], R.R.M.K.K. Wjesundara[1], R.P.V.J Rajapakse[2]
[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Department of Veterinary Pathobiology, University of Peradeniya, Peradeniya, Sri Lanka*

The aim of this study was to evaluate the effectiveness of a selected medicinal recipe used in Ethno-veterinary practice to prepare a cream to cure swine dermatitis. The toxicity was evaluated using BALB/c mice model. The results were taken from elimination of *Sarcoptes scabiei* from naturally infested swine herds. All aqueous herbal preparations and oils were prepared separately using ethno veterinary recipes. These mixtures were mixed with an aqueous solution base. The cream contains 75% aqueous cream base, 20% aqueous herbal preparation mixture and 5% oil mixture. Skin irritation test, ear swelling and histopathological studies were performed for toxicity studies. Treatment effectiveness was determined by mite count of swine using Student t-test. In the skin irritation test, there was no signs of erythema and edema after application of once until 72 hours. With application of three consecutive days it could observe that there were no signs of erythema and edema for sensitization treatment. Therefore, the formulation was not exhibited signs of erythema and edema after application of the cream. Biopsy samples were collected after 72 hours of application the cream. Histopathological evaluations were carried using light microscopy. There was an inflammation on treated ear. Measurement were taken from ear thickness to evaluate the swelling of ear. Observed mice did not show significant difference between the ear swellings. Mite count of pigs in day ten was significant than the other days. The cream has to be applied at least ten days to get better results. The cream can be used for curing swine dermatitis.

**Keywords:** Ethno-veterinary, Histopathological studies, Skin irritation, Plant extracts, Swine dermatitis

# A Study on Present Status of Cattle Farming in Badulla District

S.V. Senadhirajah, A.M. Samaraweera, R.R.M.K.K. Wijesundara
*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka.*

The present study was conducted to determine the level of technical efficiency and production characteristics of house-hold level dairy cattle farms in Badulla district. A total of 165 cattle farms in seven veterinary regions in Badulla district were randomly selected by applying the stochastic production frontier methodology. Technical efficiency estimates were generated for different categories of collected data. The results of the study indicated that technical efficiency of milk production by most of the house-hold dairy cattle farms in above-mentioned veterinary regions is high. The mean technical efficiency was estimated to be 96%, 82%, and 77% in Welimada, Ridimaliyadda and Uvaparanagama veterinary regions, and 88% for intensive farms, 84% for semi semi-intensive farms, 89% for farms with local breeds and 82% for farms with temperature breeds. The results suggested that farms in the sample could increase their level of milk production to a certain percent using the current input quantities efficiently. To enhance farm efficiency there is a need to improve farmers' access to extension services and government subsidies. Provision of education to the farmers, training and orientation of the farmers toward intensive dairy farming practices and modern technologies are the suitable measures to increase the efficiency of milk production.

**Keywords:** Technical efficiency, Stochastic, Production frontier, Cattle farming, Milk

# Antagonistic Effect of Five Native *Trichoderma* Isolates on Economically Important Foliar Pathogens of Rubber

P.K.N.N Sandamali[1], G. Chandrasena, T.H.P.S. Fernando[2], P.D.P.M.D Silva[1]
[1] *Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*
[2] *Department of Plant Pathology and Microbiology, Rubber Research Institute of Sri Lanka, Dartonfield, Agalawatta, Sri Lanka*

Rubber foliar diseases play an important role in latex yield losses of rubber plantations in Sri Lanka. The frequent use of chemical fungicides to control causative pathogens leads to environmental pollution, hazardous to human and may lead to the development of new chemical resist pathogenic strains. *Trichoderma* species are the most widely studied bio control agent against many economically important plant pathogens. Hence, an attempt was made to investigate the antagonistic effect of five native *Trichoderma* strains on the plant pathogenic fungi; *Colletotrichum* spp., *Corynespora cassiicola, Phytophthora* spp. and *Drechslera heveae.* Foliar pathogens were isolated, identified and confirmed based on the symptoms, cultural and reproductive characteristics. Five *Trichoderma* strains isolated from different rubber growing soils in Sri Lanka were tested *in vitro* for their antagonistic effects against four foliar pathogens. The results obtained from dual culture tests showed that all five *Trichoderma* isolates effectively checked the growth of the four foliar pathogens. The test antagonists grew faster than the pathogen limiting their growth. *Trichoderma* isolate A was the best antagonist against *Drechslera heveae*, *Corynespora cassiicola* and C*olletotrichum* spp. showing percentage inhibition of 75.63 %, 51.34 % and 74.46 % respectively. Isolate B showed the best inhibition rate (70.99 %) against *Phytophthora* spp. All antagonists showed their lowest inhibition rates against *Drechslera heveae.* All the tested *Trichoderma* isolates showed antagonistic effects against four foliar pathogens under investigation. Therefore, the fungal strains can be used for further greenhouse and field studies to confirm the feasibility of using for the management of rubber foliar pathogens.

**Key Words:** *Trichoderma* spp.*, Drechslera heveae*, *Corynespora cassiicola,* C*olletotrichum* spp.*, Phytophthora* spp.

# Effect of Exogenous Nitric Oxide on Growth and Physiological Parameters of Rubber Clone PB 260 Subjected to Drought

R.M.C.G Rathnayake[1], P.E Kaliyadasa[1], H.A.S.L Jayasinhe[1], N.M.C Nayanakantha[2]

[1]*Department of Export Agriculture, University of Uva Wellassa, Badulla, Sri Lanka.*
[2]*Plant Science Department, Rubber Research Institute of Sri Lanka, Dartonfield, Agalawatta, Sri Lanka*

Rubber cultivation is being expanded into non-traditional areas of Sri Lanka where drought stress is one of the major abiotic stresses that limits growth and development. Nitric oxide (NO) is a bioactive molecule involved in diverse biological pathways that proved to be protective against damages under abiotic stress. Therefore, this study was carried out to investigate the effect of sodium nitroprusside (SNP) as an exogenous NO donor on physiological parameters and growth attributes in the rubber clone PB 260 under drought. Six treatments were imposed for polybagged rubber plants namely control (normal watering), T1 (drought stress, no watering), T2 (50 µM SNP + normal watering), T3 (50 µM SNP + drought stress), T4 (100 µM SNP + normal watering) and T5 (100 µM SNP + drought stress) that grown under glass house condition. Photosynthesis rate (*Pr*) and Stomatal conductance (*gs*) were recorded at 0, 2, 4, 7 and 14 day's intervals. Chlorophyll content (*Cc*) was recorded at 0, 7, and 14 days and also two weeks after treatments. Growth parameters were recorded after maturing of the new shoot during post treatment period. Although there was no significant difference among different treatments initially, a significant increase in *Pr* and *Cc* were observed in drought stressed plants in T5 compared to T1 where no SNP treatments. Stomatal conductance was significantly decreased with increase in water stress irrespective of SNP treatments. Interestingly, significant increase in *Cc* was recorded in both concentrations of SNP in drought compared to drought stressed plants with no SNP in two weeks after recovering. There was a slight increase in dry weight of the new shoots in plants in T3 and T5 compared to the plants subjected to T1. Results revealed that single application of SNP as a NO donor at the beginning of drought stress proved to be beneficial in alleviating the negative effects of drought stress on physiological and growth attributes of rubber plants.

**Key words:** PB 260, Drought, Chlorophyll content, Stomata conductance, Dry weight,

# Factors Affecting on the Population Levels of Cigarette Beetle (*Lasioderma serricorne*)

D.T.D. Wijesinghe[1], L.M.H.R. Alwis[1], A.N.R. Weerawansha[1], S. Amarasena[2]
[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Amazon Trading (Pvt.) Ltd.*

Ceylon tea as a beverage has been enjoyed by people all over the world for generations. It still has the value and interest as a beverage with many health benefits. Over a significant period of time, Sri Lankan tea industry has made progress in expanding the value added tea products. At present, Sri Lanka's value added tea exports include instant tea, tea bags, iced tea, flavored tea, green tea, herbal tea, ready to drink tea and organic tea. Herbal tea has become a major segment of value addition sector. Herbal teas draw higher market prices not only for tea's beneficial values but also the medicinal value of the herbs. These herbs are highly vulnerable to the attacks by different insect pests at storage conditions. Cigarette beetle is being identified as the most prominent storage pest in herbs warehouses. This experiment was therefore designed to identify the optimum storing condition that depress the population level of the cigarette beetle. Temperature, moisture and light wavelength were tested in this investigation. Three experiments were conducted separately to determine the effect of moisture (5%, 7%, 9%, 11%), temperature (21°C, 24°C, 27°C, 30°C) and light condition (Blue, Red, Pure white, Day light). Pheromone traps were used as the monitoring traps for to measure the population level. Sex ratio was determined by visual observation of chemically treated beetles through the stereomicroscope for their sex. The temperature level of 21°C and the moisture level of 5% helped to reduce the population level of the cigarette beetle. Red light condition recorded a significant reduction of population level than that of other tested wavelengths. Male to female sex ratio was identified as 1 to 4. Reduction of male insect population can lead to drastic reduction of whole insect population as females in the next generation would not have adequate males for mating. Longevity of the captured beetle was recorded up to 4 weeks. Thirty five percent of beetles were able to live up to 21 days while 25% survived up to 14 days.

**Keywords:** Cigarette beetle, Herbal tea, Storage conditions

**Technical Session IV**

# Sustainable Crop and Animal Production

## Poster Presentations

# Effect of Salt Stress on the Germination of Vegetable Cowpea

S.M.S. Himaya[1], K. Prapagar[1], S. Dasinaa[2]
[1]*Department of Agricultural Chemistry, Eastern University, Sri Lanka.*
[2]*Department of Agricultural Engineering, Eastern University, Sri Lanka.*

Seed germination has been recognized as the most critical stage in seedling establishment, which is ultimately determining the success of the crop production. Salinity is one of the soil factors which is highly correlated with the degree of crop establishment in leguminous crops. Therefore, it is very important to study on leguminous crops as they supply protein rich food for human consumption as well as enrich soil with nitrogen through nitrogen fixation that enable continuous crop production. With this background, present study was conducted to evaluate the effect of salinity stress on the germination percentage of vegetable cowpea separated under laboratory conditions. This experiment was laid out in a Complete Randomized Design (CRD) with four treatments and four replicates. The treatment groups were non-saline (T1), 0.5% saline (T2), 1% saline (T3) and 1.5% saline (T4). Data were analyzed using Statistical Analytical System (SAS) and means were separated by Duncan Multiple Range Test (DMRT). Seeds of the vegetable cowpea variety "Sene" were chosen and filter papers were soaked in a 5ml solution of the respective salt concentration and placed at the bottom of tightly-fitted petri dish (87x15 mm) along with the 10 seeds. Finally, the Petri dishes were kept in the incubator at 25± 1 0C, 12 hours of day length for five days. Results of the laboratory experiment showed that the germination percentage was significantly affected by salinity level, especially by the higher salt concentration. Among the all treatments, the highest seed germination percentage (95%) was found in the T2 (0.5% NaCl) and the lowest seed germination percentage (62.5%) recorded in T4 (1.5% saline) while comparing with the control one. Same trend was observed for shoot length (1.72 cm), root length (3.92 cm) and fresh weight of seedling (0.51 g/plant) in the treatment which was treated with the 0.5% NaCl. However, except root length other parameters were no significant in T2 compared to the control one.

**Keywords:** Cowpea, Salinity, Seed germination, Seedling weight, Shoots and root length

# Determination of Growth Performances and Meat Quality of the Broilers Fed with *Saccharomyces cerevisiae* as a Probiotic

W.H.D.S.P. Macelline[1], D.K.D.D. Jayasena[1], R.M.H. Tharangani[1], Zhang Song[2]
[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*The New Hope Lanka Ltd, Ekala.*

The study was carried out to find the effect of growth performance and meat quality parameters of broilers fed with *Saccharomyces cerevisiae* (SC) as a probiotic that can enhance the gut microflora and gut health of the broilers. Total 1050 day old "cobb 500" chicks were divided in to 7 experimental units randomly. Each experimental unit consists of 3 replicates with 50 birds in each replicate. Negatively control group (T1) was fed with only basal feed while other six test groups were fed with basal feed with different dosage (0.6%, 1%, 1.4%) of SC in short term (age of 1st day to 8th day) and long term (age of 1st day to 35th day) such as 0.6%SC long term (T2) and short term (T3), 1% SC long term (T4) and short term (T5), 1.4% SC long term (T6) and short term (T7). Average initial body weight, average final body weight, average feed intake and average Feed conversion ratio values were calculated and the birds were slaughtered and organ weight, carcass weight, breast weight, thigh muscle weight, meat quality parameters (pH, cooking loss and water holding capacity) and proximate analysis of meat were measured at the age of 35th day. Data were analyzed by one-way analysis of variance using the General Linear Models (GLM) procedures of SAS (2004). Highest average feed intake (3.31 kg) (p value= 0.0041) and lowest average body weight gain (1.80 kg) shown by T1. Highest average body weight gain shown by T6 (2.07 Kg) and T7 (2.06 Kg) (p value= 0.0001). T6 and T7 gave the lowest FCR (1.49 and 1.54) and highest FCR gave by T1 (1.83) (p value= 0.0001). The highest liver weight (0.036%) (p value= 0.0166) was shown by the T6 group. T4 and T5 are the most preferable in order. T6 has lowest pH value (pH 5.5) (p value= 0.0091) and T1 has shown highest water holding capacity (78.89) (p value= 0.0002). So that broilers fed with SC shown significantly high growth performance than negative control group (T1). SC was not shown any significant effect on meat quality parameters, proximate results and internal organs weight. So SC can use as a good growth promoter of the broilers.

**Keywords:** Feed conversion ratio, Water holding capacity, Broilers, Probiotic

# Determination of Optimal Grid Size for Mapping Soil Property Distribution for Paddy Cultivation

V.P.A. Dilrukshi[1], R.M.C.W.M. Rathnayake[1], W.M.U.K. Rathnayake[2], H.M.S.K. Herath[1]

[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Rice Research and Development Institute, Batalagoda.*

The importance of understanding spatial variability of soil properties is connected to crop management and planning. This understanding makes it possible to treat soil not as a uniform, but a variable entity to increase the production in paddy cultivation. This study was conducted to propose an optimum grid size for selected soil properties in Bakamuna area in Polonnaruwa district of Sri Lanka. The study area consisted with 6.25 $km^2$ and 96 soil samples were collected within the plough depth of 0-15 cm. The number of samples distribute as 96 samples in 200 m grid size, 37 samples in 400 m grid size, 16 samples in 800 m grid size, 8 samples in 1 km and 2 samples in 2.5 km grid size. The variability of soil pH, electrical conductivity, available P, exchangeable K, available Zn and soil texture were subjected to descriptive analysis and Inverse Distance Weighted interpolation (IDW) technique. Soil pH showed Coefficient of Variation (CV) range from 1 - 7% in different grid sizes, which could be categorized as properties with low variation where CV was less than 10%. Electrical conductivity showed CV range from 30 – 60% in different grid sizes. Exchangeable K range from 10 – 80% and available Zn range from 20 – 60% of CV values indicating medium variability, (CV 10 – 100%). Soil available P showed higher CV (>100%) values for 200 m, 400 m and 1 km grid sizes and rest of grid sizes showed medium CV values. Soil texture showed low variability distribution in paddy soil. This study shows the intensity of sampling is related to variability of soil properties. Sandy clay and sandy clay loam soil texture were observed in study area. Sandy clay loam soil texture was found only for two soil samples out of 96 in 200 m grid size. These results indicate 2.5 × 2.5 km grid size is optimum for determine the soil texture. Electrical conductivity and available Zn represent higher spatial variability in 800 × 800 m grid size indicating optimum grid size for mapping of those soil properties. 1 km grid size is optimum grid size for exchangeable K, available P and soil pH.

**Keywords:** Rice, Grid sampling, Soil properties, Coefficient of variation

# Development of Soil Fertility Map for Paddy Cultivating Areas of Mahaweli System B in Polonnaruwa District

R.P.G. Chathuranga[1], R.M.C.W.M. Rathnayake[1], W.M.U.K. Rathnayake[2], H.M.S.K. Herath[1]

[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Rice Research and Development Institute, Batalagoda.*

Paddy is a major cultivation crop in Polonnarwa District. In recent time a considerable gap has appeared between the potential yield and the real yield. Though several factors contribute to this effect, imbalanced soil fertility is one of the major factors. Therefore, survey of soil fertility was carried out in the area of Mahaweli system B in Polonnaruwa district to identify the status and spatial variability of plant nutrients in paddy cultivating areas to recommend management practices to enhance productivity. Sampling points were identify using 1:50000 topographic maps of Polonnaruwa, Wakaneri, Elahera and Aralaganwila. Geographical Position Systems (GPS) coordinates were used to record the geographic position. Sampling area was divided in to 2.5 × 2.5 km grid sizes and two samples were taken from one grid and 110 samples covering the total land area. In each sampling point, soils were augured up to 15 cm and composited. Soil samples were air dried and analyzed for pH, electrical conductivity, available P and Zn, exchangeable K and Na. The pH value varied from place to place but most of the area covering the irrigation scheme had pH below 5.5. All the area had low EC value (<0.125 dS/m). It indicates the low level of salinity. Soil available P content was considerably lower (<10 ppm) than the recommended value in almost of sampling the area. Available Zn concentration was between 1-5 ppm in all the area while the soil exchangeable Na value was above the recommended value (>100 ppm). There was a low concentration of exchangeable K value (<78 ppm) in most of the area. It is concluded that inverse distant weighted is the most suitable interpolation technique for mapping soil pH, EC, available P, Zn and exchangeable Na and K as regard to the lowest Root Mean Squire Error (RMSE) and Mean Error (ME) values. The soil fertility characteristics of the Mahaweli system B in Polonnaruwa district are not at optimal level to achieve maximum potential of rice yields. Therefore, development and adoption of suitable management practices are needed to enhance and sustain the rice production in this area.

**Keywords**: Soil suitability,Soil fertility, Interpolation, Geographical position system, Mahaweli B

# Effect of Mulching on Cabbage (*Brassica oleracea* var *green coronet*) Cultivation in Welimada Area

J.M.C.K.K. Jayasundara[1], H.M.S.K. Hearath[1], R. Dabarera[2], H.K.S.G. Gunadasa[1]
[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Unipower (Pvt.) Ltd., Pelawatta, Battaramulla, Sri Lanka.*

The present study was undertaken to determine the effect of mulching on cabbage (Brassica oleracea. var green coronet) cultivation. Cabbage seedlings (25 – 27 days old) were used as planting materials and mulching applications such as (i) no mulch (control,T1), (ii) white polythene (T2), (iii) silver polythene (T3), and (iv) weed slash (organic) (T4) were applied in a randomized complete block design (RCBD). Leaf area (length and width), head girth, fresh and dry mass, length of roots, no of roots, no of leaves and weed infestation were recorded. The results showed that there was a significant ($p>0.05$) difference in plant leaf area at two weeks after transplanting between the treatments, but there was no significant difference ($p>0.05$) between the treatments with respect to the number of leaves The mean head girth of all amended treatments increased over the control. However, the increase was significant ($p<0.05$) only at T2. There was a similar effect on both fresh and dry masses of cabbage by the four treatments. Accordingly, both the lowest fresh and dry masses were recorded in the control whereas the highest was given by the white polythene treatment. The treatments also significantly ($p<0.05$) affected the number and length of roots in cabbage. Six weeks after transplanting, the mean weed score for T1, T2, T3 and T4 mulching applications were 4.0, 2.0, 2.0, and 3.0, respectively. White and silver mulches were the most effective mulch material for cabbage production. When growing green coronet cabbage in up country, it is recommended to mulch with white or silver polythene in order to realize near perfect growth and yield.

**Keywords:** Mulches, *Brassica oleracea*, Green coronet, Weed suppression, Growth and yield

# A Comparison of Selected Biochemical Parameters in Between Susceptible and Tolerant Tea Cultivars for *Glyptotermes dilatatus* (Low Country Live Wood Termite)

H.M.D.C. Abeyrathna[1], L.M.H.R. Alwis[1], A.N.R. Weerawansha[1], K.M. Mevan[2], M.S.C. Fernando[2], P.D. Senanayake[2]

[1]Department of Export Agriculture, *Uva Wellassa University, Badulla, Sri Lanka.*

[2]*Tea Research Institute, Thalawakelle, Sri Lanka.*

Pest damages are a severe problem to the Sri Lankan tea industry. Low Country Live Wood Termite (LCLWT), *Glyptotermes dilatatus* is one of the most economically important pests in Sri Lanka as they attack to the low grown teas which have the highest contribution to the Sri Lankan tea production. Introducing highly tolerant cultivar with high yielding is the most promising method among various methods of controlling pest. Feasibility of using biochemical parameters for the screening of new cultivars for the pest attack of LCLWT is a new approach in today's world. This research was conducted to compare selected biochemical parameters; Caffeine, total Catechin and total Polyphenol contents in between tolerant and susceptible cultivars for LCLWT. Healthy and rotted stems of nine cultivars (TRI 4042, TRI 4049, TRI 4053, TRI 4054, TRI 4061, TRI 3014, TRI 3025, TRI 3055, TRI 3069) which were susceptible and tolerant to LCLWT were collected separately. Caffeine content had increased in all cultivars upon infestation. Tolerant, moderately tolerant and susceptible cultivars had high, moderate and low total catechin content in the healthy stems, respectively. Total catechin and total polyphenol content decreased in all the cultivars upon infestation. There are main three clusters at 0.75 distances according to the biochemical parameters considered in healthy stems and tolerant, moderately tolerant and susceptible cultivars to the LCLWT are divided into clusters separately.

**Keywords:** Low country live wood termite, Semio-chemicals, Cultivar screening

# Interference of Tapping due to Rainfall and Effectiveness of Rain Guards Under Different Rainfall Scenarios: A Case Study in the Dartonfield Rubber Estate

M.A.V.N. Padmathilake[1], N.S. Withanage[1], R.A.P.I.S. Dharmadasa[1], W. Wijesuriya[2], W. Jeewanthi[1]

[1]*Department of Export Agriculture, Uva Wellassa, Badulla, Sri Lanka.*
[2]*Department of Biometry, Rubber Research Institute of Sri Lanka, Agalawatta.*

Well distributed moderate rainfall is essential for good growth and production of rubber trees. However, rainfall may be a limiting factor for tapping activity, as most of the rubber plantations of Sri Lanka are spreaded in the Wet Zone, where the annual rainfall is greater than 2500 mm. And thus an average of 35% of potential yield of rubber is lost due to interference of rain. In this context, rain guards have been introduced to reduce the yield loss during rainy periods. Therefore, this research study was conducted to evaluate the rainfall interference on tapping and the effectiveness of rain guards under different rainfall scenarios, as a case study in the Dartonfield Rubber Estate, RRI, Agalawatta. Hence, rainfall distribution was identified with the help of annual rainfall, annual wet and dry days and average monthly rainfall. Further, trend analyses were done for different rainfall parameters using Mann – Kendal Test. Through, a regression analysis, the most important rainfall characteristics that affect tapping and the relationship of these characteristics with tapping were determined. Moreover, the economic benefits that can be obtained by fixing rain guards were also assessed. The results revealed that the average annual rainfall at Dartonfield is 4156 mm, together with more years having wet days above 200. Mostly during evenings and nights, rains have fallen in the whole year. Further, during April to November, there have been more than 18 rainy days. The regression analysis results revealed that, under without rain guards situation, the significant rainfall characteristics affect tapping were total rainfall duration of previous day and intensity of rains fallen during 3.00 am to 9.00 am period. The significant rainfall characteristics affect tapping under rain guarded situation were highest intensity of rain and total rainfall duration on previous day. Further, the comparison done for checking the possibility of tapping under with and without rain guards revealed that, the tapping can be practiced on additional 28 rainy days by fixing rain guards, leading to an additional income of Rs. 1,19,365/ha according to the crepe rubber price of 13th September 2015. Moreover, the rain guard establishment cost can be recovered from the earnings of 6 tapping days.

**Keywords:** Different rainfall scenarios, Rainfall interference, Rain guards, Rubber Plantations, Tapping

# Evaluating the Impacts of Land Use / Land Cover Changes on Agro-biodiversity of Kandyan Home Gardens

A.M.N.S.K. Abeysinghe[1], L.M.H.R. Alwis[1], R.M.C.W.M. Rathnayake[1]
H.K. Kadupitiya[2]
[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Natural Resources Management Centre, Department of Agriculture, Peradeniya.*

Kandyan Home Gardens are multi-species traditional agro-forestry systems which conserve biodiversity. Land Use / Land Cover changes adversely affect on biodiversity in Kandyan Home Gardens. Land Use / Land Cover changes in the Kandy district were analyzed using Remote Sensing and GIS techniques. Landsat images of year 2000 and 2015 were used for the study. Supervised classification technique was used to identify different Land Use / Land Cover classes and Land Use / Land Cover change maps for year 2000 and 2015 were prepared. Normalized Difference Vegetation Index (NDVI) maps were prepared for year 2000 and 2015. Least square regression technique was used to rectify the climatic influences in satellite images. By obtaining the percentage NDVI change between 2000 and 2015, three Land Use / Land Cover change categories were identified; less changed, moderately changed and highly changed. Agro-biodiversity in Kandyan Home Gardens was evaluated through field investigations in 90 home gardens in Ambathenna, Pilimathalawa, and Gampola. The Land Use / Land Cover change category which each Kandyan Home Garden belonged to was identified using Global Positioning System. Species Richness, Shannon-Weiner index and Simpson Diversity Index were used to assess the agro-biodiversity. Land holding size in majority of home gardens was between 0.01 to 0.758 ha. Trees and root and tuber crops consisted of 88 species and 45 plant families were identified. Less changed area and moderately changed area had similar Species Richness and Shannon-Weiner values for diversity, but evenness of abundant species was higher in moderately changed area. Thus, agro-biodiversity in moderately changed area was high. Twenty seven species were perceived as threatened or lost from Kandyan Home Gardens. The study suggests the need of linking tree conservation programme with home gardens. A proper investigation has to be carried out to identify the threatened varieties.

**Keywords:** Agro-biodiversity, Kandyan Home Gardens, Land Use / Land Cover change, GIS and Remote Sensing

# Effect of Tea Waste as a Urease Inhibitor in Soil

K.G.N.D. Dassanayake, A.G.A.W. Alakolanga.
*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka.*

Efficiency of urea rarely exceeds 50%, although it is one of the major fertilizer, as most of it is lost as ammonia and $CO_2$. Urease enzyme is responsible for this break down. Excessive release of ammonia is toxic to plants, especially younger plants. Previous researches have shown that chemical compounds in drinking tea can inhibit urease enzyme to a greater extent. This research was designed to study the possibility of using refuse tea to inhibit the soil urease enzyme and slow down the hydrolysis of urea. The optimum amount of tea waste to be incorporated was determined by mixing different amounts of tea waste with constant amounts of urea and soil and released ammonia content was measured after 24 hours using Hoffman's method. The effect of time on inhibition of urease was studied by mixing constant amounts of urea with constant amounts of Tea waste and soil. Ammonia content was measured after 24 h, 48 h, 72 h, 96 h and 120 h. The effect of urease inhibition on growth conditions was also determined as follows. Soil and tea waste mixtures (10:1.5) were prepared in polythene bags with 50%, 75% and 100% urea from the recommended amount and chlorophyll content and inter nodal length were measured at two weeks intervals with "Thilina" tomato variety. Controls were prepared without tea waste and with 100% urea. Complete Randomized design was applied. The optimum amount of tea waste to be incorporated was determined as 1.5 g per 10 g of soil and per 50 mg of urea as this combination showed a 50% average inhibition. Inhibition exhibited a positive correlation with time with $r^2$ 0.976. The treatment containing 50% urea showed a significant increase in chlorophyll content than the control with p value 0.003. There was no significant difference among the treatments for intermodal length. With the results of this research, it can be concluded that the application of tea waste successfully control the hydrolysis of urea and it does not have any negative effects on growth parameters of "Thilina" tomato variety.

**Keywords:** Urease, Inhibition, Tea waste, Urea

# Evaluation of Varietal Variation in Initial Growth and Development of Sugarcane (Saccharum officinarum.L) Under Irrigation

D.S.K. Rathnaweera[1], M.K.T.K. Amarasinghe[1], G.A.H. Galahitigama[1], H.M.G.N.S.C. Bandara[2]

[1]*Department of Crop Science, University of Ruhuna, Sri Lanka,*
[2]*Gal-Oya Plantations (pvt) Ltd, Hingurana, Sri Lanka*

Sugarcane is a commercial crop grown in Sri Lanka for manufacturing sugar. Hybrid sugarcane genotypes have been developed and selected to cultivate in different locations in Sri Lanka. However, the gap between potential and actual yield in sugarcane is significant in all sugarcane growing locations. Cane and sugar yield varies on different factors such as verities, growing condition, management practices, climatic and soil characteristics in the location. Thus, the objective of this study was to investigate the initial growth performance of selected sugarcane varieties in Hingurana under irrigated conditions to select the most suitable varieties in Hingurana area. The experiment was conducted at the agronomy field in the Gal-Oya plantations, Hingurana, Ampara. Five sugarcane varieties, M 438/59 (T1), SL 7130 (T2), SL 96 328 (T3), SL 88 116 (T4) and SL 92 4918 (T5) were tested in a randomized complete block design with three replicates. Following observations in initial growth stages of sugarcane were made: time taken to emerge first shoot, germination percentage, time taken to emerge first, second and third tiller, tiller counts at 45, 60 and 75 days after planting (DAP), leaf area index and above ground total biomass, bulk density and soil moisture content. There was a significant ($P<0.05$) varietal variation in time taken for germination of first shoot, germination percentage at 45 DAP, total tillers at 60 DAP and 75 DAP and time taken for first second tillering. Bulk density of each plot was similar and around 1.47 to 1.49 g/cm$^3$. The average soil moisture content in 1 m soil profile was greater than 20% (dry weight basis) since planting up to 2 months after planting. According to overall results, initial growth performances of the variety SL 96 328 were better in Hingurana area compared with the other tested varieties.

**Keywords**: Sugarcane, Varietal variation, Hybrid varieties

**Technical Session V**

# Aquaculture and Fisheries

## Oral Presentations

# An Investigation on Total Catch, Catch Composition, Catch Quality Variation Based on Different Effort Levels in Multiday Boats in Kalutara District

A.W.K. Fernando[1], N.D.P. Gunawardane[2], I.U. Wickramarathna[1], S.C. Jayamanne[1]
[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Department of Fisheries and Aquatic Resources, Colombo 10, Sri Lanka.*

Deep sea fisheries commenced in late 1980s and introduction of Multiday boats with modern technologies (GPS, SSB radio, Freezer unit, Fish detecting sonar) and synthetic nets increased the pelagic fish production. The multi-day boats in operation today are of several types, varying according to their length and the degree of sophistication. Those vessels use several types of fishing gears based on their preference and also fishing duration also differ with those boats. Fishermen have their own selections on those variables according to their knowledge, experience to maximize their catch with good quality by applying minimum effort.This study was carried out to identify the deep sea fishery trends and optimum efficiency levels in Kalutara fishery district using landing statistics (Catch) and fishing inputs (effort) and to give recommendation on management of Kalutara fishing fleet. In this study, total catch per fishing trip and species wise catches taken as output data and gear type, fishing trip duration, boat length, facility level, no. of crew and boat capacity are taken as input data. Parallel organoleptic survey of fish catch was conducted to measure the quality level of fish. The study found that only the gear type is significantly affecting total catch per trip and other five factors (Boat length, Boat capacity, No. of crew, Trip duration, and Facility level) do not affect the total catch per trip. Three types of fishing gear including longline, gillnet and ring net and combination of gears was used basically and the catch composition of the single species catch is not significantly affected by gear type. Longline, gillnet and ring net when taken individually, significantly affects the species catch variation. The fish quality is significantly affected by total catch, trip duration, and boat capacity while not significantly affected by gear type and facility level. So according to the study it can be recommend that gear combination (better to use Longline cum Gill net) is the most suitable fishing method as it gives high fish catch (2427 236) with medium quality (1.8571 0.1650) fish and more emphasis should be given on fish quality improvement in Beruwala fishery harbor.

**Keywords**: Deep sea fishery, Multiday fishing vessels, Catch, Fishing effort, Fish quality, Fisheries management

# Effectiveness of Ultraviolet Filtration of Incoming Sea Water for Controlling *Vibrio* spp. in Shrimp Hatcheries in North Western Province

I.P.D.H. Pathirana[1], R.M.G.N. Rajapakshe[1], S.C. Jayamanne[1], R.M.N.P.K. Ranathunga[2]
[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka.*
[2]S*hrimp Farm Monitoring and Extension Unit, National Aquaculture, Development Authority, Batthuluoya, Sri Lanka.*

*Vibrio* spp. are natural micro flora that presence in marine waters are one of the main factors which responsible for larval mortality of penaeid shrimp. To avoid bacteriological problems, shrimp hatcheries adopt extensive water treatments which include effective ultraviolet filtration. But there the effectiveness of UV filters is a considerable problem. Therefore effectiveness of UV filtration of incoming sea water for controlling the *Vibrio* spp. and the management procedures that can be implemented for improving the efficiency of UV filters were studied. Ten shrimp hatcheries out of forty seven hatcheries in north western province of the country were selected. Sea water samples were taken before and after the UV filtration and were subjected to the Total Vibrio Count (TVC) test. Thiosulfate Citrate Bile salt Sucrose (TCBS) agar was used as the culture medium and pH, salinity, Ammonium-N, Nitrate-N, Nitrite-N were checked. Questionnaire survey was also conducted for collecting information regarding water treatment systems, disinfection procedures and the factors affecting on the efficiency of UV filters. According to this study there is a significant difference by considering the TVC among hatcheries and between the TVC of sea water before and after UV filtering. It was observed that salinity and pH have no significant effect on the TVC. According to questionnaire survey, although each hatchery uses the UV bulb capacities which are relevant to the water flow rates by considering the water usage volume, the effectiveness of UV filtration is not in an efficient level when comparing the mean values of TVC of sea water before and after UV filtering. According to Chi square Goodness of fit test, availability of charcoal filters, maintaining the records of hours of UV filter operation, replacing UV bulbs after its life time and routine changing of filter media in sand, charcoal and cartridge filters have significant impact on the TVC of UV filtered water. Therefore productive maintaining of the filter system is very important for the effectiveness of UV filtration.

**Keywords**: Water quality, Shrimp disease, Bacteriological problems, Water treatments, UV filters

# The Aspects on Reproductive Biology of Blue Swimming Crab *Portunus pelagicus*, (Linnaeus, 1758) in Mannar Area

A.P. Abeygunawardana,S.C. Jayamanne
*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka.*

Blue swimming crab fishery is a newly emerging export oriented fishery in North and North-Eastern provinces of Sri Lanka. Since the exploitation is heavy in these areas establishment of management strategies are important for sustainability of the fisheries. Hence the aspects on reproductive biology such as maturity stages, pre-spawning and post spawning fecundity, size at first maturity and gonadosomatic index of the Blue swimming crab (*Portunus pealagicus*) in Mannar area were studied during the period, May to July, 2015. The fecundity was estimated using Gravimetric method. Six ovarian development stages, immature, developing, early Mature, late mature, ripe and spent were identified in non ovigerous crabs and five ovarian development stages, light yellow ovaries, pale yellow ovaries, pale orange ovaries, black colour ovaries and grey colour ovaries were identified in ovigerous female crabs. The size at first maturity was determined as 57.5 mm carapace length and carapace width 113.50 mm. The pre spawning fecundity estimates ranged from 105874 to 516000 in the crabs of 133 mm to 158 mm carapace width. The post spawning fecundity estimates ranged from 537600 to 1739000 in the crabs of 121 mm to161 mm carapace width. The pre spawning fecundity and the post spawning fecundity showed positive correlations with the carapace width, carapace length and the body weight ($P<0.01$). The Gonadosomatic Index of the female crabs varied from 0.94±0.0208 in immature crabs to 30.6 ±0.8048 in matured crabs. More than 80 % of the catches contained immature crabs while percentage of ovigerous females was 8%. High exploitation of immature crabs and ovigerous crabs may have serious impacts on the sustainability of the Blue swimming crab fishery in future.

**Keywords**: Carapace length, Pre spawning fecundity, Post spawning fecundity, Reproductive biology.

# An Investigation of the Economic Impact on Fishing Communities in Mannar District Caused by Illegal Fishing by Indian Trawlers in Sri Lankan Waters

B.M.K. Sosai, I.U. Wickramaratne, S.C. Jayamanne,
*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka,*

Mannar district is located in the Northwestern Sri Lanka (8° 52′ 0″ N, 80° 4′ 0″ E). Thalaimannar, Pesalai, Vankalaipaadu, Erukkalampiddy, Pallimunai, Panankaddikoddil, Thalvupadu in Mananr District were selected for the study. Primary data were collected through a questionnaire survey and direct interviews with fishing community leaders, officials of department of fisheries, fishing agents and traders. Information on fishing season (charts), monthly income, the relative impact of Indian trawlers on village fishing activity, direct and indirect losses to the ancillary service sectors in each village, the quantities of fish and fish species caught by Indian trawlers and the number of Indian trawlers and their annual production were obtained. Secondary data was gathered through research papers, publications and internet. Gathered data were analysed with three approaches i.e. Approach A: Direct losses due to Indian trawlers harvesting Mannar's marine resources, (estimated daily and annual direct losses were Rs.54.4 million and Rs.6955.2 million, respectively) Approach B: Indirect loss due to Mannar fishermen by not being able to harvest Mannar's marine resources (estimated annual indirect losses were Rs.425.63 million), Approach C: Direct losses due to the destruction of fishing gears (Rs. 2, 56, 18,750), Approach D: Direct and indirect losses for ancillary service sector (Rs.24, 59,400 and Rs.24, 59,400 respectively). Data were analyzed using MS Excel 2010. Indian trawlers fish in the northern Palk Bay and south of Gulf of Mannarall year round, while they trawl Pesalai, Vankalaipadu, Erukkalampiddy and Pallimunai in northern coast of Mannar from May to October. Further, Panankaddu koddil and Thalvupadu, located in Southern Mannar were trawled from November to April. Mechanized trawling has been banned by Tamil Nadu State Government for 45 days a year, therefore illegal trawl fishing stops in between March to April (about 45 days). In this study it was found that Thalaimannar (with idela location for fishing), Peasalai and Vankalaipaadu villages were highly affected. Vankaalaipaadu fishery activities mainly depend on gill net. It was found gill net fishing activity was affected by trawler activity. Five other villages faced less loss due to the operation of trawlers, because fishery activities carried out only for six months using variety of fishing gears.

**Keywords**: Mannar district, Indian Trawlers, Coastal fishery, Gill net, Economic Impacts.

# Efficacy of Aloe vera Against Aeromonas hydrophila in Gold Fish (*Crassius auratus*)

D.M.S.G. Dissanayaka[1], S.S.S de S Jagoda[2], R.R.M.K.K. Wijesundera[1]
[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Center of Aquatic Animal Disease Diagnosis and Research, Faculty of Veterinary Medicine and Animal Science, University of Peradeniya, Peradeniya, Sri Lanka.*

Sri Lanka is a pioneer county of ornamental fish industry. Guppy, Goldfish, Swordtail, Moly are some fresh water fish species which have high export potential. Disease is one of the major constraints to the development of the ornamental fish industry and bacterial infections are very common in ornamental fish. Herbal medicines have become cheaper and better alternatives to antimicrobial drugs to treat bacterial infections in fish. Therefore, this experiment was conducted to determine the efficacy of *Aloe vera* for gold fish growth and against artificially injected *A. hydrophila. A. hydrophila* was isolated from a septicaemic fish and the identity was confirmed through conventional bio chemical tests and Polymerase Chain Reaction- Restriction Fragment Length Polymorphism (PCR-RFLP). Fresh and mature *A. vera* leaves were used for the experiment. Antibacterial efficacy of *A. vera* was tested in *in- vitro* by using *A. vera* supernatant. To examine in- *vivo* antibacterial efficacy, *A. vera* supernatant was combined with commercial fish feed and three different *A. vera* concentrations, *i.e;* 250 g/kg, 500 g/kg and 750 g/kg were used with a control. According to the results, there was a positive effect of *A. vera* against *A. hydrophila* i*n-vitro.* Original *A. vera* supernatant had the highest inhibition zone *in-vitro*. Inhibition zone diameter was decreased with increased dilution. When consider about the *in- vivo* method, a noticeable increase in body weight and Feed Conversion Efficiency was observed as the *A. vera* concentration in feed goes up, though the values are not statistically significant. Different levels of mortalities were observed in all groups, but the highest mortality within the observed period was recorded in control group and the lowest in the group fed with highest *A. vera* concentration.

**Keywords**: Bacterial infections, PCR- RFLP, Feed conversion efficiency, Antimicrobial drugs, Ornamental fish industry.

# Examine the Appropriate Ovulation Time to Determine Latency Period of Golden Tinfoil Barb (*Barbonymus schwanenfeldii*) Using Ovaprim™

W.A.U. Isharini[1], E.D.M. Epasinghe[2], T.A.D.W. Karunaratne[2], A.M.A.N. Adikari[2], N.P.P. Liyanage[1]

[1]*Deparment of Animal Science, Uva Wellassa University, Badulla, Sri Lanka.*

[2]*National Aquatic Resources Research and Development Agency, Crow Island, Colombo 15, Sri Lanka.*

Fertility of the Golden Tinfoil Barb is very low when they are subjected to induced breeding practices. The research was carried out to determine the appropriate ovulation time for maximizing the fertility rate of Golden Tinfoil Barb, *Barbonymus schwanenfeldii*. Induced spawning of *Barbonymus schwanenfeldii* was conducted at different Ovaprim (sGnRHa and Domperidone) dose and latency period combinations to observe the appropriate ovulation time to increase the fertility. For the purpose, three doses of Ovaprim (0.4, 0.6 and 0.8 mL/kg of body weight) and three latency periods (4, 6 and 8 hours) were considered in nine combinations. Males were injected with half of dosage from female. Induced of breeding was carried out in the hatchery and same water source was used for maintaining the equal condition. After the injection, biopsy tests were performed for all the females after 4, 6 and 8 hours from the injection to detect the moment of ovulation. After eight hours, mean egg diameter was 982.81 ± 48.49 μm, germinal vesicle had broken down, follicle had already removed and ovulation had occurred. When ovulation was observed, hand stripping and then artificial fertilization was carried out. One hour after fertilization, between 40 and 60 eggs of three samples were taken from the hatching jar for each dosage and eggs were counted to calculate percentage of fertilization. Although all ovulation times were recorded in approximately eight hours after the injection, the recorded fertility rates were different. 4% fertility rate was recorded with the 8 ± 2.0 hours in 0.4 mL/kg, while it was 80% with the 8 ± 0.5 hours in 0.6 mL/kg of Ovaprim and fertility rate was 52% when 8 ± 0.5 hours in 0.8 mL/kg. The highest fertility rate was recorded in 0.6 mL/kg of dosage. Although 8 ± 0.5 hours ovulation time was recorded in 0.6 mL/kg and 0.8 mL/kg of body weight of female, their fertility rates were different.

**Keywords**: Fish breeding, Egg diameter, Hand stripping, GnRH, Fertility rate

# Strategies to Reduce Larval Cannibalism of *Pangasius sutchi*

W.M.W.S. Thilakarathna[1], E.D.M. Epasinghe[2], T.A.D.W. Karunaratne[2], A.M.A.N. Adikari[2], N.P.P. Liyanage[1]

[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka.*

[2]*National Aquatic Resource Research and Development Agency, Crow Island, Colombo 15, Sri Lanka.*

Ornamental fish industry is the most significance income earning approach in Sri Lankan economy. *Pangasius sutchi* (Thai pangus) is considered as the most popular ornamental fish species. In their early larval stage, they show cannibalistic behaviour which leads reduction of population. Then experiment was conducted to reduce the larval cannibalism of larvae within first 72 hours because it has been identified as the critical period of their cannibalistic behaviour. Therefore several types of feed, feeding frequencies and stocking densities were tested. We investigated the effect of two different types of feed(*Artemia* and Moina),three different feeding frequencies (3hr,4hr,5hr)and three different stocking densities(60.90.120)one square feet can hold 80 larvae and 22"×10×10glass tank can hold approximately 94 *P.sutchi* larvae. Each tank was randomly assigned to one of the treatment. At the end of the experiment numbers of survivals were calculated to determine the cannibalism rate. Five fish from each tank were sampled to measure body length. Then numbers of average body length were recorded. Data were statistically analized by using MINITAB 17 software. Significance levels were calculated to determine whether there is any relationship or not. Results showed that the feed types were not significantly ($p>0.05$) affect the survival rate and it only affected the body length. Feeding frequency was significantly ($p<0.05$) affected the survival rate and not affected the body length. And also results showed that stocking density affected the survival rate significantly ($p<0.05$) and not affected significantly for body length of larvae. Final results indicated that highest mean survival rate was recorded with 60 stocking density whereas lowest survival rate was recorded in 120.highest mean body length was recorded with the *Artemia* feeding with 3hour feeding frequency.

**Keywords**: Cannibalism, Feeding frequency, Stocking density, *Artemia*, *Moina*

# Effect of Diets Incorporated with Dried and Autolyzed Shrimp Waste on Growth Performance of Goldfish (*Carassius auratus*)

R.M.C.P. Rathnayake[1], N.P.P. Liyanage[1], J.A. Athula[1], K.P.G.K.P. Guruge[1], W.A.R.K. Senaarachchi[2]

[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka.*

[2]*Agri-Star compost, Peliyagoda, Sri Lanka.*

The shrimp processing industry turns out tons of head, tail and shell waste every year and this is a rich source of protein that could be used to prepare aquaculture feeds. The efficiency of different methods for extracting protein from shrimp waste were observed. This study has been designed to assess the possibility of partial replacement of fish meal with shrimp waste in diets formulated for goldfish. Known amount of shrimp waste samples were subjected to autolysis and subsequently subjected to oven drying and make fine powder. Crude protein, crude lipid, ash and moisture were estimated for both autolysed and powdered dried shrimp waste (purchased from Agri-Star Compost private limited). Two different diets were prepared by incorporating autolysed shrimp waste powder and dried shrimp waste powder as supplementary source of protein. Commercial feed that contains 42% protein was used as the control diet. Uniform sized glass tanks were stocked with twenty individuals with an initial mean weight of 0.13 ± 0.00 g per tank. Fishes were hand-fed daily three times per day for 30 days with three diets. Wet weight of the fish were measured weekly. Feed Conversion Ratio (FCR), Specific Growth Rate (SGR), Protein Efficiency Ratio (PER) and Condition Factor (K) were calculated for each diet. The highest protein level (65.55% ± 0.60) and lowest ash level was observed (11.35% ± 0.03) in autolysed shrimp waste. Significantly higher SGR, PER and survival rate (91.25% ± 3.15) were observed in individuals fed with diet incorporated with autolysed shrimp waste while significantly low FCR was observed in the same ($P<0.05$). Condition Factor was not significantly changed among the test diets ($P>0.05$). The findings of this study indicate that autolysis is the best method to extract protein form shrimp waste. During the process of autolysing meat part was detached from the shell and extracted to the aqueous medium. This process will facilitate to collect comparatively pure source of protein with compared to the dried shrimp meal. Therefore, autolyzed shrimp waste powder that contains significantly higher protein percentage can effectively enhance the growth parameters while use as protein supplement in the diet of goldfish.

**Keywords**: FCR, SGR, Fish feed, Fish nutrition, Ornamental fish.

**Technical Session V**

# Aquaculture and Fisheries

## Poster Presentations

# Identification of Factors Affecting the Survival of Lobster Exports Industry in Sri Lanka with Special Reference to Spiny Lobster

L.P.S. Chamodika[1], S.C. Jayamanne[1], T.G.A. Duminda[2]
[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Biodiversity Protection Unit, Sri Lanka Customs, Colombo 01, Sri Lanka*

At present there are five main species of Spiny Lobsters exported from Sri Lanka. There are controversial findings regarding lobster resource and it is required to know the current status of the lobster resource in Sri Lankan oceanic waters. Thereby the status of lobster fishery and exports industry as well as the factors affecting the survival of lobster exports industry in Sri Lanka are required to be identified. The present study was carried out to fulfill this requirement. Questionnaires and direct interview methods were used to obtain the relevant information from the exporters, lobster fishermen, lobster purchasing centers and collectors. Lobster export data and catch data were analyzed by using MS Excel. Information related to legal aspects and other stock assessment projects related to lobsters were obtained from Ministry of Fisheries and NARA. Currently, *Panulirus longipes* is the mostly exported lobster species and it accounts for 30.4% of total lobster exportation. *Panulirus ornatus* is nearly overexploited. *Panulirus polyphagus* has completely vanished from Sri Lanka. *Panulirus ornatus* fetch the highest price in the export market (US$ 70/Rs. 8200 per Kilogram). Highest lobster production and export quantity as well as the highest export value were earned in 2013. Availability of the lobsters in the ocean around Sri Lanka, laws and regulations, political influence, Scuba divers & other recreational divers, problems faced by the lobster fishermen, problems faced by the exporters, illegal activities done by fishermen, collectors and exporters are the factors affecting the survival of lobster exports industry in Sri Lanka which were identified from the present study. Some of these factors affect positively on the survival of lobster exports industry while other factors affect negatively on the survival of this industry. Relevant authorities should take steps to protect this lobster resource while providing opportunities to the fishermen, exporters and local consumers to use the resource in a sustainable manner.

**Keywords**: Lobster export industry, Lobster production, Stock assessment

**Technical Session VI**

# Water Science and Technology

## Oral Presentations

# Introducing a Cost Effective Treatment Process to Improve the Effluent Water Quality of Natural Rubber Processing Factories

K.H.I. Gamage[1], N.P. Premachandra[1], H.M.T.S. Ritigala[2]
[1]*Deapartment of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka,*
[2]*Ceylon Green Consultants (Pvt) Ltd, Battaramulla, Sri Lanka*

Most natural rubber processing factories in Sri Lanka tends to discharge their effluent water without treating properly or directly into the nearest stream as proper treatment processes reduce their profit. The objective of this study is introducing a cost effective and commercially viable treatment process to treat the effluent water generated from natural rubber processing factories. The proposed cost effective treatment process includes two treatment steps mainly as Pretreatment Process and Biological Treatment Process. In the Pretreatment Process Total Suspended Solids (TSS) and the Turbidity of the effluent water are reduced using a natural coagulant, and in the Biological Treatment Process the amount of Nitrate and Sulphate dissolved in the effluent water are biodegraded using facultative anaerobic bacteria. As the natural coagulant in the Pretreatment Process Bentonite clay is used and to increase the surface area for the growth of anaerobic bacteria in the Biological Treatment Process a bio brush media made up of bristle fibre coir is used. The effectiveness of proposed treatment process was analysed using effluent water samples collected from eight natural rubber processing factories. In the analysis pH, TSS, Turbidity, Total solids, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Sulphate and Nitrate contents were measured before and after the treatment process. The proposed cost effective treatment process can reduce the TSS content even below the permissible value of 100 mg/l (Turbidity and TSS reduction up to 97% and 54% respectively) and it can reduce the BOD and COD values very close to the permissible levels of 50 mg/l and 400 mg/l respectively (BOD and COD reduction up to 79% and 70% respectively). Sulphate and Nitrate biodegradation efficiency is nearly three times higher when using the introduced bio-brush media as it increases the surface area for anaerobic microbial growth. As Pretreatment Process needs about 6 hours of contact period and Biological Treatment Process needs about 15 days of contact period, this process is more suitable for medium scale natural rubber processing factories where large amount of effluent water is not produced daily.

**Keywords**: Waste water treatment, Biological treatment, Cost effective treatment

# A Preliminary Study on Absorption of Heavy Metal (Lead) From Synthetic Waste Water Using Mullet (Mugil spp.) Fish Scales

H.M.S.S. Herath[1], A.G.A.W. Alakolanga[2], E.D.N.S. Abeyrathne[1]
[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*

Heavy metals are relative dense metals present in earth crust that are in high accumulation level in water bodies. Among several technologies to remove these heavy metals, biosorption is a novel concept that use in waste water facilities. This study was carried out tofind the feasibility of using mullet (*Mugilidae spp.*) fish scales as a biosorbant and find the best cost effective form of mullet fish scales to absorb heavy metal (Pb) in synthetic waste water.The effect of oven drying conditions, particle size, and dosage of fish scales and pH for the absorption of heavy metal (Pb) absorption were investigated by Atomic Absorption Spectrophotometer (AA240, 283.33 nm, Varian., Australia). The reusability was investigated with the use of nitric and hydrochloric acids. The highest mean absorption results were obtained for 3 g (98.70 ± 0.73) of damaged 1-2 $cm^2$ size (92.03 ± 0.51) with oven drying conditions of 80°C (99.10 ± 0.52) for 24 hours (93.93 ± 2.38). All parameters were indicated that there was a significant difference among the treatments ($P < 0.05$). In addition to that, absorption was not depended on pH and reusable ability was high with the nitric (19.83 ± 5.66) compared to hydrochloric acid (3.09 ± 0.37). But in cost effective manner new fish scales were more applicable. The observed reason for the efficient biosorption from the fish scales were the crystal structure, chemical composition of hydroxyapatite with porous structure and the highly ordered three dimensional structure of collagen. This research revealed that, there is a high potential to use mullet fish scales as a biosorbant for treat waste water in wastewater treatment facilities and it is a rapid, cost effective and high efficient biosorbant among other biosorbants.

**Keywords**: Heavy metal, Biosorption, Cost effective, Hydroxyapatite, Collagen

# Development of a Systematic Risk Identification and Assessment Method in Water Safety Plan: A Case Study of Pelmadulla Water Supply Scheme, Sri Lanka

L.H.T. Nadeeshani[1], A.A.G.D. Amarasooriya[2], S.K. Weragoda[3]
[1]*Deapartment of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka,*
[2]*Postgraduate Institution of Science, University of Peradeniya, Sri Lanka*
[3]*National Water Supply & Drainage Board, Kandy, Sri Lanka*

This study proposes a novel method for risk assessment in Water Safety Plan (WSP). WSP is a management approach proposed by the World Health Organization to ensure the water quality from the source to the consumer. WSP consists of 11 modules that assist to identify and solve water quality issues and possible risks in water source, treatment and supply through an organizational management approach. However it does not provide adequate guidelines for its most critical risk assessment as described in Module 3 - Identify hazards and hazardous events and assess the risks to the water quality. WSP guideline Module 3 proposes a semi quantitative single factor risk assessment. But for a single risk there may be several associated co-risk factors. Therefore this study proposes a systematic risk identification and assessment method by considering co-risks. Furthermore this study evaluates the novel method and old method results. Co-risk factors involved in single risk were identified by using past and current water quality data, consumer opinions and operator opinions through questionnaire surveys and laboratory analysis. Risk assessment was performed with semi-quantitative approach. Results reveal that the new method is capable of identifying and evaluating the risks in a more objective manner and there is a significant difference between then risk ratings obtained through this novel approach and previous methods. Of the 16 hazardous events 10 were identified to be 'high risk' under the previous scheme. The new method has lowered it to 6 high risk hazardous events. The proposed novel method will be more economical in implementation of the WSP as it performs a rigorous assessment of critical hazardous events.

**Keywords**: Water Safety Plan, Hazardous events, Risk assessment

# Study of Oil Contamination in Chunnakam Area due to the Wastage from Power Station

W.Thulasitha, N.P. Premachandra
*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*

Jaffna Peninsula relies totally on groundwater resources for the water needs of its inhabitants as this karstic terrain does not have any other potable water sources. Chunnakam, Thenmaradchi, Vadamaradchi and Kayts are the four main aquifers in Jaffna Peninsula. Of these Chunnakam aquifer has the highest capacity and acceptable quality as a drinking water source and for other usages. However, its water has become completely unsuitable for drinking due to an oil contamination. The groundwater contamination is attributed to oil waste from a 36 MW diesel power plant operated by the Ceylon Electricity Board (CEB) located in Chunnakam - Valikamam part of Jaffna Peninsula. High levels of contamination have been reported from areas such as Earlali, Mallakam and Uduvil around Chunnakam. Irrespective of the magnitude of the hazard no systematic study on the spatial distribution of the subsurface contaminant distribution has been carried out so far. This study focuses on determining the extent of contamination of groundwater in Chunnakam. Groundwater samples were collected during mid-April 2015 from wells within 2km radius around the power station to represent different uses such as domestic, domestic with home garden, public wells and agricultural wells. Important chemical parameters, namely oil and grease content, electrical conductivity (EC), pH and heavy metals such as lead and cadmium were determined in water samples obtained from 40 wells. Oil and grease concentration was measured by EPA method 1664, Hexane Extractable Gravimetric method. The spatial variation of water quality was mapped on GIS. Analyses reveal that 33 (82.5%) wells contain oil concentration above the permissible level (1.0 mg/l). Only 3 (7.5%) wells showed oil concentration below the permissible limit while 4 (10%) wells were not contaminated with oil and grease. A reciprocal relationship is observed between the oil and grease content in the groundwater and the distance from the power station. It implies that the contaminant front is expected to migrate in the aquifer although the waste disposal has ceased. Spatial pattern of the contamination shows that it spreads more towards the north.

**Keywords**: Oil contamination, Chunnakam power station, Water quality

# Arsenic Removal from Water by Using Rice Husk Ash

N.P. Edirisinghe[1], B.A.J.K. Premachandra[2], C.K. Jayasuriya[3]
[1]*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Department of Chemical and Process Engineering, University of Moratuwa, Sri Lanka*
[3]*Department of Chemistry, University of Kelaniya, Sri Lanka*

Arsenic is a toxic heavy metal present in water in organic and inorganic forms. It is highly toxic in its inorganic form. Long-term exposure to inorganic arsenic, mainly through drinking water, can lead to various health issues. The current research focuses on removing arsenic from water by the adsorption method using Rice Husk Ash (RHA). Particularly, RHA was used to check its suitability for arsenic removal since it will enable a value addition to the agricultural by-product. Rice husks were washed, dried and ground and then separated into different particle sizes using sieve analysis. Ashes from the rice husks were produced using a muffle furnace at 5 different temperatures as 300 ˚C, 400 ˚C, 500 ˚C, 600 ˚C and 700 ˚C. The resulting ashes were used as the absorbent in the columns through which 75 ppb arsenate solutions were passed. The experiments were carried out to determine the effects of particle size, charred temperature, pH and the use of RHA treated with phosphoric acid. Amounts of arsenic adsorbed were determined by using Atomic Absorption Spectrophotometry. Maximum adsorption was observed for RHA with particle sizes in the range (150 -500) μm and the lowest for RHA with particle sizes in the range (125 -150) μm. This result is deviated from the expected results. Theoretically, adsorption should be higher for small particles due to larger surface area. The maximum adsorption occurs at a charred temperature of 600 ˚C. Decreasing adsorption efficiencies after pH 7.0 for untreated RHA and after pH 7.5 for treated RHA were observed and it could possibly be due to the adsorption of more hydrogen ions due to high ion migration rate and high ion concentration. However, further investigation is required to study the effect of pH on the adsorption of arsenate by untreated and treated RHA.

**Keywords:** Water, Purification, Arsenic, Adsorption

# Removal of Heavy Metal Ions from Drinking Water by Using Rice Straw Method

A. Gowsiya, J.T. Cooray
*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*

Adsorption of some common heavy metals ions from drinking water by rice straw method was investigated by using filtration method. The adsorption capacity was investigated by various concentrations of heavy metals ions solutions. The effect of initial metal ion concentration and binding capacity of rice straw for each heavy metal have been studied. Initial concentrations of water sample were selected according to the most available range of natural waters in Sri Lanka. The results showed that rice straw was not releasing anything undesirable to the water. When the initial concentration of heavy metal irons increased, removal percentage also increased. Manganese and lead were efficiently removed from drinking water by using rice straw method. But iron has showed less binding capacity in rice straw method. As the result rice straw method is not efficient for removing iron from drinking water. The order of efficiency of metal ion removal in rice straw method is Mn (II) > Pb (II) > Fe (III).Average removal percentage of heavy metal irons are Mn (II), Pb(II) and Fe(III) is 71.5%,51.18% 21.1% respectively.

**Keywords:** Adsorption, Binding Capacity, Heavy metal, Rice straw method

**Technical Session VI**

# Water Science and Technology

## Poster Presentations

# Investigation of Trihalomethane Formation in Kandy South Water Treatment Plant and Distribution System with Other Water Quality Parameters

T.C. Rathnasiri[1], A. A. G. D Amarasooriya[2], S. K. Weragoda[3]
[1]*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Postgraduate Institute of Science, University of Peradeniya, Peradeniya*
[3]*National Water Supply & Drainage Board*

In most of the cases where chlorination use as disinfection method it will lead towards the byproduct formation, mainly the trihalomethanes (THMs). During the investigation, 74 water samples were taken from the Kandy South Water Treatment Plant, 13 service reservoirs, and user end points and analyzed for THMs and other water quality parameters. Results were used to calculate the correlation between THMs and other water quality parameters. Trichloromethane (TCM) and bromodichloromethane (BDCM) were the major disinfection by-products found in treated water samples of Kandy South distribution system. DBCM and TBM were not detected in any of the samples. For the formation of BDCM there should be a possible bromine source in raw water. TCM was the most abundant THMs with the concentration ranged from 0 to 42.47 µg/L. Second abundant was BDCM and it ranged 0 to 13.0 µg/L. Total THMs found in Kandy South distribution system ranged from 0 to 54.85 µg/L. Distribution THMs formation depends on various factors such as residual chlorine, pH, conductivity, TOC but there are many significant relation with distance from WTP and service reservoirs. Average level and highest levels of TTHMs in water supply schemes of KSWTP were not exceeding WHO 80 µg/L standard value. But long exposure of THMs in KSWTP will be a threat to consumer's health

**Keywords:** Disinfection, Chlorination, Trihalomethanes, Kandy south water treatment plant, By-products

*Acknowledgement: I would like to thank the National research council (NRC), Sri Lanka for funding to carry out the research work under the grant 12-116.*

# Investigation of the Effectiveness of Upparu Saltwater Barrage in Jaffna Peninsula, Sri Lanka (4th Stage)

K. Muraly[1], D.T. Jayawardhane[2], D.T. Udagedara[1]
[1]*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Department of Forestry and Environmental Sciences, University of Sri Jayewardenepura, Nugegoda, Sri Lanka*

Groundwater is the prime source of water for the people in Jaffna Peninsula. Saltwater intrusion into aquifers has been a persistent issue caused by excessive extraction of freshwater. In order to overcome the groundwater scarcity and quality issues, a barrage has been constructed as a saltwater exclusion bund expecting to convert the saltwater lagoon into a freshwater lake. Major aims of this study are to evaluate the effectiveness of the barrage by delineating the salt water intrusion patterns in groundwater and to study the variation of groundwater types recorded after the barrage construction. Electrical conductivity (EC) and water level of the wells were measured in the field. Groundwater samples were collected from 66 wells during the wet season. Water samples were analysed using Atomic Absorption Spectrometer (AAS) and Spectrophotometer to determine the concentrations of sodium, magnesium, calcium, potassium, chloride, sulphate and bicarbonate. Results indicate that EC of groundwater varies between 403 – 20760 μS/cm. Chloride, sodium, calcium, potassium, magnesium and bicarbonate concentrations are between 7 – 497 ppm, 0.09 – 986 ppm, 0.6 – 371 ppm. 0.86 – 125 ppm, 0.52 – 167 ppm and 10 – 1464 ppm respectively. Spatial distribution of the groundwater composition shows that the fringe of the Upparu lagoon which is far from the barrage is having better quality water than the groundwater close to the barrage. Availability of groundwater has significantly increased after barrage construction. It has been noted that if barrage function properly the groundwater in the fringe of the lagoon will become freshwater soon. Comparing with the results of past analyses it can be concluded that barrage system is slowly recovering to produce freshwater.

**Keywords**: Saltwater barrage, Upparu Lagoon, Saltwater intrusion

# Formation of Trihalomethane (THM) with Humic Acid and Correlated to Distribution System

S. K. Weragoda[1], A. A.G. D. Amarasooriya[2], S. Suranjani[3]
[1]*National Water Supply & Drainage Board*
[2]*Postgraduate Institiute of Science, University of Peradeniya,*
[3]*Uva Wellassa University, Badulla*

Disinfection of drinking water reduces pathogenic infection, but may pose risks to human health through the formation of disinfection by products. Chlorination remains as one of the simplest and cheapest disinfection methods used in water treatment. The main objectives of this research were Predict model to simple chlorine decay and $CHCl_3$ formation, Assessment the distribution of the THMs concentrations in Greater Kandy Water distribution system in relation to water quality data. Series of reactions were performed between the different concentration of total organic carbon (TOC) in Sigma Aldrich Humic acid (SHA) and Chlorine dose. Water samples were taken from greater Kandy water supply scheme, Nugawela, Kulugammana, Kahalla, Kondadeniya and Asgiriya service reservoirs, to measure the Trihalomethane (THM) and other water quality parameters. Trihalomethanes were analyzed using Gas Chromatography, Finally simple model (contour map model) predicted for rate of chlorine decaying and THMs formation. The proposed contour map model was validated by using the data obtained from Mahaweli river filtered water chlorination to ensure the results. According to descriptive statistics and correlation statistics distribution THMs formation depends on various factors such as residual chlorine, pH, conductivity, TOC. However, there are no any significant relation with distance from Water treatment plant. Average level and highest levels of TTHMs in water supply schemes were not exceeding World Health Organization (WHO) 80 µg/L standard value.

**Keywords:** Trihalomethane, Humic acid, Disinfection, Chlorine decay, TOC

*Acknowledgment: NWSDB and National Research council (NRC Grant12-116) for funding the project.*

# Antioxidant Properties in Four Cyanobacteria sp., Isolated from Fresh Water Bodies of Sri Lanka

M.F. Hossain[1,2], R.R. Ratnayake[2], K. Meerajini[3], S.N. Premetilake[3], K.L.W. Kumara[2]
[1]*National Institute of Fundamental Studies, Kandy, Sri Lanka*
[2]*Department of Agriculture Biology, University of Ruhuna, Sri Lanka*
[3]*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*

The aim of this investigation was to study the total phenolic content (TPC), total flavonoid content (TFC), antioxidant activity, phycobiliproteins and active compounds in four cyanobacterial species, i.e., *Oscilatoria sp*., *Lyngbya sp*., *Microcystis sp*. and *Spirulina sp.* isolated from fresh water bodies of Sri Lanka. Water sample was collected from different fresh water bodies representing two climatic zones of Sri Lanka that is dry zone and wet zone and was filtered through 20 µm planktonic net. The retentiate was cultured in BG11 and GO media recommended for cyanobacteria. Frequent sub culturing was carried out to isolate uni-algal culture. Isolates were identified morphologically under microscope (40X magnification). In the present study, *Lyngbya sp.,* showed highest TPC (5.02±0.20 mg/g), TFC (664.07±19.76 mg/g) and total phycobiliproteins (127.01 mg/g) value. The ferric reducing antioxidant power (FRAP) was recorded highest in *Oscillatoria sp.* (39.63±7.02) whereas the 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity was also reported the highest in *Oscillatoria sp.* (465.31±25.76) followed by *Lyngbya sp*. (248.39±11.97). In FTIR spectroscopy *Lyngbya sp.* does not show any N-H stretching band which is ultimately responsible for the inhibition of antioxidant activity. The study revealed that *Lyngbya sp*. and *Oscilatoria sp*. can be an excellent source for food, pharmaceutical and other industrial use.

**Keywords**: Cyanobacteria, Total Phenolic Content (TPC), Total Flavonoid Content (TFC), DPPH, FRAP, Antioxidant, Phycobiliproteins

**Technical Session VII**

# Environmental Science

## Oral Presentations

# Preliminary Study of Bioluminescence Species in the Southern Bay of Bengal

H.B.U.G.M. Wimalasiri[1, 2], S.U.P. Jinadasa[1], D.C.T. Dissanayake[2], A. Weidemann[3], H. Wijesekera[3]

[1]*National Aquatic Resources Research and Development Agency (NARA), Sri Lanka.*
[2]*Department of Zoology, University of Sri Jayewardenepura, Sri Lanka*
[3]*Naval Research Laboratory (NRL), USA.*

Marine organisms ranging from bacteria to fish make their own chemically induced light called bioluminescence, it is used to hunt, frighten predators, attract mates, communicate, or camouflage them. The bioluminescence phenomenon was studied in the southern Bay of Bengal during August 2015 onboard R/V Roger Revelle operating from Colombo, Sri Lanka. The intensity of light produced by bioluminescence spices was measured using Recoverable Bathy Photometer (RBP). The RBP recorded light intensity while free falling at a speed of about 1-1.5 m/s. Several RBP profiles in the upper 200 m were collected at six different sites encompassing a region 5 - 8N, 85.5 - 88.5E. All samples were collected in the night time to minimize interferences from other light sources. Zooplankton samples were collected using 150 µm mesh size plankton net from each location to identify light producing zooplankton species. The RBP measurements showed the existence of bioluminescent organisms in all the sampling locations and high light intensity was found up to 150-200 m water depths. *Sapphirina sp* belonging to the family Sapphirinidae of phylum Arthropoda was identified as one of the light emitting zooplankton species. Studies are underway to examine the luminous substances, and vertical and spatial distribution of these species, especially around Sri Lankan coastal waters.

**Key words:** Bioluminescence, Recoverable bathy photometer, Zooplankton, Bay of Bengal.

# Can Diversity Indices Reflect the Forest Degradation Status? A Case Study of Hurulu Dry Forest Sri Lanka

W.W.M.A.B. Medawatte[1,2], M.C.M. Iqbal[1], S.M.W. Ranwala[2]
[1]*Plant Biology Lab, National Institute of Fundamental Studies, Hantana Road, Kandy, Sri Lanka.*
[2]*Department of Plant Sciences, University of Colombo, Colombo, Sri Lanka.*

The degree of dry forest degradation due to anthropogenic disturbance is not yet quantified and this impedes forest restoration interventions and conservation in Sri Lanka. This study investigates selected diversity indices in response to anthropogenic disturbance to assess the severity of disturbance in the Hurulu forest reserve. Three different disturbance regimes (Un-Disturbed [UD], Moderately-Disturbed [MD] and Highly-Disturbed [HD]) were considered based on previous maps of the forest reserve and by conducting a reconnaissance survey. Sixty randomly selected plots (10 m X 20 m) were placed in the above disturbance regimes. In sampling plots, all living trees ≥1 cm was identified and enumerated by species. Tree species diversity was measured as different diversity and evenness indices such as Shannon's, Simpson's, Berger (reciprocal Berger-Parker diversity), Pielou's evenness and Simpson's evenness index. These indices were transformed to log and compared using one-way ANOVA. There were significant differences among disturbance groups regarding all the indices ($P<0.05$) excluding Pielou's evenness index ($P>0.05$). Significantly high mean Berger diversity index value ($P<0.05$) was observed at UD (3.70±0.01) and lowest at the more disturbed forests, i.e., MD (2.63±0.03) and HD (2.43±0.04). Though mean Shannon and Simpson diversity indices for UD showed significant differences ($P<0.05$) with HD, they did not show such differences with MD. Mean Simpson's evenness index for UD showed no significant differences ($P>0.05$) with HD forest. Though mean Shannon and Simpson diversity indices for UD showed significant differences ($P<0.05$) with HD, but not showed such differences with MD. Mean Simpson's evenness index for UD showed no significant differences ($P>0.05$) with HD. Though Shannon and Simpson diversity indices are sensitive to high disturbance, best diversity indices to explain differences between Un-disturbed and disturbed forests were Berger diversity index showing its highest value and high sensitivity in those dry forest which are in an undisturbed condition.

**Key words**: Forest degradation, Anthropogenic disturbance, Dry forest

# Impact of Pesticide Use Practices on Farmers' Health: A Case Study in Wijayagama and Eheranda in Matale District

K.G.A.P. Dulanjalee[1], K.G. Prematilake[1], A.N.R. Weerawansha[1], J.A. Sumith[2]

[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Office of the Registrar of Pesticides, Gatambe, Peradeniya*

The study documented a serious consequence of the indiscriminate use of pesticides for the farmers' health in Wijayagama and Eheranda, two rural villages located in Naminigama Grama Niladhari division of Wilgamuwa Divisional Secretariat division in Matale district. The farmers residing in both villages, who applied pesticides by themselves, were selected as the sample and it was 110. Primary data were collected through pre-tested questionnaires. Secondary data were collected from the reports of National Census and Statistical Department and Office of the Registrar of Pesticide. Over 55% of farmers were found to be overusing pesticides. Only 11% of farmer's usage of personnel protective equipment to be called as "good" and 89% belongs to "bad" usage of personnel protective equipment. The 16% of the farmers not affected, 43% lightly affected, 30% moderately affected, 11% highly affected and nobody was very highly affected. Therefore, only 16% of the farmers were not affected and 84% of the farmers reported to having one or more considered acute pesticide poisoning symptoms, after routine application of pesticides. Considered acute pesticide poisoning symptoms occurrence was positive for 85% of the farmers and negative for 15% of the farmers for the previous cropping seasons, during or after pesticide application. This study gave indications that a majority of farm households do not take cognizance of the long term and short term health hazards of pesticides in pesticide use practices and acute pesticide poisoning symptoms are under- reported in Wijayagama and Eheranda in Matale district.

**Keywords:** Pesticide use practices, Farmers' health

# Spatial and Temporal Variation of Physico-chemical Parameters of Water in Badulu-oya Upper Catchment Area

R.M.G.N. Rajapaksha[1], U. Edirisinghe[2], J.M.C.K. Jayawardana[3], S.C. Jayamanne[1]
[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Postgraduate Institute of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka.*
[3]*Sabaragamuwa University, Balangoda, Sri Lanka.*

Upper catchment area of Badulu-oya, is one of the natural lotic systems, where its pristine status is getting ruined as a result of excessive pressure exerted due to various anthropogenic activities. The present study was planned to study the spatial and temporal variation of physico-chemical parameters of water in the Badulu-oya upper catchment. Covering a 20 km distance, 12 study locations were selected, which included 4 tributaries that confluenced to the main river and possessed different land use patterns as well as urbanized and relatively less disturbed locations. Thirteen physico-chemical parameters were analysed for one year period, monthly. General Linear Model was used to identify the significance differences of spatial and temporal variations of water quality. Correlations of water quality parameters with respect to their spatial and temporal variations were analysed by Principle Component Analysis using PRIMER 7 software. Throughout the study period, water temperature, turbidity, EC, TDS, apparent colour, pH, DO, $BOD_5$, total alkalinity, total hardness, nitrate, nitrite and orthophosphate contents fluctuated between 20.9 – 30.4$^0$C, 2.27 – 159 NTU, 40.2 – 198.5 µS/cm, 20.1 – 99.5 ppm, 4 – 454 PtCo., 5.6 - 8.64, 8.4 – 13.4 mg/L, 0.28 – 6.32 mg/L, 34 – 136 mg/L $CaCO_3$, 34 – 134 mg/L $CaCO_3$, 0.5 – 17.5 mg/L, 0.001 – 0.045 mg/L and 0.11 – 0.95 mg/L respectively. Five principle components (PC) were obtained with Eigenvalues >1 summing almost 76% of the total variance in the data set. The PC1 represented 24% while PC2 represented 20 % of the data variability. Water temperature, pH, EC, TDS, total alkalinity and total hardness negatively correlated with PC1, while BOD and $NO_3^-$, EC, TDS, alkalinity and hardness negatively correlated with both PC1 and 2. Study revealed that water quality of Badulu-oya upper catchment is still under the recommended surface water quality standards which support healthy aquatic life.

**Keywords:** Catchment, Water quality, Spatial, Temporal

*Acknowledgement: Authors wish to thankfully acknowledge the financial support provided by Uva Wellassa University of Sri Lanka.*

# Possible Effects of Climate Change Driven Sea Level Rise on Small Islet Complex of Negombo Lagoon Sea Entrance with Respect to Mangrove Floral Community and Fisheries

E.N.S. Silva, N.P.P. Liyanage, S.C. Jayamanne
*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka.*

The climate change driven long term sea level rise by global warming will be a potential threat to the islet system of Negombo lagoon sea entrance which is a unique Eco geographic feature of the Sri Lankan coastline. The study was carried out to identify both ecological and socioeconomic impacts by long term sea level rise on this islet system of Negombo lagoon as a fisheries hub and ecologically important mangrove forests to the country. Three possible sea level rise scenarios by year 2100 were developed based on Intergovernmental Panel on Climate Change (IPCC) forecasts of sea level rise through Representative Concentrative Pathways (RCPs'). Inundation patterns due to sea level rise for the islet complex was projected. As ecological impacts, pneumatophore heights of *Sonneratia* spp. and *Avicennia* spp. for its distribution and inundation percentage along the Siriwardene mangrove forest due to sea level rise by 2100 were calculated. A timeline analysis for Munnakkarai islet was conducted to understand the socioeconomic significance for two selected shorelines at Munnakkarai islet with an emphasis to fisheries activities. Results have expressed that percentage land loss of Munnakkarai islet due to sea level rise scenarios I, II and III are respectively 18.21% 27.54% and 42.20% by year 2100 and projected loss of pneumatophore distribution for the scenarios I, II and III were respectively 79.7% , 99.2 % and 100%. There is a possibility of displacement, effect on fisheries and species loss in this islet complex by year 2100 due to the loss of pressure on mangrove outskirts of the island where they are possible nursery grounds of economically important fish and shellfish. In conclusion, current study has predicted negative ecological and economic impact for the islet complex due to climate change driven sea level rise by year 2100, emphasizing immediate requirement to overcome global warming nationally and internationally.

**Keywords:** Global climate change, Sea level rise, Lagoons, Fisheries, Mangroves

# Effects of Cascade Min-hydropower Plants on Some Aspects of Eco-hydrology of Wee Oya in Kelani River Basin

R.A.S.N Jayawardhana[1] N.P.P Liyanage[1], E.I.L Silva[2]
[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Water Resources Science and Technology, Ragama, Sri Lanka.*

The establishment of small hydropower schemes has become a lucrative business today considering streams and rivers as hydraulic systems rather than living ecosystems. It is assumed that the negative effects of construction and operation of mini hydropower plants are negligible because of relatively minor generation capacities in comparison to large hydropower projects. The operation of small hydropower plants in Kelani River basin was investigated with special emphasis on power generation capacities and affected stream stretches between the intake weir and the powerhouse. Detailed studies were conducted further at Wee Oya, a major tributary of the Kelani River on habitat alteration and fish fauna endemic to Sri Lanka in relation to small hydropower operation. The Kelani River has 31 mini hydropower plants with total generation capacity of 56 MW ranging from 0.060 MW to 9.928 MW per plant. The results show that the length of the affected stream stretch is a function of the generation capacity of the power plant. The percentage of natural stream loss is high in Kehelgamuwa Oya (60.3 %) and Maskeliya Oya (62.9%) due to the establishment of major hydropower schemes whereas the high percentage of natural stream loss computed for Seethawaka Ganga (43.8 %) can be attributed to the large number of mini hydropower plants. Although, 18 endemic fish species have been recorded from the Kelani River basin, only four species were reported from the Wee Oya which has 4 mini hydropower plants within 24 km stream length with 32.5 % loss of natural stream in the present study. Significant declinations of fish populations and endemic fish varieties in Wee Oya have denoted the negative effects on aquatic biodiversity, emphasizing immediate conservational requirements.

**Keywords**: Cascade Mini-hydropower plants, Affected stream stretches, Fish endemic to Sri Lanka, Eco-hydrological aspects

# Usability of Fish Haematological Parameters as a Biological Indicator for Freshwater Quality in Badulla District

J.M.N.M. Jayasundara, N.P.P. Liyanage, R.R.M.K.K. Wijesundera, J.D.M. Senevirathne, D.P.N. De Silva

*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka.*

Water, the fundamental of life, requires continuous monitoring because water quality deteriorates over time. Fish haematological parameters respond more quickly for environmental changes with more precise results than chemical analysis which conduct periodically. As it is profitable to authenticate eco-friendly method for assessing water quality, this study was conducted to investigate the usability of fish haematological parameters as a bioindicator for assessing freshwater quality. Comparison of physico-chemical parameters of water quality was done in two inland static water bodies in Badulla district: Horabora and Mapakada reservoirs. Results of present study revealed that Transparency, Total Dissolved Solids, Biochemical Oxygen Demand (BOD), pH, Total hardness and Trace metal (As, Pb and Cu) levels were significantly different between Horabora and Mapakada reservoirs ($p<0.05$). No statistical difference was found for total alkalinity, Dissolved Oxygen level, and Surface water temperature ($p>0.05$). Both water bodies were identified as polluted in terms of Universal Water Quality Index, although Horabora reservoir was much more polluted than Mapakada reservoir by resulting higher BOD, Total Dissolved Solids, Total hardness and trace metal levels (Pb and As) with less clear water. Blood from Tilapia (*Oreochromis mossambicus*), *Labeo rohita* and *Catla catla* was used for fish haematology analysis. Red blood cell count was significantly different ($p<0.05$) between two different water bodies for each fish species. Eosinophil count showed a significant difference among two water bodies ($p<0.05$). The study revealed that a great possibility exists for using fish haematological parameters as a bioindicator for freshwater quality. Moreover, a multi-year continuous study with elaborated investigation require for clarify trends which may exist between fish haematological parameters with respect to water quality changes.

**Keywords**: Water quality study, Haematology, Tilapia, Eosinophil, Trace metal

**Technical Session VII**

# Environmental Science

## Poster Presentations

# Study of the Diversity of Benthic Macro-Invertebrates at Panadura Estuary in Sri Lanka

M.S. Weerasooriyagedara[1], N.D. Hettige[2], A.A.D. Amarathunga[2], R.M.G.N. Rajapaksha[1], S.C. Jayamanne[1], K.A.W.S. Weerasekara[2], M.D.S.R. Maddumage[2], S.A.M. Azmy[2], W.D.N. Wickramaarachchi[2], J.K.P.C. Jayawardane[2], S.R.C.N.K. Narangoda[2]

[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka.*

[2]*National Aquatic Resources Research and Development Agency, Crow Island, Colombo 15, Sri Lanka.*

Panadura estuary situated in the western province in Sri Lanka where Bolgoda lake opens into Indian Ocean harbours a lot of aquatic biodiversity. Therefore, main objective of this study was to identify the diversity of benthic macro-invertebrates, to assess the correlation between physico-chemical parameters and macro-benthic invertebrate diversity and to evaluate the pollution level in the estuary with respect to the diversity of benthic macro-invertebrates in Panadyra estuary. Both sediment and bottom water samples were obtained from 19 randomly selected sampling locations in Panadura estuary. Collected Benthic macro-invertebrate samples were wet sieved and identified using standard identification keys. The diversity of benthic macro – invertebrates was determined by using Shannon – Weiner index, richness was calculated using Margalef's index and the health status of the estuary was determined by using Pollution Tolerance Index. Similarities among macro-benthic communities at different locations were determined by using Bray – Curtis similarity coefficient. This study also attempted to determine the physico – chemical determinants that govern the spatial variation. Individuals of 1708 species of macro benthos belonging to 14 families were identified. Planobidae, Haminoidae and Veneridae were the most abundant families. The lowest species richness and diversity was reported at PE6 while highest species richness and diversity was reported at PE7. The sampling locations were separated into several clusters based on the diversity of macro benthos. The major physico-chemical parameters which had effect on the diversity of macro benthos were Biochemical oxygen demand and nitrate nitrogen concentration. Shannon Weiner diversity index in each location at Panadura estuary was in between 2 – 3 and Pollution Tolerance Index in each location was lower than 20. Both these indices confirmed that the aquatic health of Panadura estuary was in poor condition.

**Key words:** Benthic macro- invertebrates, Diversity, Pollution

***Acknowledgements:*** *The authors are thankful to the National Aquatic Resources Research and Development Agency for providing funds to carry out this research project.*

**Technical Session VIII**

# Entrepreneurship and Management

## Oral Presentations

# An Empirical Study of Work Life Balance with Special Reference to Educators in Colombo District

P.A.B.H Amarathunga[1], Shamitha Pathiratne[2]
[1]*Faculty of Business Studies and Finance, Wayamba University*
[2]*Faculty of Computing, ESOFT Metro Campus*

The concept of Work Life Balance (WLB) has become a concern for every business: failure to manage work-life balance can pose an earnest threat to a business. However, despite its paramount, managing work-life balance remains a chore for many businesses. In Sri Lanka especially in Edification Industry it is not felt to induce the WLB practices either in Government sector or in Private sector whether in School or College level of Inculcation. Objectives of this study are to ken about level of work-life balance among Educators of different edifying institutions, analyse gender sapient work-life balance issues, ken how the age factor influences work-life balance and ascertain different work-life balance practices adopted by government and private scholastic institutions. Descriptive Study is orchestrated with a well-structured questionnaire to accumulate primary data from 100 members of edifying fraternity working at Schools, Colleges and Universities of both Regime and Private sectors. This sample is culled from Colombo District in Western Province of Sri Lanka. Results denoted that 72.9% people of the respondents have feeling of blissful at work. 54.3% respondents have feeling of missing their qualitative life sometimes, 30% respondents are infrequently feeling of missing their life. 60% of respondents are feeling tired at work and to manage stress arisen 64.3% of them, have opted for regalement. 72.9% respondents verbalized that there is no work-life balance policy (total of 84% when included Not Cognizant withal) in their organization. The chi square tests resulted Having Children and Quality of Time at Work dependent on each other. Having Children and Feeling of Missing Life are dependent on each other and Gender and Factor Facilitating Working Balance are dependent of each other. And, Hours of Travel and Factor Facilitating Working Balance are independent of each other. Also Hours of Travel and How often work worries are dependent of each other The Educators in both sectors aren't exposed to Work Life Balance Practices and even their employers haven't exerted in designing and implementing the Work-Life Balance. A 5-day work is one of such policy which can enable the employees to orchestrate their life part and manage it efficaciously.

**Keywords**: Colombo, Educators, Edification, Work life balance

# The Impact of Social Media Marketing on Purchase Intention; With Special Reference to Facebook Use in Beauty Care Brands in Sri Lanka

U.A.S Yapa, P.I.N Fernando
*Department of Management Sciences ,Uva Wellassa University, Badulla, Sri Lanka.*

Companies widely use social media platforms, such as Facebook, Twitter, Pinterest and YouTube, to enhance their brand communication and to promote and propagate their product information among consumers. The trend of exerting social media platforms by beauty care brand carries a significant control over customer-based brand equity and purchase intention. In the present world the traditional modes of advertising and marketing such as television, print media and outdoor media contribute to a major portion of the advertising budget, still they are unable to grab the target audience exclusively. Hence, the objective of this study is to fill the gap in the literature, by examining the relationship between user-generated communication, examine the relationship between firm generated communication, examine the relationship between brand equity with purchase intention and consequently find out impact of firm generated and user generated communication on purchase intention through Facebook related to beauty care brands The study conducted through 200 female and male users in Colombo district who are engaged in Facebook and already liked at least one beauty care brand. A standardized online-survey has conducted to collect the data. The each objective has fulfilled by constructing the relationship between independent and dependent variables by occupying the regression analysis and has drown the final conclusion, considering the each results that has been achieved. The results show that User Generate Communication has a positive relationship with brand equity, Firm-Generated Communication has a positive relationship with brand equity and Brand equity has positive relationship with purchase intention. Hence, it conclude as Social media marketing has a positive impact on purchase intention in beauty care brands in Sri Lanka. The study suggests that beauty care brands marketers need to create platforms to generate more user content as user generated communication displays more impact on creating brand equity compare to firm generated communication and generally, creating brand related unrelated communication, combining traditional media with social media, achieving company target audience though Content/Adds/Apps can further improve brand equity and purchase intention.

**Keywords:** Social media marketing, Brand equity, Purchase intention, Facebook

# Service Differentiation Intention and Firm Performance; with Special Reference to Banking Industry in Sri Lanka

H.B.D. Sandaruwani, P.I.N Fernando
*Department of Management Sciences, Uva Wellassa University, Badulla, Sri Lanka*

Cost leadership and differentiation are the two generic strategies that business firms exploit to get the competitive advantage in the market. Between these two strategies this study focused on identifying the differentiation intention and its relationship with firm performance of the banking industry in Sri Lanka. There are contradictory ideas regarding the relationship between these two variables among the scholars who conducted their studies attached to this field. Service marketing mix including product, price, place, promotion, people, process and physical environment was taken as the service differentiation indicator. To measure the firm performance, each firm's annual profit before taxes was taken. In order to reach the objectives of the study, all thirty three (33) licensed banks in Sri Lanka were taken as the sample. A specifically designed questionnaire was administered to collect primary data from the managers and for the secondary data annual reports of the selected banks were administered. To analyze the collected data simple and multiple linear regression analysis were exploited. Research findings show that there is a strong positive relationship between service differentiation intention and firm performance. Further, out of the service marketing mix elements people element is the most influential element to the firm performance. Product and physical environment elements have come as second and third elements respectively. Firms intend to harvest the competitive advantage should consider planning and implementing the strategies focusing on all the other elements in the service marketing mix. Almost all the firms have virtually identical products and prices it is worth to follow more customer centric strategies which address the other elements in the service marketing mix. These consumer-focused approaches can improve revenue by attracting new customers and increasing the bank's share of existing customers.

**Keywords:** Differentiation intention, Firm performance, Service marketing mix, Licensed commercial banks

# Impact of Online Banking Service Quality on Customer Satisfaction

B.G.T. Madhushani, P.I.N Fernando
*Department of Management Sciences, Uva Wellassa University, Badulla, Sri Lanka*

This study aims to investigate the impact of online banking service quality on customer satisfaction. The different dimensions such as efficiency, reliability, responsiveness, fulfilment and privacy can be identified as determinants of service quality. The research objectives aim to find, the relationship, most influential factor withal relative contribution of each influential factor of online service quality towards customer satisfaction. All online banking users of Badulla district were selected as population of the research. 60 online banking customers of five banks in Badulla, selected as the sample of the research. Multiple regression model and Correlation coefficient analysis were used to analyse the research. Research findings were emphasized that 66% of the total satisfaction is influenced by the five selected service quality dimensions withal findings of the research, Efficiency, Responsiveness, Fulfilment, and Privacy shows positive relationship with Customer Satisfaction. Positive relationship between Reliability Variable and Customer satisfaction is not significant under this study. Banks should pay more attention to improve speed, high security applications for protect customer Privacy.

**Keywords**: Online banking, Service quality, Customer satisfaction.

# The Effect of Work-Family Conflict on Organizational Commitment of Managerial Level Employees

Y.G.A.S.Deshani, S.F. Fasana
*Department of Management Sciences, Uva Wellassa University, Badulla , Sri Lanka*

Work-family conflict is a form of inter-role conflict in which work and family demands are mutually incompatible, meeting demands of both the domains is difficult. Commitment implies an intention to persist in a course of action. Hence, organizations often try to foster commitment in their employees to achieve stability and reduce costly turnover. The present study empirically evaluated two dimensions of work-family conflict as work to family conflict and family to work conflict. The objective of the study was to identify the effect of work-family conflict on the organizational commitment of the managerial level employees in Colombo District. The sample consisted of eighty managerial level employees and questionnaires were used to collect data. Considering the relationship between work-family conflicts and organizational commitment, the analysis represented that there is a strong negative relationship between work-family conflict and organizational commitment, and family to work conflict was having a higher impact than work to family conflict among employees of banking industry in Sri Lanka. Further, it reveals that work-family enrichment is a current need for the employees of the banking industry in Sri Lanka.

**Keywords:** Work-family conflict, Organizational commitment, Work to family conflict, Family to work conflict

# Impact of Employee Engagement on Turnover Intention

S.G.S Rangika, S.F. Fasana
*Department of Management Sciences, Uva Wellassa University, Badulla, Sri Lanka.*

Turnover intention is one of the critical problems of apparel industry in Sri Lanka. According to current context of Apparel industry in Sri Lanka, diminish the turnover intention is more important because the apparel sector is the highest industrial employment generator and the highest foreign exchange earner. This study empirically evaluated the three dimensions of employee engagement (Goal setting, Job autonomy and Role benefits) and impact on the Turnover intention of the operational level employees in apparel companies in Katunayake Export Processing Zone. The sample consisted of one hundred and ten operational level employees working for 22 garment factories in Katunayaka Export Processing Zone. The data were gathered by administering questionnaires. The findings exposes that there is a strong negative relationship between the employee engagement and turnover intention. Further results were implied that effect of Role Benefits on Turnover intention is higher than other relationships. Researcher found that the apparel sector companies should be taken the appropriate strategies to develop the current context base on the important factors that had been found by the study.

**Keywords**: Employee engagement, Turnover intention

# A Study on Effect of Team Leader's Personality Traits on Team Performance: With the Special Reference to Apparel Industry in Northern Province

S.T Alan, S.F.Fasana
*Department of Management Sciences, Uva Wellassa University, Badulla, Sri Lanka*

Personality is primarily a combination of emotional reactions, attitudes and behaviors. Personality comprises on different element of thoughts, feelings and actions that make a person distinctive. It is a encourage factor to the performance. Under this study an attempt was made to investigate the relationship existing between personality dimensions and team performance of team leaders in apparel industry Northern Province. The present study empirically evaluated five personality traits dimensions (Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to experience) and their impact on team performance in apparel industry in Northern Province. For the convenience of the analysis a sampling consisting of 50 team leaders were selected by using simple random sample technique. Primary data were gathered through a structured questionnaire among the team leaders in apparel industry where the high involvement of team performance. The research findings shown that Team performance has significant strong positive relationship with Conscientiousness, Extraversion and Openness to experience and it has statistically insignificant weak positive relationship with Agreeableness and Neuroticism. Multiple regression analysis was used here. Conscientiousness and Neuroticism were highly significant for the model. Among these two variables team performance was highly impacted by Conscientiousness. Extraversion, Agreeableness and Openness to experience were not significantly contributed to the model. In the light of the results, possible managerial implications are discussed and future research subjects are recommended. This research contributes to the growing literature on the apparel industry in Northern Province.

**Keywords:** Personality traits, Team performance, Apparel industry, Team leaders

# An Investigation of the Barriers Faced by SME Exporters in Sri Lanka: with Special Reference to Manufacturing Sector

J.M.D.S. Wijerathne [1], M.P.S.R. Perera [2], R.M.G.S. Jayarathna [3]
[1]*Department of Commerce, University of Sri Jayewardenepura.*
[2]*Department of Entrepreneurship, University of Sri Jayewardenepura.*
[3]*Information Technology Resource Centre, University of Sri Jayewardenepura.*

The export sector of a country plays an important role in promoting economic growth and development. Each and every nation uses Small and Medium Enterprises (SMEs) as a strategic tool to develop their export sector. The barriers existing in the export market hamper the maximum contribution of SMEs to the development of export sector. This study involved an investigation on the export barriers faced by SMEs in the Sri Lankan export market with special reference to manufacturing sector. The main purpose of this study is to identify major export barriers faced by SME exporters in the Sri Lankan export market. Further, this study attempts to identify the top ten barriers fall under the major export barriers. This study was quantitative in nature and personally administered questionnaire was used to gather data. Parametric tests of ANOVA, Test of Equality of Measure, Test of Homogeneity, Robust Test of Equality, Games Howell Test of Equality were performed to achieve the objectives of the study. In line with the literature, this study found that financial barriers, governmental barriers and economic barriers as the major export barriers while high cost of capital to finance exports, lack of government incentives, lack of new technology, complexity of export documentation procedure, lack of financing sources, high tariff and nontariff barriers, currency fluctuations, lack of competitive prices to foreign customers, high insurance cost and inadequate institutional support as the top ten export barriers fall the major export barriers faced by SME exporters in the Sri Lankan export market. The findings of the study might be useful to policy makers in formulating suitable export assistance programs for SMEs.

**Keywords:** Small and Medium enterprises, Internationalization, Export barriers

# The Impact of the Practices of Human Resource Management on Job Satisfaction of Operational Level Workers in Apparel Sector in Sri Lanka

K.G.C.C. Piyasena
*Department of Human Resource Management, University of Sri Jayewardenepura.*

Human Resource Management (HRM) becomes a significant and important management area and it has many positive impacts on the employees' behavior. This study was aimed to discuss the impact of the HRM practices on employees' job satisfaction. The absenteeism and labour turnover in the apparel sector remains at high level and recruiting of operational workers to the company is a major issue in this industry. On this context, there are no any research findings on how HRM practices affect to job satisfaction of operational workers in this sector. The main problem of the study based on the research gap is: Does HRM practices affect to the job satisfaction of the operational workers in the apparel industry in Sri Lanka. Scientific research method was used in this study and the research setting was non-contrive setting. This study was cross sectional and operational workers were the unit of analysis. The population was the all operational workers in the apparel sector in Sri Lanka and 300 operational workers were selected randomly for this study. Structured questionnaire was developed by the researcher using 25 HRM functions to measure the HRM Practices and the MSQ short-form of standard questionnaire was used to measure the job satisfaction. The results of 0.73 (HRM practice) and 0.76 (Job Satisfaction) of test-retest analysis of external reliability and 0.72 (HRM practice) and 0.74 (Job Satisfaction) of Cronbach's Alpha for inter item consistency reliability were found under the reliability of the instruments. Simple regression analysis was the main method used to analysis the data. The major finding of the study was that there was an impact of HRM practices on job satisfaction of the workers and majority of HRM functions have impact on employees' job satisfaction. The conclusion of the study is that there is an impact of HRM practices on job satisfaction of the sample. To maintain and enhance the employee job satisfaction, the companies have to maintain and upgrade appropriate HRM practices in this sector proposed as recommendation.

**Keywords**: HRM practices, Job satisfaction, Operational workers, Apparel industry

# Leadership Behaviour and Its Impact on Employee Job Performance: the Mediating Role of Organizational Commitment

B.C.H. Maduwanthi, R.P Mahaliyanaarchchi
*Department of Agribusiness Management, Sabaragamuwa University of Sri Lanka*.

The leadership role is a necessity in any organization. This study builds on theoretical argument that has dominated the field of organizational behaviour for many years that leadership behaviour directly suggests the competent and committed employees in a firm and organizational commitment has significantly positive effect on employee's job performance. The objective of this study was to assess the impact of supervisor leadership behaviour on employee job performance while investigating the mediating role of organizational commitment on relationship between leadership behaviour and employee job performance. Data were gathered using cross sectional survey strategy. Sample size was 220. Data were collected using, (a) individual semi structured interviews (b) adaptations of House's Path Goal Model of Leadership with Perceived Leadership Behaviour Questionnaire (PBLQ) and Meyer and Allen's Organizational Commitment Questionnaire (OCQ). Pearson Correlation analysis was employed to assess the correlation among three variables. Sobel Goodman mediating test was carried out to find out the mediating effect of organizational commitment. Results revealed that supervisor leadership behaviour s and organizational commitment of operational level employees are having a positive correlation. Further, it was found that directive and achievement oriented leadership behaviour s are negatively correlated with affective commitment whilst positively correlated with continuance and normative commitments. Further, supportive and participative leadership behaviours are positively correlated with all three types of commitments. Moreover, affective, normative and continuance commitments were positively correlated with employee job performance. Organizational commitment significantly mediated the relationship between supervisor leadership behaviour and employee job performance. Extensive training programs to develop above leadership skills of supervisors and give proper guidance to adopt appropriate leadership style according to the situation is immediate action in order to sustain and retain the competent labor force within the company and enhance the performance of operational level employees and formulating recruitment policy is a long term strategy.

**Keywords:** Path goal leadership behaviour, Job performance, Organizational commitment, Mediating role

# Impact of the Income Tax System on Tax Payers' Satisfaction: With Special Reference to Kegalle District Income Tax Payers

S.R.S.H.Ranasinghe, K.M.M.C.B. Kulathunga
*Department of Management Sciences, Uva Wellassa University, Badulla, Sri Lanka*

Tax system of a country is the primary mechanism of revenue generation. In Sri Lanka tax revenue has declining trend over the past 15 years. According to the literature the income tax system of Sri Lanka has failed to generate sufficient revenue because of its inherent weaknesses. As well as there is relatively a few number of articles and journals published about the income tax system and it has not yet been covered regarding perception of the tax payers' towards the income tax system. Hence, intention of this paper is to fill the gap in the literature by examining the impact of income tax system on tax payer satisfaction, ascertaining the relationship between income tax system and tax payer satisfaction and identifying the most affecting factor to tax payers' satisfaction. In this study tax system is conceptualized as multidimensional construct which depends on four dimensions such as Fairness, Tax Compliance, Tax Competencies and Simplicity. Primary data were gathered through distributing self-administrative questionnaire and 120 individual income tax payers were selected proportionately from each income category by using Judgmental sampling. Descriptive statistics, Correlation coefficient analysis and Regression analysis were used for the purpose of data analysis. The research findings revealed that there is a strong positive correlation between tax competencies and tax payer satisfaction while other three dimensions have weak positive correlation. It is further supported by the values of multiple linear regression tax competencies and simplicity were highly impact to the tax payers' satisfaction. Hence, it can be concluded that tax competencies is the most important income tax system dimension and the satisfaction of taxpayers are based on their knowledge and understanding of tax law and awareness of paying tax. In addition, the low complexity of income tax system reduces the tax evasion. The study suggests that government need to build a positive morality of the tax payers through conducting awareness programs, providing transparency with regarding the tax revenue and introducing several facilities.

**Key words**: Tax compliance, Tax evasion, Tax competencies, Fairness, Simplicity

# Relationship between Entrepreneurial Education and Strategic Orientation

P.G.M.S.K. Gamage , W.M.P.G.C. Weerakoon
*Department of Management Sciences, Uva Wellassa University, Badulla, Sri Lanka*

Despite the importance of entrepreneurial education in encouraging strategic behaviour of SMEs, there is a dearth of literature examining this link. A sample of 50 SMEs owner managers in Badulla Divisional Secretariat was investigated with the aim of identifying the relationship between entrepreneurial education and strategic orientation. A structured questionnaire was used to collect data. Overall level of strategic orientation of the studied sample was at a medium level while the entrepreneurial education level was at a high level. The regression model (52.9% R-square) confirmed that entrepreneurial education is a strong predictor ($P<0.01$) of strategic orientation. This study informs the provincial level policy makers the direction they should take in designing and delivering the training programmes for future entrepreneur development initiatives.

**Keywords:** Entrepreneurial education, Strategic orientation, SMEs, Owner managers

# The Impact of Brand Image on Customer Loyalty with Reference to the Hotel Industry in Colombo District

A.D.L. Abisheka, W.M.P.G.C. Weerakoon
*Department of Management Sciences, Uva Wellassa University, Badullla, Sri Lanka*

Brand image is considered to be a critical determinant of the growth and performance of hotel businesses theoretically. Yet, the revenue of star rated hotels in Colombo district is reported a higher variation. This study examined the impact of brand image on the customer loyalty of registered star rated hotels in Colombo district. Attract and retain customers is vital to hotel's success. Thus, the main research objective is to identify the determinants of brand image impact on customer loyalty. Brand image dimension: sensory, emotional and cognitive were considered as the independent variables and customer loyalty was considered as dependent variable. To fulfil the research objective five tourists from each 41 star category hotels were surveyed with a structured questionnaire. According to research findings most guests are male and the frequent age category of visitation is representing the middle age. Employing a simple linear regression this study found that brand image is a strong predictor of customer loyalty. There was a strong positive association between all the customer loyalty dimensions and brand image. This study informs the management of the star rated hotels on the strategic direction to be taken in promoting the business.

**Keywords**: Brand image, Customer loyalty, Hotel industry

# A Study on the Influential Factors towards Consumers' Choice for a Self-Service Retail Store - with Special Reference to Colombo District

T.C.R Peiris, P.I.N Fernando
*Uva Wellassa University, Badulla, Sri Lanka*

The study on influential factors towards consumers' choice for a self-service retail was conducted by myself T.C.R Peiris, UWU/ENM/11/0039 as a partial fulfillment of the Bachelor of Business Management in Entrepreneurship and Management degree programme. The self-service retail stores' culture in Sri Lanka was initially commenced in 1980's and due to various constraints the industry began to expand from year, 2000. This study was focused on the consumers' choice for self-service retail stores in Colombo district. Objectives of the study is to identify the most influential factor, relative contribution of each influential factor and the degree of correlation between the influential factors towards consumers' choice for self-service retail stores. The study was based on both primary and secondary data. The primary data were collected from the sample survey which was conducted in three divisional secretariats of Colombo; Maharagama, Kotte and Thimbirigasyaya. 200 respondents were selected for the sample. A questionnaire was designed to obtain information about consumers' choice with reference to major influential factors when selecting a self-service retail store. Influential factors were grouped into four variables namely store image, range of brands available, ease of access and the pricing strategies used by the retail stores. The secondary data were collected from published sources. Descriptive statistics has implied the existing level consumers' choice while correlation and multiple linear regression were used in identifying the relationship between the influential factors and consumers' choice towards self-service retail stores. The results illustrated that there is a strong positive relationship between each influential dimension and the consumers' choice towards self-service retail stores. The identified most equally influential factors towards consumers' choice for self-service retail stores were ease of access to the store and range of brands available in the store hence it is recommended that retail store chain owners should focus more on the strategies which will make an impact on these two influential factors in order to attract and retain customers.

**Keywords**: Self-service retail store, Consumer, Consumers' choice, Influential factors, Divisional secretariat

## Technical Session VIII

# Entrepreneurship and Management

## Poster Presentations

# Continuous Professional Development Approach to Enhance the Competencies of Bank Branch Managers through Alternative Delivery Method

K.S.D Fernando
*Institute of Human Resource Advancement, University of Colombo, Sri Lanka.*

Considering the contemporary banking business, role of the typical branch level bank manager provides very significant business results in order to achieve banks pre-defined both financial and non-financial business objectives. In this context the total set of competencies of the branch level bank managers is vital. Therefore, this study has been conducted to find the alternative avenues to deliver the most essential learning and development inputs in an effective way for the purpose of developing the above mentioned professional group in a continuous basis. Recently done empirical study to find whether the branch level bank managers have sufficient learning and development exposure under the scheme of Continuous Professional Development has found that there is absolute 0% continuous professional development exposure among 115 branch level bank managers those who are representing top 5 licensed commercial banks located in the western province of Sri Lanka. In the human resource development point of view this existing situation is not healthy to the banking industry in the long run since the individual firms cannot be able to gain competitive advantages through its human resource development via continuous basis with professional learning approach. Moreover, based on the available literature it has been identified 10 key essential competency enhancement inputs to develop a successful bank branch manager. Therefore the ultimate finding of this study was amalgamate those key competency enhancement inputs also called Professional Bank Managers Competency Enhancement Framework and the E learning method (The alternative learning and development delivery method) to deliver effective self-learning environment to the branch level bank managers to improve their set of competencies in a continuous basis. Field survey with stratified random sampling technique has been applied as a primary data collection method while both quantitative and qualitative techniques have been applied as a data analysis method. All findings, conclusions and recommendations of the study are absolutely based on the analysis.

**Keywords**: Continuous professional development, Human resource development, E learning, bank managers, Competitive advantages

# Impact of Work Life Conflict on Turnover Intention (Special Reference to Software Engineers in IT industry Sri Lanka)

T.L.Waduge, S.F Fasana
*Department of Management Sciences, Uva Wellassa University, Badulla, Sri Lanka.*

Information Technology industry is an important industry which can provide more economical value to Sri Lanka and these firms are in a need of strong strategy in order to retain talented employees. Therefore managers have to give a big attention to retain their employees Work life problems and family life problems are the major causes to leave the organization. Hence this study assessed the relationship of work life conflict and turnover intention among software engineers in Sri Lanka. This study empirically evaluated two work life dimensions (Work interference with Family conflict and Family interference with work conflicts) and their impact on turnover intention. The sample consisted of one hundred software engineers in Information Technology industry Sri Lanka. Primary data was gathered through an adopted questionnaire by the investigator. The research findings revealed that work life conflict was higher positively associated with turnover intention. Family interference with work was the key driver which has influenced on turnover intention of software engineers in industry. Future research should be directed to study work life conflict on turnover intention in other types of sectors

**Keywords**: Turnover intention, Work life conflict, Software engineers, Information technology industry

## Technical Session IX

# Entrepreneurial Agriculture

## Oral Presentations

# Determinants for Contribution of Pineapple Growers for Export Volume in Gampaha District

R.A.D.S. Rupasinghe[1], H.A.S.L. Jayasinghe[1], R.M.P.S. Rathnayake[1], T.A.P. Silva[2]
[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Kelani Valley Canneries Ltd, Hanwella, Sri Lanka*

Pineapple is the third largest agricultural product after tea and coconut which has a demand in export market. Although the nature has blessed with an ideal climate for growing wide range of delicious fruits including pineapple, Sri Lanka is not in a position to meet the growing demand. Therefore, that is very important to study about the export performance of fresh pineapple in Sri Lankan context. The general objective of this study was to identify the determinants of contribution of pineapple growers for export volume in Gampaha district. A structured questionnaire based survey was carried out to collect the data from random sample of 130 pineapple growers in Dompe and Diulapitiya DS divisions in Gampaha district. Tobit model was used to find out the relationship between dependent variable and other explanatory variables, and descriptive analysis was used to explain the characteristics of the sample. The result of Tobit model revealed that the contribution of pineapple growers for exports of pineapple was significantly determined by the age of grower, experience of the grower, pineapple cultivated land extent, amount supply for local market, domestic price and export price. The specific objectives of this study were to study the past export performance of fresh pineapple since 1990 to 2012 in Sri Lanka and to develop the forecasting model and the generalized model for fresh pineapple exports in Sri Lanka. There was an upward trend from 1990 to 2004 and trend was declined from 2004 to 2012 with some fluctuations. The reason was that the export of preserved pineapple has shown a significant improvement within last few years. The other specific objective was to develop the forecast model for future forecast and generalized model for current situation analysis for fresh pineapple exports in Sri Lanka. Vector Autoregressive Model was used to develop the forecast model and the generalized model was developed without considering the time factor. The result revealed that the export of fresh pineapple was significantly determined by the average exchange rate and the domestic price.

**Keywords**: Export performance, Fresh pineapple, Gampaha district, Tobit model, Vector Autoregressive Model

# Determinants of Tea Exporters' Intention to Import Other Origin Orthodox Tea

M.A.D.T. Dilina[1], K.P.M. Kahandage[1], H.M.S.K. Herath[1], S. Yasarathne[2]
[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Asia Siyaka Commodities PLC, Colombo 10, Sri Lanka*

Currently, Sri Lanka allows importing all Cut, Tear, Curl (CTC) tea, green tea, organic tea and specialty tea but restricts Orthodox tea. Under such condition, exporters have a positive intention on importing Orthodox teas too. Therefore, this study attempted to find the determinants of intention to import other origin Orthodox tea to Sri Lanka and to assess awareness of tea exporters' on repercussions if importation of tea is liberalized. A sample with 90 tea export companies was randomly selected and data were collected using structured questionnaires and interviews. Regression analyses were undertaken to find determinants. According to descriptive analysis, large scale companies have the highest intention to import tea than small and medium companies. Moreover, it revealed that the companies having an intention to import Orthodox tea to the country are experiencing higher cost of production than no intention companies. As per the results, cost of production, market share, international competition and time period of company started significantly affected on the intention to import other origin Orthodox tea to the country.

**Keywords**: Importation, Orthodox tea, Intention

# Identification of Present Status and Constraints of the Flower Vendors in Two Selected Religious Areas

N.U.M. Perera[1], P.E. Kaliyadasa[1], A.M.C. Amarakoon[1], J.K.M.D. Chandrasiri[2], S.M.P.C. Padmini[3]

[1]*Department of Export Agriculture, Uva Wellassa University, Badulla Sri Lanka.*
[2]*Hector Kobbekaduwa Agrarian Research &Training Institute, Colombo 7, Sri Lanka.*
[3]*Sri Lanka Council for Agricultural Research Policy, Colombo 7, Sri Lanka.*

Cultivation and use of flowers for religious and cultural festivals is popular in Sri Lanka. Small-scale flower vendors can be seen near temples selling fresh flowers. These huge demanded niche markets were hidden and less studied. Therefore, this study was conducted to review present status, major constraints and potentials for younger generations' involvement related to the flower-vending sector attached to "*Kiri-vehera* temple in Katharagama" and "*Maha Saman Dewalaya* in Ratnapura". The population was both registered and non-registered vendors. The sample consists registered 30 respondents from *Kiri-vehera* temple and 28 respondents from *Maha Saman Dewalaya*. Data were collected using structured questionnaire. Data were analyzed using descriptive statistics, correlation analysis and multiple linear regression. Study reveals that majority of the vendors are females (84.5%) with average monthly income level of Rs. 24966. Most of the respondents (87.9%) are satisfied with their profession as a flower vendor. Involvement of younger generation in the sector is 46.3%. The level of constraints faced by vendors is considerably high in both places. However, vendors at *Maha Saman Dewalaya* face relatively high level of constraints. Lack of market demand and its' fluctuation, non-availability of proper selling location/area, multiple responsibilities, lack of support from government and other related authorities, laws and regulations, policies were the most affecting constraints for the vendors in both areas. Higher competition, less social acceptance of venture, lack of ability in obtaining financial and banking resources, non-availability of proper selling location, laws, regulations and policies and lack of support by responsible parties were the most affecting barriers for potential involvement of younger generations. According to the regression analysis, the level of constraints was significantly affected by the socio-economic factors such as household size, gender of the respondent, working hours per day, stall availability, availability of other income sources and vending area.

**Keywords**: Constraints, Flower vendors, Present status, Religious areas, Younger generations' involvement

# Conjoint Analysis to Evaluate the Consumer Preference on Flavoured Tea

W. A. H. A. Gunarathna[1], K. G. Premathilaka[1], P. D. P. M. De Silva[1], M. Wanniarachchi[2]

[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Ceylon Fresh Teas (Pvt) Ltd, Sri Lanka*

There is less number of flavoured tea brands in the tea market in Sri Lanka. Mostly value added products are exported to foreign market while exporters do not consider much about the local market. The main reason behind this trend is that exporters do not have information on consumption patterns and their concerns about flavoured tea in local market. Therefore, this study focuses on evaluating consumer preference on different product attributes and identifying other factors that affect consumer preference. The target population was the flavoured tea consumers living in Western Province of Sri Lanka. Sample size is one hundred and fifty consumers. Purposive sampling method was used to select the sample from the population. The factors considered in the study are Product attributes, Age level, Gender, and Income level. Market analysis was conducted by descriptive analysis and by conjoint analysis. The result of the study shows that most of the males prefer to drink flavoured tea than females. Descriptive analysis on age level shows that consumers in 15- 30 age category most prefer to consume flavoured tea. Market analysis also proved that most of the flavoured tea consumers have high income implying that consumers were highly concerned with the value for money.

**Keywords**: Conjoint analysis, Consumer preference, Flavoured tea

# Factors Affecting on Direct Supply of Pineapples by the Pineapple Growers

D.G.N.R.Karunarathna[1], M.C.W.M. Rathnayake [1], R.M.P.S Rathnayake [1], T.A.P. Silva[2]
[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Kelani Valley Canneries Ltd, Hanwella, Sri Lanka*

Marketing fresh pineapple produce is important amongst pineapple growers because they derive benefits such as income and rural employment. In developing countries like Sri Lanka, most growers are characterized by poor direct supply of pineapples because they lack market information, high cost of inputs, fluctuations of the prices on pineapple marketing. In Gamapaha and Kurunegala districts growers cultivate pineapple more predominantly than those in other districts. Most of the growers sell their fresh pineapple to the pineapple collectors. However, growers get low income from the fresh pineapple marketing. Therefore, the objective of the study was to determine factors affecting direct supply of pineapple by the pineapple growers and specific objective is to study the socio economic and market characteristics of the pineapple growers .The study was conducted in Gampaha district (Dompe, Diwulapitiya Divisional Secretariat (DS) divisions) and Kurunegala district (Kuliyapitiya, Dambadeniya DS divisions). Judgmental sampling technique was used to select two districts and DS divisions within the districts. Respondents were selected from each DS divisions using simple random technique using a list of pineapple growers. Semi structured questionnaires were used to collect data from pineapple growers through face to face interview and through telephone calls. The data was analysed using descriptive statistics and binary logistic regression model. The results showed that age, farm gate price of pineapple, educational level marketing experience and occupation significantly influenced the decision of direct supply of pineapple by the pineapple growers. The study recommends that government should take necessary actions to develop direct pineapple marketing and facilitate the involvement of the younger generation.

**Keywords**: Binary logistic model, Direct supply, Market characteristics Pineapple growers, Socio economic characteristics

# Determinants of Value Added Production in Cinnamon Industry

W.S.P. Jayathilaka[1], L.M.H.R. Alwis [1], A.M.C.Amarakoon,
T.D. Batuwantudawa [2], G. Palakatiya [2]
[1]*Department of Export Agriculture, Uva Wellassa University, Badulla Sri Lanka*,
[2]*Board of Investment of Sri Lanka*

Value addition is currently an important topic in agriculture sector, especially to increase the economic value of agricultural products and to reduce wastage. Value addition has the ability to create employment, absorb excess labour from agriculture, enable rural residents to capture more margins from agriculture, hence raising rural income levels. Spice is one of the key agricultural sub sector of Sri Lanka. True cinnamon (*Cinnamomum zeylanicum*) is unique and most economically valuable indigenous crop known as Ceylon cinnamon among all other spices in Sri Lanka. Regardless of the unique benefits associated with true cinnamon, there is limited value added cinnamon products range hence cinnamon processors receive less return from cinnamon industry. Using survey data from 83 cinnamon processors from Galle and Colombo Districts, this study analyzed factors affecting on value added production in cinnamon industry, an economic activity with a potential to improve household livelihoods but whose development has remained rudimentary. Binary logistic regression technique and SWOT analysis were used to identify the potentials and problems in the industry. The results revealed that cinnamon processors involvement in value added production is positively influenced by a number of significant factors including technology, attitude, cost of production, credit access and labour availability. Lack of support services and access to credit, inadequate technology, labour scarcity and high cost of production are the major problems of the value addition in the cinnamon industry. The major potentials of the industry are the established name and reputation of the Ceylon cinnamon around the world, health benefits of true cinnamon and the higher quality of true cinnamon than its major competitor *Cassia* cinnamon. Study recommended that cinnamon manufacturers should be informed about the benefits and importance of adding value to their agricultural commodities as a tool for poverty reduction, employment creation and economic development.

**Keywords**: Binary logistic regression, Cinnamon industry, True cinnamon, Value addition

# Developing Marketing Information System for Fruit Marketing

M. Aphinaya[1], R.M.C.W.M. Rathnayake[1], A.M.C. Amarakoon[1], S. Sivakumar[2]
[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Provincial Department of Agriculture, Jaffna, Sri Lanka*

Concerning the fruit production in Sri Lanka, Jaffna District plays a major role by cultivating fruit types like Banana, Mango, Jack fruit, Papaya and Grapes. These fruits are demanded by buyers, especially for the export market. The marketing information linkage between fruit growers and buyers is not available in fruit marketing. Therefore, the requirement of developing Marketing Information System was initially identified in order to reduce the limitations in providing information regarding fruit growers. This study was mainly aimed to develop Marketing Information System for fruit marketing in Jaffna. A questionnaire based survey was carried out to collect the data from 113 stratified sample of fruit growers. Descriptive analysis was performed to select the fruit growers who are able to market fruits with quality and adequate quantity. With the information gathered about fruit growers, database was developed by using 'My SQL' software. Database carries information regarding name of grower, cultivated fruits and varieties, selling quantity, quality of fruit, price of fruit and contact details of grower. Subsequently, the application with user interface was created. Eventually, Marketing Information System was designed to easy access by users. Major findings of the study revealed that the selected fruit growers have adopted to quality practices and are with higher production quantities. The Marketing Information System was successfully developed with the information about fruit growers. With the use of this Marketing Information System, the buyers who are scattered in farther locations in the country can easily access the information regarding the fruits that they require. It will facilitate accurate purchasing decisions by the buyers even without physically checking the produce. Moreover, with that, the producer-farmers will find a better market for their produce by identifying more potential customers, while receiving fair prices according to the quality characteristics of their fruits.

**Keywords**: Adoption to quality practices, Database Management System, Marketing Information System, User Interface

# Determinants of Adoption Decision of Newly Improved Tea Cultivars by Tea Small Holders in Uva Region

W.S. Jayasinghe, L.M.H.R. Alwis
*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka.*

Tea small holding sector plays a pivotal role in the economy of Sri Lanka. Tea small holders in Uva region face some challenges caused by biotic and abiotic stresses in tea growing as the consequences of them. Therefore these issues such as fungi, bacteria, sun scorch, cold lead the low productivity and poor quality tea. Adoption of newly improved cultivars in tea sector is a vital investment to enhance the productivity and to sustain the yield stability under different environmental stress conditions. The purpose of this study is to identify the factors affecting on adoption decision of newly improved tea cultivars by tea small holders. The research was carried out in small holdings areas of Haliella, Bandarawela and Welimada divisions of Uva region. Two hundred tea smallholders were selected from 16 Tea Inspectors ranges in these divisions using cluster sampling and simple random sampling techniques. Population in each Tea Inspector range consists with separate farmer organizations called clusters. Then a simple random sample of clusters selected from the population. Probit model was used to identify the factors affecting adoption decision of newly improved tea cultivars by tea small holders. Results revealed that higher proportion (74%) of tea small holders in Uva region were to adoption of newly improved tea cultivars in their cultivations. 26% of tea small holders in Uva region did not get the adoption decision of newly improved tea cultivars. Tea small holders education, awareness and knowledge level, extension service contact, experienced with drought, membership of agricultural association, field affected by pest and deceases are the factors affecting to increase the adoption decision of newly improved tea cultivars by tea small holders. The factor of constraints to access of newly improved planting materials influences to discourage the adoption decision of newly improved tea cultivars by tea small holders.

**Key words**: Adoption decision, Newly improved tea cultivars, Quality and productivity of tea, Tea small holders

# Determinants of the Level of Value Added Product Exportation in Tea Industry of Sri Lanka

D.A.O.C. De Silva[1], P.E. Kaliyadasa[1], A.M.C. Amarakoon[1] and B. Balamurali[2]
[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*
[2]*J.V. Gokal Ceylon (Pvt) Limited, Sri Lanka*

Tea industry plays a vital role in Sri Lankan economy. Sri Lanka is still holding its' reputation in the global tea market though it is associated with number of problems like declining productivity, increasing cost of production, declining world share of production and continuous increase of price in Colombo auction etc. Those problems of the industry should be addressed in order to increase the country's revenue from tea exportation as bulk tea and Value Added Tea (VAT). In this context, VAT will become an important determinant of the future of Ceylon Tea industry as the global market trends changes towards value addition. Therefore objective of the study was to identify the determinants that affect the level of value added product exportation at different levels. The research was carried out in Colombo district with 32 tea exporters. A structured questionnaire was used to collect primary data. Secondary data for the study was gathered from statistical bulletins, annual reports, research papers, survey reports and other related documents. Tobit regression analysis was conducted to find the determinants. The result of the study revealed that there are six factors which significantly affect the level of value added product exportation in tea industry. Those were scale of exportation (small scale), bilateral agreement, brand ownership, number of new market approaches, and investment on research and development activities and attitude on value addition. Moreover, results reveal that small volume exporters tend more towards the value addition and with beneficial bilateral agreement, exporters are more involved in exporting value added tea products. Further, investment on research and development and having own brand has positive impacts on the exporter to push them towards value addition. Attitude on value addition and number of new market approaches have an effect on the level of value added tea exportation. It shows a positive relationship which encourages the value addition level of the company.

**Keywords**: Export volume, Investment, Value Added Tea (VAT)

# Determinants of Ceylon Black Tea Market Penetration in Chinese Tea Market

R. Kirusiya[1], K. G. Prematilake[1], A. M. C. Amarakoon[1], A. Chitty[2]
[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Eastern Brokers (Pvt) Ltd, Colombo 7, Sri Lanka*

A growing economy and a booming middle class makes China a potentially lucrative market for exporters and further, changing younger generation's preference towards black teas creates a new export wave for the black teas to China. In view of this, a study was conducted to explore the factors effect on Ceylon black orthodox tea market penetration in Chinese tea market. The data employed to analyse the factors influencing market penetration of Ceylon black orthodox tea in Chinese tea market were obtained through a questionnaire. 52 Ceylon black tea exporting companies to China were selected as the sample using simple random sampling technique. Both descriptive analysis and multiple linear regression analysis techniques were used for the analysis. The major findings of the study indicated that, the model used for the study is significant at 95% significance level. Moreover, value addition, quality of tea, recognition of brand, consumer focus, competition, promotional activities and trade barriers were identified as significant factors that affect market penetration of Ceylon black tea into Chinese tea market. In addition, value addition, quality of tea, consumer focus, competition, promotional activities and standard barriers are having positive relationships with market penetration while failure rate, recognition of brand, unit price and trade barriers are having negative relationships with the market penetration. The results will assist Ceylon tea exporters in understanding the key necessities of the Chinese tea market and thereby improving the market penetration of Ceylon black tea into Chinese tea market.

**Keywords**: Ceylon black orthodox tea, Chinese tea market, Market penetration

# Market Analysis on Young Adult's Purchasing Decision Regarding Tea Products

S. M. Vidanapathirana[1], K. G. Premathilaka[1], K. P. M Kahandage[1], Q. Dissanayake[2]
[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*A. F. Jones Exporters Ceylon (Private) Limited, Sri Lanka*

Most tea companies are engaged in Colombo local market due to the high consumption level of tea products in the local market apart from tea exporting. The best target group for tea products is young adults, because they tend to try out new trends. Young adults belong to the age level between 20-40 years. Young adults represent a huge part of the local market. Hence we are interested to study the factors affecting young adults purchasing decision of tea products. The target population is young adults that live in Colombo city. 300 individuals were selected from 10 zones of the Colombo city using convenient sampling. Market analysis was conducted using a descriptive analysis and conjoint analysis. Four product attributes were selected as brand, package color, price and taste. Five existing products in the local market were selected as TM1, TM2, TM3, TM4 and TM5 (Trade Mark- TM) for analyzing the market share in the local market. The results showed that, there were five factors which were considered by young adults on their purchasing decision regarding tea products as Product, Place, Promotion, Familiarity and Demographic factors (income level and employment status). Four companied were found to be selling most preferred tea brands. Best advertising method to promote tea products was through Social media. In order to overcome the Colombo local market, tea products should be modified according to the consumer preferences. According to the market analysis conducted, using conjoint analysis, most preferred attribute levels were TM5, green color package, bitter tasting pack for Rs.205/- price among selected attribute levels. According to the predictions based on consumer preferences, highest market share was gained by TM1 at the local market in the Colombo city, among young adults.

**Keywords***:* Young adults, Purchasing decision, Tea products

# Awareness of and Adoption to the Recommended Management Practices of Big Onion Growers (Case Study in Dambulla D.S. Division)

D.N. Nanayakkkara[1], P.E. Kaliyadasa[1], A.M.C. Amarakoon[1], S.M.P.C. Padmini[2], J.K.M.D. Chandrasiri[3]

[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Sri Lanka Council for Agricultural Research Policy, Colombo 7, Sri Lanka*
[3]*Hector Kobbakaduwa Agrarian Research and Training Institute, Colombo 7, Sri Lanka*

Big onion is considered as an important cash crop in Sri Lanka. Within few decades big onion production has increased significantly along with the increasing demand for consumption. Though the production has increased, productivity is not satisfactory as average of 17 MT/ha where the potential productivity lies at 30-37 MT/ha. Therefore, it is imperative to study the knowledge level of the farmers and their adoption behavior regarding the recommended cultivation practices. Sixty five big onion growers who have not less than 5 years of big onion farming experience were interviewed in Dambulla D.S. division. Sample was selected randomly and data were collected using structured questionnaire. Total of 17 DOA recommended practices were considered initially but only 7 management practices were shown correlation with the level of awareness and adoption status. Therefore those practices viz use of recommended varieties, nursery sterilization procedure, seed treatment, spacing, seedling treatment, pre emergence herbicide application, correct harvesting stage and providence of optimum storage conditions were considered for further analysis. Results reveal that awareness on pre emergence herbicides and optimum harvesting stage has reported comparatively higher and they are 98.5% and 89% respectively. When considering the adoption, 76.9% of the respondents reported that they did not keep spacing while transplanting. Though the respondents have high awareness on optimum harvesting stage, only 27.7% well adopted to practice it. Factors affecting adoption are analyzed by using a multiple linear regression model and 5 factors were found significant. Respondent's age and off farm employment negatively affect the adoption level whilst education level, big onion farming experience and community leadership have no impact on adoption. According to the results it can be suggested that, though the farmers have sufficient knowledge on pre emergence herbicide application, correct harvesting stage and optimum storage conditions, majority has not at all adopted to those practices. Ultimately, it causes serious market based issues.

**Keywords***:* Adoption level, Awareness, Big onion, Management practices

# Detrminants of Replanting Decision by Tea Small holders in Badulla District

G.D.T.G.Dayaratna , R.A.P.I.S. Dharmadasa

*Department of Export Agriculture,Uva Wellassa University, Badulla, Sri Lanka*

One significant issue over many years regarding tea small holders is the low replanting rate. Replanting rate of tea small holders is 0.8%, which is relatively a poor value. In accordance with national policy, 2% of the existing tea extent has to be annually replanted in order to maintain the tea extent to obtain maximum yield. With this context,this study was designed to identify the factors influencing on the replanting decision to find out reasons behind the low level of replanting in tea small holding sector in Badulla district. Simple random sampling technique was used in choosing the sample. Primary data were collected from 300 respondents in Badulla, Passara, Haliela and Etampitiya Tea Inspector (TI) ranges. The probit regression was used to identify the determinants of replanting decision by tea smallholders. The results indicate that age, replanting subsidy, cost of replanting, education level of household head, household size, and tea land size significantly affect replanting decision of tea small holders. More specifically, cost of replanting, replanting subsidy, tea land size positively affect replanting decision while age and education level of small holderand house hold size negatively affect replanting decision of tea small holders in Badulla district. The study results suggests that, increase in replanting subsidy and provision of credit facilities at a low interest rate should be considered vital importance in maintaining required replanting rate.

**Keywords**: Replanting decision,Replanting subsidy, Tea small holders

**Technical Session IX**

# Entrepreneurial Agriculture

## Poster Presentations

# Tea Manufacturers' Attitude towards Implementation and Maintaining Quality and System Certifications

V. K. Wickramasinghe[1], K. P. M. Kahandage[1], S. Yasarathne[2], M.G.P.P. Mahindarathne[1], E. D. N. S. Abeyrathne[3]

[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka,*
[2]*Asia Siyaka Commodities PLC, Colombo 10, Sri Lanka,*
[3]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*

Tea plays a major role in the economy of several underdeveloped and developing nations in Asia and Africa. Tea production in Sri Lanka, plays a major role in the country's economy. Many standards are being applied for tea and international buyers very much concern about the certifications obtained. Today, maintaining quality of the product in the value chain is very crucial. Price movement in markets differ depending upon the quality. Therefore the objective of this study was to investigate the factors influencing tea manufacturers' attitude towards implementation and maintaining quality and system certifications in export trade. The overview and attitudinal characteristics of tea manufacturers were examined. Data were collected using data semi structured questionnaire. 82 respondents from three major tea growing regions based on the elevation, were participated in the survey. Based on the previous research done on factors considered in selecting quality certifications by tea exporters, awareness of market and certifications, cost and expenses, perceived benefits, perceived risks, demand for tea, extension support and competitive advantage were found to influence tea manufacturers' attitude towards implementation and maintaining quality and system certifications. Majority of the manufacturers in up and mid country were maintaining at least one quality system or standard while 79% of low country manufacturers were not maintaining any standard. Among the noncertified manufacturers, 34% of them do not have visible gain in implementing quality certification due to the perception of low returns to the investment incurred for implementing quality standards. Out of the certified manufactures, ISO 22000 and HACCP were the most obtained and there was a positive image within manufacturers' point of view on ISO 22000. Ethical Tea Partnership and Rainforest Alliance were more prominent corporate social responsibility based system certifications among tea manufacturers. The study reveals that awareness of market and certifications was the highest influencing factor for tea manufacturers' attitude towards implementation and maintaining quality and system certifications than others.

**Keywords**: Attitude, Awareness, Quality and system certifications, Tea

# Determination of Meat and Meat Products Consumption Pattern of A/L Students in Uva Province

H.K.S.P. Kumarasinghe[1], D.K.D.D. Jayasena[1], K.K. Wijesundera[1], D.C. Mudannayake[1], N.M.N. Nambapana[1], J. Siyambalapitiya[2]

[1]*Department of Animal Science, Uva Wellassa University, Badulla, Sri Lanka*

[2]*Department of Management Sciences, Uva Wellassa University, Badulla, Sri Lanka*

The factors affecting purchasing and consumption of meat are diverse and complex. The objective of this study was to identify different meat and meat products consumption patterns of A/L students in Uva province. A total of 58 schools were selected from Uva province. Pre-tested structured questionnaires were used to collect information from 1231 randomly selected students. Body Mass Index was calculated to detect the malnutrition condition of students. Collected data was analyzed using Microsoft Excel 2013 and Minitab 16. According to results, 85% respondents consumed at least one type of meat. Ninety percent of the participants consumed meat mainly at home. Among non-meat consumers, 48.39% had malnutrition condition. The religious believes (26.18%), allergies (15.71%) and antipathy for killing animals (46.07%) were the most popular reasons for not consuming meat. The most preferred meat types were chicken followed by beef, pork, and mutton, respectively. Among the processed meat types, most of students (57.52%) consume sausages and 4.35% of students consume meat balls. A total of 28.82% students consume both meat balls and sausages. There was a significant correlation between the meat consumption and malnutrition. In addition, a significant correlation between meat consumption and sex, religion, income level and living place (urban or rural) were observed, but not with education level and occupation. Type of meat, price, and nutrition were the priority determinants that influenced the purchasing behavior of meat and meat products. It can be concluded that the meat and meat product consumption of A/L students in Uva province of Sri Lanka should be increased to reduce malnutrition and that awareness on processed meat products and different meat types should be increased.

**Key words**: Body Mass Index, Consumption, Malnutrition, Meat, Uva Province

# Factors Affecting on Adoption of Paddy Transplanter in Mahawali Areas

A.M.S.B. Athapaththu[1], R.M.P.S. Rathnayake[1], H.K.S.G. Gunadasa[1], N.L. Sudeera[2]
[1]*Department of Export Agriculture,Uva Wellassa University, Badulla, Sri Lanka*
[2]*Rice Research Development Institute, Bathalagoda, Sri Lanka.*

After the industrial revolution, many agriculture activities were mechanized. However, seed establishment of paddy is still not mechanized in Sri Lanka. This research was designed to find the reasons for low usage and poor awareness among the farmers about the transplanting machineries. Mahaweli system B was selected for the study considering the usage of machineries in paddy cultivation. Judgment sampling and random sampling methods were used to select the 100 respondents from Aselapura, Damminna and Sewanapitiya areas. A pre tested structured questionnaire was used to collect data. Fourteen variables were subjected to the logistic regression. According to the results, five variables were significantly affected and positively related to adoption for the paddy trans-planter namely; age of the farmer, experience of the farmer, land area, average yield per acre under 5% significant level and paddy variety under 10% significant level. According to the study, there was a higher yield when using paddy trans-planter rather than using sowing method. But the cost of production and time consumption were high comparative to the sowing method which caused to low usage and poor awareness among the farmers and less attraction of younger generation towards the usage of transplanting machineries.

**Keywords**: Cost of production, Paddy transplanter, Sowing method, Yield

**Technical Session X**

# Hospitality and Tourism Management

## Oral Presentation

# Identifying Push and Pull Factors of Booming Chinese Tourist Arrivals to Sri Lanka: With Special Reference to the Dambulla and Nuwara – Eliya Area

A.M.D.B. Nawarathna
*Department of Public Administration, Uva Wellassa University, Badulla, Sri Lanka*

China is a potential origin of international tourists for many tourists receiving countries. In 2014, the number of Chinese tourists arrived in Sri Lanka was 128,166 and increased by 136.1 percent (SLTDA). Although Sri Lanka is receiving an increasing number of Chinese tourists' arrivals annually, it doesn't capitalize on the higher income generation opportunities of it. Most of the Chinese tourists don't stay at luxury hotels and they prefer economy and medium-priced hotels. Therefore, the objectives of this study are to analyze the push and pull factors of booming Chinese tourists' arrival to Sri Lanka and thereby to identify the strategies to gain the maximum yield of Chinese tourists' arrivals. Primary data collected by the author from 100 Chinese tourists interviewed using convenience sampling method in Dambulla and Nuawara-Eliya areas is the main data source. Both quantitative and qualitative data analytical methods were employed in analyzing the data. The study found that both push and pull factors stimulate the higher Chinese tourists' arrivals to Sri Lanka. The major push factors identified were different lifestyles, enhance communication with local communities, physical relaxation, sightseeing, mental relaxation, visit to a new place and increase knowledge about foreign destination. The major pull factors were entertainment, high environmental quality, cultural experiences, traditional foods, natural reserves, natural observation and awareness through internet. Promoting travel experiences about different lifestyles, making documentaries on attraction places and publishing those documentaries via online, enhancing relationship with Chinese film making companies, providing some brochures in basic Sinhala words and phrases, promoting Chinese literacy among shop owners, establishing more shopping opportunities directly affect on gaining a higher yield from Chinese tourists.

**Keywords:** Chinese tourists, Push and pull factors, Sri Lankan tourism

# A Study on Impact of Promotional Mix on Brand Equity with Special Reference to Franchise Fast food Restaurants in Colombo District

A.G. Haseena, S.F. Fasana
*Department of Management Sciences, Uva Wellassa University, Badulla, SriLanka*

Promotional mix is the important tool between the service providers and the customers in building up a good relationship among them. It is the stimuli factor to the service consumers. This study sought to analyze brand equity with promotional mix in franchise fast food restaurants in Colombo district. The present study empirically evaluated five promotional mix dimensions (advertising, sales promotion, personal selling, direct marketing, public relation) and their impact on brand equity in franchise fast food restaurants in Colombo district. The sample consisted of 90 customers of 9 franchise fast food restaurants in Colombo district. Primary data were gathered through a structured questionnaire among the respondents in sample. The research findings revealed that there is a strong positive relationship between promotional mix and brand equity and all the promotional mix dimensions have scored higher value with existing promotional mix. However, advertising and direct marketing are the key factors that influence mostly on brand equity in franchise fast food restaurants. In the light of the results, possible managerial implications are discussed and future research subjects are recommended. This research contributes to the growing literature on the franchise fast food restaurants in Colombo district.

**Keywords**: Promotional mix, Brand equity, franchise fast food restaurants

# Impact of Beach Boys' on Tourism Industry With Special Reference to *Hikkaduwa*

K.P.W.S. Kumara, D.A.K.A. Damunupola
*Department of Public Administration, Uva Wellassa University, Badulla, Sri Lanka.*

Tourism industry comprises a complex network of stakeholders and groups those who are having special interest in the tourism development, management and marketing for a particular destination. Tourist guides are one of the most significant stakeholder parties who play a critical role in the tourism industry. Among tourist guides Beach Boys those who are classified as non-licensed tour guides can be identified as one of the key influential stakeholder group in the industry. Therefore, the aim of this research is to critically investigate and evaluate both direct and indirect impacts of Beach Boys on tourism industry. Since the functions, roles and responsibilities of various middlemen engaging in the tourism industry are varying from many aspects this study focuses the impacts of Beach Boys upon three main perspectives, namely the tourist, tourism establishment owners, and the host community perspective. The study was conducted in Hikkduwa as it is ranked as one of the popular tourism destinations in Sri Lanka. And the convenience sampling technique was used to collect the first hand data and several other secondary sources including police reports, newspaper articles, books etc; were also used to gather information for this study. Moreover, both open ended and 5 point Likert scale questionnaire were developed to collect accurate data and the Qualitative approach was used for this study. The study revealed that most tourists' likely to get beach boy services as it's cheap and easy to get. The findings of this study would be beneficial for the policy makers and the tourism industry to recognize and to minimize the negative impacts while creating a positive destination image.

**Keywords**: Beach boys, stakeholders, impacts, tourism industry, destination image

# The Impact of Tourists' Satisfaction on Revisit Intention of Ayurvedic Tourism in Sri Lanka (With reference to Galle District)

H.A.A. Dilhani, J.P.R.C. Ranasinghe
*Department of Public Administration, Uva Wellassa University, Badulla, Sri Lanka*

The competition of modern business industry is growing rapidly to face the changes in present era. In the hospitality sector guest satisfaction and revisit behavior continue to be as important areas since satisfied customers willing to communicate their experience with others and get the service repeatedly. Since this is the knowledge era visitors have different expectations and tend to travel different destinations to relax their body and mind. Interest of tourists on Ayurvedic tourism is increasing to get mental and physical healthiness and to get away from their busiest life. By identifying guests expectations Ayurvedic Tourist Hotels provide ayurvedic treatments under recommendation of medical specialists within calm and quiet environment to satisfy guests. The growth in tourism is well anticipated as evident in the researches and analyses conducted by experts and relevant organizations in this industry. Therefore subject of concurrent studies on satisfaction and revisit intention in the hotel industry. This research was conducted to examine the relationship between satisfaction and revisit intention of tourists on Ayurvedic Tourism sector in Galle District. Primary data were collected from 80 tourists who have visited Ayurvedic Tourist Hotels in Galle utilizing structured questionnaire. The sample was selected randomly and 100% respondent rate has been achieved and Pearson rank correlation and multiple regression analysis have used for data analyzing. The result revealed that there is a strong positive relationship between satisfaction and revisit intention. In addition Staff Service Quality as most critical factor which influence on revisit intention and the treatments quality need to be maintaining in higher level to get repeat visit of guests to the service.

**Keywords:** Satisfaction, Revisit intention, Ayurvedic tourism, Ayurvedic tourist hotel

# Hospitality and Tourism Management Graduates' Perceptions and Attitudes of a Career in the Hospitality Industry

A.C.I.D. Karunarathne
*Department of Public Administration, Uva Wellassa University, Badulla, Sri Lanka*

Sri Lankan hospitality industry is surpassing a thriving era than ever before. In the key development contour of the sector, human resource development has been identified as a foremost prerequisite in the hotel sector. There is currently a severe dearth of employees in the tourism and hotel sector in relation to catering the authorities' targets. Tertiary academic stakeholders are currently crossing the threshold to fulfil the essentials fabricating graduates in Hospitality and Tourism Management. Yet, very less number of bachelor holders are working in the hospitality industry as a paradigm. In order to recruit and retain desirable personnel in today's competitive labor market, it is important for employers to understand demands and perceptions of the workforce. The purpose of this empirical study is to identify the perceptions and attitudes of Hospitality and Tourism Management graduates towards a career in the hospitality industry. Sample was undertaken with most recent graduating cluster who are ready to start their career after the academics of four years special bachelor degree in Hospitality and Tourism Management from two national universities of Sri Lanka. Graduates' perceptions were identified by means of variouse dimensions utilizing a structured questionnaire and graduates were asked to rate each. Discovering interests, attitudes and perceptions of the recruitment pool, employers will be able to gain competitive advantages and develop successful human resource strategies knowing what graduates looking for. Meantime, Universities and vocational institutes would cultivate sustaining protocols to produce graduates who are physically and mentally fit with the industry careers.

**Keywords:** Hospitality industry, Graduates, Career, Perception, Attitudes

# Impact of Service Quality Dimensions on Tourist Satisfaction, with Special Reference to Tourists' Satisfaction in Pasikudah Region

A.M. Rasmy[1], P.I.N. Fernando[2]
[1]*Department of Public Administration, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Department of Management Sciences, Uva Wellassa University, Badulla, Sri Lanka.*

Tourism has been identified as one of the booming industries in Sri Lanka has all the potentiality to contribute to the Socio-Economic development of Sri Lanka. Post-War peaceful environment has been privileged the industry to attract higher number of tourists from every corner of the globe to the Island. Hospitality that leads for the service quality and satisfaction is playing a main role while shape up the visitor expectations. Main objective is to identify the impact of service quality dimensions on tourist satisfaction by using the SERVQUAL model. Tourists from Pasikudah region has been chosen as the Eastern Development projects of the country way forwarded Tourism industry in Eastern region. The sample of 120 tourists selected through structured questionnaire among the tourists from hotels in Pasikudah and the convenient sampling technique has been adopted. Results revealed the positive relationship between service quality dimension and tourist satisfaction and five service quality dimensions; Tangible, Reliability, Responsiveness, Assurance, and Empathy, have an impact on tourist satisfaction. Accordingly, tangible is the most influential dimension, Empathy is the second dimension and Responsiveness is less influential dimension on tourist satisfaction in hotels in Pasikudah. Results suggest the importance of Service quality on tourists satisfaction and destination image. As recommendations, the overall service quality improvements as well as product, service and experience innovation packages as destination offerings would be proposed as managerial implications.

**Keywords**: Hospitality, Satisfaction, Service quality dimensions, Tourism, SERVQUAL model

## Technical Session XI

# Material Science and Engineering

## Oral Presentations

# Determination of Factors Affecting to the Hardness of the Compound Used for Apex of Bead of Industrial Pneumatic Tyre

W.S.S. Dharmathilaka[1], A.G.A.W. Alakolanga[1],
P. K.W. Arachchi[2] , A.N.R. Weerawansha[1]

[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Camso Loadstar, Central Mixing Plant, Minuwangoda road, Kotugoda, Sri Lanka*

The market for industrial pneumatic tyres created a demand for high hardness compounds for bead filler (apex) and sidewall support applications to increase the performance and load bearing capacity of the tyre. A number of different approaches have been used to increase the hardness of bead filler compounds. To obtain additional hardness for the bead filler compound phenolic reinforcing resins are used and mixing conditions are changed. The study was conducted to find out the factors affecting to the hardness of bead filler compound and identified their appropriate values. As well as verified those factors by performing the experiments. Through that hardness was improved to the expected limit. Effect of dumping temperature and maturation time and the interaction between maturation time and dumping temperature were checked. For that intermediate mixing was done under three different dumping temperatures and kept under three different maturation time. Obtained results were analyzed using two factor factorial analysis. There is no significant effect of dumping temperature and maturation time and also the interaction between dumping temperature and the maturation time. But highest mean hardness values are given by 18hrs of maturation time and 110 ˚ C dumping temperature. As the second experiment HMT incorporation stage has been changed. Generally HMT is incorporated in to 2nd stage mixing but here it was incorporated in to intermediate mixing stage. Previously founded maturation time (18 hrs) and dumping temperature (110 ˚C) were used for the 2nd experiment. Two sample t-test was applied to analyze obtained data. According to the analysis, there was a significant effect of HMT incorporation stage for the hardness of bead filler compound. It is concluded that if there is not a significant effect of dumping temperature and maturation time there is a considerable effect of dumping temperature and maturation time for the hardness.

**Keywords**: Bead filler, Dumping temperature, Maturation time, intermediate mixing, 2nd stage mixing

# Reducing Photocatalytic Degradation of Exterior Paint Prepared with $TiO_2$

S.D.M.A.S.S. Dissanayake[1], N. Jayaweera[2], C.K. Jayasuriya[3],
[1]*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka,*
[2]*Union Chemicals Lanka (PLC) Ltd., Sri Lanka,*
[3]*Department of Chemistry, University of Kelaniya, Sri Lanka*

Titanium dioxide ($TiO_2$) is the most widely used white pigment in the paint industry. $TiO_2$ is a photocatalyst under ultraviolet (UV) light. When it absorbs UV radiation, a UV photon which overcomes the energy gap between the valence and conduction bands of $TiO_2$ creates an electron-hole pair. The hole then reacts with water to produce hydroxyl radicals followed by a series of other reactions that produce more and more hydroxyl radicals which react with the organic matter to form water and carbon dioxide leading to the destruction of the polymeric binder of the paint film. This effect could be reduced by mixing the pigment with an inert oxide such as silica. The current research focuses on reducing photocatalytic effect of $TiO_2$ and thereby increasing the durability of the paint. A series of emulsion paint samples were prepared according to an exterior paint formulation by varying the ratio $TiO_2$:$SiO_2$. Formation of photocatalytic oxides were determined by measuring the absorbance using Orange II solution. Samples were exposed to UV radiation by applying them on small watch glasses as thin layers. The solution absorbance values on the samples were measured before and after exposure to UV radiation and recording absorbance at 60 min, 120 min and 240 min. The best sample with the lowest photocatalytic effect was used to determine paint properties. The lowest photocatalytic effect was observed for the sample containing 20% $SiO_2$ and 80% of $TiO_2$ and the paint properties were determined for that sample. Most of the properties are comparable with those of the industrial paint. However, viscosity and opacity are significantly reduced. It could be due to the undesired particle size of silica incorporated. Further investigations must be carried out to determine the optimum particle sizes which give the lowest photocatalytic effect with enhanced paint properties.

**Keywords**: Photocatalytic Effect, Paint, Titania, Pigment

# Development of Glassy Hard Wearing Glaze for Floor Tiles

S. L. Gamage[1], S. Medawela[2], J.T.Cooray[1]
[1]*Department of Science and Technology, Uva Wellassa University,Badulla, Sri Lanka.*
[2]*Lanka Tiles Private Limited Company, Jaltara, Sri Lanka.*

Glaze is a decorative layer on the tile surface and mainly there are three types, gloss, matt and rough. In Sri Lanka, most of people would like to use gloss tiles than matt or rough. Gloss glazes easily bounce the light and render adorable surface of the tile. However, gloss glazes can be easily scratched and wearable. Therefore, hard wearing gloss glazes are very important in Sri Lankan tile industry. However, Sri Lankan ceramic industry is not producing any glazes and all raw materials for production of glazes are importing. The main problem is lack of technology and high production cost. In this work, we developed a new glaze with increasing the surface hardness using $TiO_2$, $ZrO_2$, $V_2O_5$, and $Al_2O_3$/corundum as suitable additives without change the composition of frit, glossiness and firing temperature. In addition, fast firing cycle with single firing system was use for this research. The study was carried out changing the composition of above materials and checked the surface abrasion. In our results, $Al_2O_3$ was shown positive results for increasing wear resistance among other materials. Further, dry glazes made here used to remove unwanted organic materials and other impurities, and also reduced the surface defects on the tiles. In addition, we show that the abrasion class was increased by glaze when it add as in particle form, since it helped to reduce the contact area on the tile surface.

**Keywords**: Glaze, Frit, Alumina, corundum, surface abrasion

# Evaluation of Octosol A-18(E) & Sodium Silico Fluoride (SSF) as Shrinkage Reduction Agents in the Continuous Natural Latex Foam Sheet Manufacturing Process

P.D.A Gunasekara[1], A.G.A.W. Alakolanga[1], A.N.R. Weerawansha[1], U.H.T.P. Samaraweera [2]

[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Research and Development Department, Richard Pieris Natural foams Ltd, Biyagama*

Natural rubber latex foam sheet, which is made directly from centrifuged latex with 60 % dry rubber content and used for production of mat, mattresses or pillows. Shrinkage issue that occurs during the manufacturing process of Natural Latex Foam Sheets is a major issue which leads to greater wastages and economic losses. Shrinkage occurs during the gelling or curing period and may shrink as much as 50% in volume. However shrinkage cannot be prevent entirely and can be reduced only to an economically acceptable level. There is a possibility of using a foam stabilizer like Octosol A-18(E) to reduce the shrinkage while maintaining the expected physio-mechanical properties. Therefore, a study was conducted to find the best Octosol A-18(E) and Sodium Silico Fluoride combination which can reduce the shrinkage issue. Latex Foam was prepared and each of the sample was incorporated with Octosol A-18(E) at 0.05 phr,0.10 phr,0.15 phr,0.20 phr,0.25 phr levels and Sodium Silico Fluoride at 5.14 phr,6.14 phr,7.14 phr,8.14 phr levels. The developed twenty different foams were replicated three times and these foam were compared with a reference foam prepared without adding Octosol A-18(E) and the physio-mechanical properties were evaluated according to the ISO procedures. At 0.25 phr Octosol A-18(E) level Latex foam shows the lowest shrinkage but at that level another problem arise the "blooming" of the foam. "Blooming" of the foam can lead to the loose skin defect. However shrinkage, density and hardness decreases with increasing Octosol A-18(E) and Sodium Silico Fluoride levels than the reference sample. However compression set values decreased till 0.20 phr Octosol A-18(E) level and increased thereafter. Further this study also revealed that the effect of Sodium Silico Fluoride level on Shrinkage can be submerge by elevated Octosol A-18(E) levels. Also the results indicate that, up to 0.20 phr Octosol A-18(E) level and 5.14 phr Sodium Silico Fluoride level, most of the required properties of the foam could be maintained but the Octosol A-18(E) 0.15 phr level and Sodium Silico Fluoride level 5.14 phr level can consider as the best combination.

**Keywords**: Octosol A-18(E), Sodium Silico Fluoride, Shrinkage, Blooming, Physio-mechanical properties

# Improvement of Modified Bitumen Using Low Density Polyethylene

S. Kajugaran, V.S.C. Weragoda
*Department of Materials Science & Engineering, University of Moratuwa, Sri Lanka*

The modification of bitumen mainly involves on better materials properties and lower short term failures. At the same time, the durability also plays with for reducing maintains cost. In this manner, the wastage Low Density Polyethylene (LDPE) was used as a polymeric modifier of bitumen as such as 2%, 4%, 6% and 8% of total bitumen content and the properties of those samples were investigated under penetration test, softening point test, ductility test and specific gravity test. The 6% of LDPE content was preferred as a bitumen modifier percentage which was used to improve the performance of bitumen at high temperature. The strength and elastic properties of bitumen was validated in this modification. Finally, the Marshall test was conducted with using neat bitumen and modified bitumen. The physical properties of asphalt mixture were differed when the modified bitumen was used as a binder. The durability of pavements can be improved by using wastage LDPE.

**Keywords:** Polymer, Modifier, Bitumen, Low rensity polyethylene, Pavements

# Study on Relative reactivity and Toxicity of Metal-Glyphosate Complexes

D.N. Liyanage, R.A. Jayarathna, D.D.C. Wanniarachchi
*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*

Glyphosate (Glp), ($C_3H_8NO_5P$), N-(phosphonomethyl)glycin is a non-selective, post emergence organophosphorus herbicide. Metal-glyphosate complexes can be formed via coordination of amine, carboxylate, and phosphonate functional groups in glyphosate with di/tri valent metal ions in surface water. However, adequate studies on toxicity of metal-glyphosate complexes are not yet conducted. Furthermore, glyphosate metal complexes are suspected to cause chronic kidney disease in Sri Lanka. The goal of this study is to compare relative reactivity of metal ions towards glyphosate and toxicity of metal-glyphosate complexes. Therefore, metal-glyphosate complexes which has a higher potential to contaminate the surface water can be identified. Complexes were synthesized for Cu, Fe and Ca ions and characterized with FTIR and UV-Visible spectroscopy. Solubility was measured for these complexes and suggests higher solubility for Cu-Glp. However, the fastest complex formation was observed for formation of Ca-Glp followed by Fe- Glp and Cu- Glp. Fish embryo toxicity (FET) test results indicates metal-glyphosate complexes have a higher toxicity compared to individual metal ions and the highest toxicity was reported for Cu-Glp complex.

**Keywords:** Glyphosate, Metal glyphosate complexes, Toxicity, Glyphosate-metal reaction rates.

# Reinforcement of Natural Rubber vulcanisates Using Mixed Fillers of Carbon Black and Mica

L. Navaneethan [1], U. Jayalath[2], C. K. Jayasuriya[3]
[1]*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*
[2]*CEAT Kelani Holdings (Pvt) Ltd, Sri Lanka*
[3]*Department of Chemistry, University of Kelaniya, Kelaniya, Sri Lanka*

The current research was carried out to investigate the possible use of mixed fillers of carbon black and mica to reinforce natural rubber vulcanisates. It is expected that the use of reduced amounts of carbon black would minimize environmental effects and allow the production of more cost effective filler system. In addition, the use of mica as a filler material would make a value addition to mica which is one of the mostly available minerals in Sri Lanka. Mica was ground into powder and was kept at 80 °C for 24 hours. The powder having the particle size in the range of (63 -125) μm was separated. Seven compounds were prepared according to the tire inner layer compound formulation by varying the relative amounts of carbon black and mica. Processing characteristics of compounds were investigated by using a Rheometer. Vulcanized samples were prepared using a hydraulic press maintaining at 160 ºC for 20 minutes. Tensile and tear tests were carried out using a Tensometer. Hardness was carried out by using a Durometer. Tensile and tear strengths of the samples prepared with mixed fillers have been decreased compared to the reference sample. The modulus has been increased with increasing the amount of mica. Hardness has been improved only when small amounts of silica were replaced by mica particles. Diminishing properties could be due to undesired particle size of mica incorporated and non-uniform dispersion which interferes the process of crosslinking. Possible phase separation of mica and carbon black when higher amounts of mica are used could also be another reason. Further studies on the structure determination of the two types of particles incorporated are required to confirm the causes for observed variations. Such studies will also allow determining the best conditions for achieving reinforcing effects.

**Keywords:** Natural-rubber, Carbon-black, Mica, Reinforcement

# Ionic Liquid Based Gel Polymer Electrolyte for Magnesium Ion Batteries

R.R.D.V. Rathnayake[1], M.A.K.L. Dissanayake[2], H.M.J.C. Pitawala[1]
[1]*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Institute of Fundamental Studies, Hanthana Road, Kandy, Sri Lanka.*

We present here the synthesis and characterization of ionic liquid incorporated poly (ethylene oxide) (PEO) based $Mg^{2+}$ ion conducting gel polymer electrolyte for magnesium- ion rechargeable batteries. In this work magnesium triflate $Mg(Tf)_2$ was used as the salt in order to facilitate the $Mg^{2+}$ ion conduction and *N-butyl-N-methylpyrrolidinium bis(triflouromethylsulfonyl)imide* ($PyR_{14}TFSI$) ionic liquid was used as an additive to increase the transport properties of the electrolyte. The Complex impedance spectroscopy was used in order to measure the ionic conductivity whereas D.C. polarization test was used in order to obtain the transference numbers of the electrolyte. The polymer-ion and ionic liquid-ion interactions were investigated using FT-IR spectroscopy. Our results shows that the maximum ionic conductivity ($1.021x10^{-4}$ $Scm^{-1}$ at room temperature) can be obtained with the electrolyte having PEO: $Mg(Tf)_2$ is 15:1 molar ratio. The addition of ionic liquid into the parent electrolyte shows the further improvement in ionic conductivity with the highest value of $3.204x10^{-4}$ $Scm^{-1}$ for the 20wt.% ionic liquid. The electronic transference number of the electrolyte without ionic liquid is 0.129 and the electrolyte with 10wt.% of ionic liquid is 0.024. Our FTIR results show minor changes of the interactions of PEO and $Mg^{2+}$ when addition of ionic liquid. Thus, this structural modification after addition of ionic liquid has a major influence for the transport properties of the parent polymer electrolyte.

**Keywords**: Gel polymer electrolyte, Ionic liquid, Poly (ethylene oxide),Magnesium Triflate

# Fabrication of Dye Sensitized Solar Cells on Conducting Plastic Substrates

W.A.K.C. Wijesuriya, A.J.M.H.L. Senevirathna, P.M. Sirimanne
*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*

Ninety percent of the energy consumption in the world is fulfilled by fossil fuels. As a result of unending usage, all kinds of fossil fuels will be depleted within next few decades. Therefore finding alternative energy sources is the prime scientific goal which has many challenges associated to it. In this context, solar energy has received a greater attention as an alternative and viable energy source. Several types of solar cells have been designed and fabricated by researchers to harness the solar energy. Dye-sensitized solar cell is one such device that belong to the 3rd generation solar cells and has roused significant attention due to its easy fabrication and low cost. Highest efficiency has been achieved from dye-sensitized solar cells using ruthenium based metal complexes. However, ruthenium metal complexes cause environmental issue and so does the weight of the glass substrates. Therefore reduction of the weight of the solar cells and finding an efficient organic sensitizer are essential scientific hurdles. In this study, an environmental friendly dye, 1-(2-hydroxycarbonyl-phenyl)-5-(2-hydroxy-5-sulfophenyl)-3-phenylformazan (zincon) is used as a dye (sensitizer) to fabricate a solar cell. Zincon dyes have their own conjugated *p*-orbitals with delocalized electrons in the compounds thus absorbing unique portion of the visible light and giving an intense color. Zincon dye exhibits solvatochromic behavior due to enforcement of Van der Waals interaction between dye molecules and solvents depending on their polarity. Zincon was coated on titanium coated conducting plastic substrate, which was prepared by doctor blade method and then was pressured using a hydraulic pressure instrument. Zincon dye has different surface chelating groups and making bonds easily with metal oxides. Coupling of zincon dye by COOH group with $Ti^{4+}$ was confirmed by FTIR measurements. A platinum coated plastic substrate is attached to the dye coated film and the space was filed by the $I^-|I_3^-$ electrolyte by capillary action. I-V characteristics were measured under 1 Sun. Current-voltage characteristics of the cell were studied under simulated one sun. Photocurrent of 1.6 $mAcm^{-2}$, photo-voltage of 395 mV, fill factor 26.5 % and efficiency of 0.2 % were observed as the best performances of the cell. The photo-performances of the cell are much lower than those sensitized with ruthenium metal complexes based dyes.

**Keywords**: Zincon, Dye sensitized solar cells, Conducting polymers, Solvatochromic behavior

## Technical Session XI

# Material Science and Engineering

## Poster Presentations

# Study the Effect on Physical Properties of Rice Husk Ash and Carbon Black Filled Natural Rubber Vulcanizates

M. Gnanasubramaniam[1], J.K. Premachandra[2]
[1]*Department of Science and Technology Uva Wellassa University, Badulla, Sri Lanka*
[2]*Department of Chemical and Process Engineering, University of Moratuwa, Moratuwa, Sri Lanka*

Rice husk ash is mainly composed of silica and carbon black remaining from incomplete combustion. Both silica and carbon black have long been recognized as the main reinforcing fillers used in the rubber industry to enhance certain properties of rubber vulcanizates, such as Hardness, Resilience and tensile strength. In this study, two grades of rice husk ash (low- and high-carbon contents) were used as filler in natural rubber. Comparison was made of the reinforcing effect between rice husk ashes and carbon black. The effect of these fillers on cure characteristics and mechanical properties of natural rubber materials at various loadings, ranging from 0 to 45 pphr, was investigated. The incorporation of RHA into natural rubber improved curing properties, tensile strength and hardness of rubber compound. But decreased tear strength, abrasion resistance, and Young's modulus of the compound. However, RHA gave a better resilience property, and Elongation than that of carbon black. Altogether the rice husk ash filled rubber product gave cost reduction and comparable mechanical properties like carbon black fillers.

**Keywords**: Resilience, Abrasion, Young's Modulus

# Identification of Method to Minimize Glaze Pinhole in Porcelain Tableware

W.A.S.H. Weerakkody[1], P. Hettiarachchi[2], J.T. Cooray[1]
[1]*Department of Science and Technology,Uva Wellassa University, Badulla, Sri Lanka,*
[2]*Dankotuwa Porcelain Plc, Dankotuwa, Sri Lanka*

Sri Lankan porcelain industry governs a vast reputation of producing high quality porcelain products. Among different companies Dankotuwa Porcelain PLC upholds a great demand as the world's whitest porcelain manufacturer. Porcelain refers to a wide range of ceramic materials heated at higher temperatures to acquire vitreous qualities. This study was focused on the reduction of the defects that are determined as the faults or failures in porcelain items which can be occurred at any stage of the manufacturing process. The main focused defect in this study is the defect Glaze Pinhole. It is defined as pin pricks or small cavities beneath the surface on the mould side of the article. Aiming a profit maximization through reducing extra processing cost due to repaired and damaged items efficient methodology was built up to reduce glaze pinholes. In our study root causes for glaze pinhole were identified with the aid of a causes and effect diagram. It was identified that the particle size of the ball milled glaze, glaze flow and the dust particles on the porcelain body critically affect the occurrence of glaze pinholes. It was noted that best method to minimize glaze pinhole is dust must be removed perfectly and glaze particle size is within 71-72% (below 8μm particles). Glaze flow should be within 25 and 26mm. The cost efficiency was calculated as cost reduction due to decreasing of glaze pinholes and the reduction of ball mill grinding time. The energy saving due to the reduction of ball mill grinding time from 28-17 hours worth more than one thousand. As a result of this study it could be minimized the glaze pinhole percentage of porcelain tea cups from 8.21% to nearly 3%.Thus it showed a significant cost reduction worth nearly eighty two thousand rupees due to the 5% decrement of glaze pinhole percentage for nearly twenty thousand pieces.

**Keywords**: Porcelain, Defects, Glaze pin-holing

# Development of Novel Bricks Using Ceramic Waste

A.A.D.D.C.B. Alahakoon[1], S. Ranasinghe[2], H.M.J.C. Pitawala[1]
[1]*Uva Wellassa University, Badulla, Sri Lanka*
[2]*Lanka Tiles PLC, Jaltara, Ranala, Sri Lanka*

The major ceramic waste found in the ceramic industry is called filter cake. This is a semi-solid material and mainly generated during the processes of tile glazing and shaping. It is estimated that 15 to 30% waste is produced from the total raw materials used. However, there are no popular methods to reuse this waste. Therefore we study and develop novel bricks using above ceramic waste. Different types of proto type brick samples were fabricated using pure filter cake and also mixing shaping waste, kiln roller waste, rice husk, red clay and cement into the filter cake. The mechanical properties of the samples were carried out using Universal Tensile Machine (UTM). The density, water absorption and pH of different samples were also obtained during this study. The results showed that red clay incorporated samples have high mechanical properties and very low water absorption compared to pure filter cake, pure red clay, and other investigated mixtures. However, the density of red clay incorporated filter cake mixture is higher compared to pure filter cake. The chemical composition of the filter cake and red clay was obtained using XRF analysis in order to determine the major elements present in these two materials. Our analysis showed that filter cake consists of $SiO_2$ (55.83%), $Al_2O_3$ (17.41%), and CaO (7.72%) whereas red clay consists of $SiO_2$ (60.67%), $Al_2O_3$ (15.18%), and $Fe_2O_3$ (7.61%) as major compounds. These values clearly indicate both filter cake and red clay have quit similar chemical compositions and can be obtained as homogenous mixtures. Therefore, addition of red clay into ceramic waste and develop novel bricks would be a very good solution compared to using ceramic waste alone, to reuse the ceramic waste in Sri Lankan ceramic industry. Also, high abundance of red clay in Sri Lanka will lower the production cost.

**Keywords**: Ceramic waste, Filter cake, Red clay, Mechanical properties, XRF analysis

# Preparation and Characterization of a Mosquito Repellent Paint

A. Arunraj[1], N. Jayaweera[2], C.K. Jayasuriya[3]
[1]*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Union Chemicals Lanka (PLC) Ltd., Sri Lanka*
[3]*Department of Chemistry, University of Kelaniya, Kelaniya, Sri Lanka*

Paints are used to decorate, protect and extend the life of natural and synthetic materials. The current research focuses on a different aspect on which paint can be utilized. The objective of this study was to develop a mosquito-repelling paint while maintaining the desired paint properties. In this regard, neem oil, one of the known mosquito repellents was used as an additive in emulsion paint formulation. A series of paint samples were made according to the interior paint formulation by varying the amount of neem oil. The reference sample was prepared without adding neem oil. In addition, properties were also compared with a commercial paint sample. For each 500 g of emulsion paint, neem oil was added in amounts to prepare samples with neem oil percentages 4 wt%, 8 wt% and 12 wt%. Various paint properties of thus prepared paint samples were investigated. The mosquito repellency of the paint samples were monitored by counting the mosquitoes flying on to the surfaces coated with the paint at 30-minute intervals for 4 hours. Neem oil added paint samples show improved mosquito repellency, however, it could be retained only for few days. This drawback could possibly be remedied by using a proper bonding agent to prevent volatility of the active ingredient. According to the results, opacity and glossiness of the paints with neem oil are lower compared to those of the industrial paint sample. Some improvements in these properties could possibly be achieved by maintaining pH in the neem oil added samples close to that of the industrial sample. According to the results, water resistance is significantly reduced upon adding neem oil compared to the industrial paint sample. Further research must be carried out with a proper bonding agent to retain the desired paint properties as well as the mosquito repellency.

**Keywords:** Mosquito-repelling paint, neem oil

# Fabrication of Solid State Dye-Sensitized Solar Cells Using Squaraine Dyes as Sensitizers

A.J.M.H.L. Senevirathna, W.A.K.C. Wijesuriya, P.M. Sirimanne
*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*

Dye-sensitized solar cells (DSSCs) are 3rd generation solar cells combining both high efficiency and low cost of production. A solid-state dye sensitized solar cells are fabricated by using a hole-transporting p-type semiconductors replacing the liquid electrolyte used in DSSCs. Metal complexed dyes exhibit highest efficiencies over metal free organic dyes in DSSCs. However, there are several advantages of metal free organic dyes with respect to the metal centered dyes such as, low cost, and large absorption coefficients. The liquid electrolyte present in DSSCs exhibits several disadvantages such as evaporation, and degradation. Therefore, we made an attempt to produce solvent free, DSSC using two metal free organic dyes squaraine 3 (sq3) and squaraine 4 (sq4) dyes. In order to do that, a mesoporous $TiO_2$ layer was deposited on a compact layer of $TiO_2$ and sq3 and sq4 dyes were deposited on $TiO_2$ by immersing them in the dye solution for 12 hours. The dye - coating process was carried out in an oil bath. Dye coated electrodes were dried in nitrogen atmosphere. Then hole conductor CuI was deposited on dye coated $TiO_2$ films until the conductivity of the CuI film reaches 50 $\Omega cm^{-1}$. The cell was constructed by pressing a Ni-coated FTO glass plate on the $TiO_2$|dye|CuI electrodes. UV-Vis spectra show both sq3 and sq4 absorb visible light in the visible region. Three different electron transitions with different intensities were observed for sq3. Broad peak over visible region was observed for sq4 when dissolved it in water. Almost constant absorption over near infrared (NIR) region was observed for sq4 when dissolved in acetonitrile and ethyl acetate. Both sq3 and sq 4 have surface chelating groups (COOH) with metal oxides. Thus, an efficient chelation was observed for sq3 and sq4 with $TiO_2$ electrodes. sq3 and sq4 exhibit a broad absorption band in solid-state compare to liquid state because of the aggregations of dye molecules. Coupling sq3 and sq4 dyes with $Ti^{+4}$ via COOH groups were confirmed by FTIR measurements. The current-voltage characteristics of TiO2|dye|CuI cells with sq3 sq4 dyes are studied under simulated one sun, the best achieved performances of the cells are sq3 dye efficiency 0.27% and sq4 dye exhibits 0.43% of efficiency which makes sq4 dye the better sensitizer than sq3 dye.

**Keywords**: Dye sensitized solar cells, P-type semiconductors, Electrolyte, Chelation, aggregations

# Preparation and Characterization of Geopolymer Composites Containing Fly Ash, Bottom Ash and Rice Husk Ash

K. Kajanthan[1], J.K. Premachandra[2], J.T. Cooray[1]
[1]*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Department of Chemical and Process Engineering, University of Moratuwa, Sri Lanka*

Geopolymers being the synthetic analogues of natural zeolitic materials possess excellent properties, including fire and acid resistance, and mechanical properties. As a result, geopolymers have become an alternative construction material in place of Portland cement. They find structural applications such as sculpture, building repairing and building restoration. In producing geopolymers, the raw materials containing mainly silica and alumina are converted through chemical reactions into aluminosilicate structures in alkali medium. These aluminosilicate structures are composed of a network of randomly arranged silicate and aluminate tetrahedra in conjunction with charge-balancing alkali metal cations. The compressive strength of this resulting inorganic polymer depends on both the ratio of Si/Al and the types of the raw materials utilized. This research focused on the use of fly ash (FA), bottom ash (BA) and Rice husk ash (RHA) as a value addition in the preparation of geopolymer composites and the characterization of composites prepared. The effects of relative amounts of raw materials and the curing time of geopolymers on their compressive strength and water absorptivity were investigated. In sample preparation, a series of samples was prepared by hand mixing of selected amounts of cement, fine FA, BA, fine RHA, prewashed and dried sand, water and NaOH. The other series of samples was prepared by hand mixing of selected amounts of the same raw materials with $Ca(OH)_2$. Further, the cylindrical samples for characterization were prepared by molding using a hydraulic press and demolded samples were kept at 80 $^{o}$C for 4 hrs. Compressive strength of both series of samples was measured after curing them for 7 days and 14 days. The results showed that the compressive strength of the samples increases with increasing the curing time. At high relative amounts of cement and low amounts of the mixture containing FA and RHA, the compressive strength increases with decreasing the amount of cement and increasing the amounts of the mixture containing FA and RHA with compared to that of the samples in the absence of FA and RHA, regardless of the curing time. The incorporation of $Ca(OH)_2$, has resulted in increase of compressive strength of samples with high relative amounts of cement and low amounts of the mixture containing FA and RHA.

**Keywords**: Geopolymers, Fly ash, Bottom ash, Cement, Compressive strength

**Technical Session XII**

# Mineral Science and Technology

## Oral Presentations

# Improve the Green Tile Strength of the Tile Body by Using Montmorillonite

A.M.I. Ahamed[1], W.H. Kumarasinga[2] , J.T. Cooray[1]
[1]*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Macksons Tile Lanka (pvt) Ltd, Sri Lanka.*

Floor tiles are commonly made of ceramic, porcelain and stones due to their attractiveness, durability, and easiness to clean. The main components of a tile are tile body, glaze layer, and printed layer. The production cost lost is mainly depending on green and dry tile body. The tile body is very important for good quality and high strength finished products (fired tile). This research aims to manufacture high strength green and dry Tiles by using montmorillonite (MMT) because montmoillonite is consists of nano particles which will increase the density of the tile body. MMT sample was selected from Murunkan, Mannar for the investigation. First, silica test was carried out for clay samples (Ball clay and MMT clay). After the silica test; the tested clay sample were used for making base formula by adjusting silica percentage of the body composition because, MMT has high amount of silica. The green tile body was made using ball clay, MMT, feldspar, silica sand, dolomite, sodium triphosphate and sodium silicate. The raw materials were grind with 40% water in a pod mill about 13 minutes. The grind sample called slip. The slip was dried at 120 °C. Dried sample was crushed and sieved by 1000 μm sieve. Then 6% of water was added to the sieved sample and mixed with hand. It's called moisture powder. Then 83g of moisture powder was weighted and green tile was pressed by using Laboratory press and flexural strength (modulus of rupture-MOR) was measured. Dried and fired tiles were made and finally tile strength (MOR), loss on ignition, shrinkage, water absorbance were measured and analyzed according to reference tile. MMT has nano particles; it was reducing the pore space and increases the packing fraction of the green tile body that's why prepared green tile, dried tile and fired tile strengths were increased.

**Keywords:** Montmorillonite, Flexural strength, Shrinkage

# Development of Graphite/Ir Anode for Electro-chemical Denitrification of Landfill Leachate

U. Sivasubramaniyam[1], A. Manipura[2], K.G.N. Nanayakkara[2]
[1]*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Faculty of Engineering, University of Peradeniya*

Contamination of water by $NO_3^-$ can cause health issues such as methemoglobinemia or blue baby syndrome. Previous studies revealed that high concentration of inorganic nitrogen compounds such as $NO_3^-$ and numerous organic nitrogen compounds present in leachate. Thus, appropriate treatment of landfill leachate is urgently required. Electro-chemical denitrification is one of the best technologies which can be used in denitrification. In this research, anode was developed by applying iridium (Ir) coating onto the graphite substrate by electro and electro-less plating methods. In electro-less plating, glycerol or formaldehyde was used as reducing agent while 325 ppm $Ir^{3+}$ standard solution was used as the Ir precursor. EDTA was used as complexing agent. In electroplating, Ir was deposited onto well cleaned graphite cathode at 0.3 V and 110 mA from 250 ppm $Ir^{3+}$ standard solution coating bath. The success of the plating process was initially analyzed using UV-Visible absorbance spectrum studies. UV-Vis spectrums and color changes of plating baths were shown that the $Ir^{3+}$ concentrations in the plating bath were reduced with time for all methods. According to UV-Vis spectrums, excess formaldehyde which was used as reducing agent resulted high efficiency of plating. Therefore graphite/Ir anode which used excess formaldehyde in the plating bath was examined for Scanning Electron Micrograph (SEM), Energy Dispersive X-ray spectroscopy (EDX) and denitrification process. Observation of very small sizes of grains and 12.44 % Ir element present in the anode surface were the evidences that Ir deposited onto graphite substrate. Finally, developed anode and commercially available cathode electrodes were used for removing nitrate from nitrate solution.

**Keywords:** Denitrification, Landfill leachate, Iridium, Graphite

***Acknowledgement:*** *Financial support given by University of Peradeniya-University Research grant (RG/2014/22/E) and laboratory facilities of Faculty of Engineering, University of Peradeniya also acknowledged.*

# Optimum Heat Treatment Condition for Low Gem Quality Zircon in Sri Lanka

V. Kalansooriya[1], S. Illangasinghe[2], T. Cooray[1], C. Sutthirat[3]
[1]*Department of Science and Technology, UvaWellassa University, Badulla, Sri Lanka*
[2]*Gem Treatment Center, Ratnapura, Sri Lanka*
[3]*Environmental Research Institute, Chulalongkorn University,Bangkok , Thailand*

To increase the earnings from the gem exports as well as to encompass the international gem market it should be upgrade the quality by value adding to low quality natural stones. Dull and dark low quality zircons are commonly found in gem pits in Sri Lanka. As a value addition method for gem treatment, heating is commonly done to improve the color and clarity of gem stones. This research investigated the optimum heat treatment condition for low gem quality zircon. Dark brown zircons from Rathnapura area in Sri Lanka were annealed under reducing atmosphere by using "Lakmini" gas furnace. The annealing temperatures were 700 $^0$C to 1100 $^0$C for 2 hours at each temperature for all the samples. The green, yellowish green and blue colors were obtained by annealing in reducing atmosphere for 2 hours soaking time, respectively at the temperatures of 800 $^0$C, 900 $^0$C and 1100 $^0$C with the highest market value.

**Keywords:** Heat treatment, Zircon, Green zircon

# Development of Cost Effective Carrier Material for the Bio Fertilizer to Enhance Eppawala Phosphate Solubility

T. Rajhkumar, C.M. Peries, J.T. Cooray
*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*

Plants acquire phosphorus (P) from soil solution as phosphate anion. It is the least mobile element in plant and soil contrary to other macronutrients. Phosphorus solubilizing bacteria play role in phosphorus nutrition by enhancing its availability to plants. Bio fertilizers are inputs containing microorganisms which are capable of mobilizing, nutritive elements from non-usable form to usable form through biological processes. This study focused to develop a cost effective carrier material for the bio fertilizer to enhance the solubility of Eppawela phosphate. Eppawala Rock Phosphate samples were collected and microbial isolation was performed. Isolated microbial strains were inoculated on Pikovskaya's medium (PVK), a selective medium to screen Phosphorous Solubilizing Microorganisms. Thereafter, High-grade Eppawala Rock Phosphate (HERP) was mixed with carrier materials such as Kaolin, Fly ash and *Glyceride* were used because of containing high amount of plant nutrients and having the ability to increase the soil fertility. Kaolin and fly ash proportions were mixed in different proportions and apatite and gliricidia were maintained in constant in every treatment. Carrier material packets were prepared by mixing the broth cultures with sterile other ingredients. The P content was determined by the UV spectrophotometer at 400 nm. Two bacterial strains (B1 and B2) were selected as potential phosphate solubilizes on PVK agar medium. There was significant effect on carrier material type and the bacterial type for the P solubalization ($p < 0.05$). Both B1 and B2 bacterial types were shown high performance of the P solubalization with the addition of carrier material compare to the control. The most effective proportion of carrier material was Treatment 03 for the B1 bacterial types (Bacteria 1+ Rock Phosphate (40 g) + *Gliricidia sepium* (10 g) + Kaolin (30 g) + fly ash (20 g)) with the p value of 0.043 ($p < 0.05$). Both B1 and B2 bacterial types were shown highest P solubalization in 1st week.It can be concluded nutrient enriched carrier material can enhance the activity of phosphorous solubilizing bacteria for solubilizing phosphorus in HERP. Further, it can useful to develop the bio fertilizer with combining low water soluble HERP and the microbial population.

**Keywords:** Bioleaching, Carrier material, Phosphorus solubilizing bacteria

# Characterization of Hydroxyapatite Derived from Sri Lankan Rock Phosphate for Biomedical Applications

M. Chrishanth, K.B. Wijesekara
*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka.*

Hydroxyapatite ($Ca_{10}(PO4)_6(OH)_2$, (HA) is an important inorganic biomaterial with a structural similarity to minerals of human bone and teeth. HA is widely used for repairing bone defects in dental and orthopedic sites as filler or as a coating to promote bone ingrowth into prosthetic implants. Rock phosphate deposit at Eppawela Sri Lanka provides a rich source of chlorofluoroapatite which could be converted to HA. Conversion of apatite into hydroxyapatite was done by mixing 19.9 g of calcium hydroxide with 250 g of apatite powder (3:1 ratio) with constant stirring to achieve a homogeneous mixture, followed by high temperature sintering at 1000°C for 3 hours. Sintered HA was subjected to physical and chemical analysis to confirm successful conversion of apatite to HA and to establish its suitability in biomedical applications. Test conditions used were similar to pH and temperature changes that may occur in oral cavity of humans. FTIR spectroscopy patterns confirmed the formation of a hydroxyl group to crystalline phase of HA. FTIR spectra showed a stretching bond at 3420 $cm^{-1}$ which indicates the presence of HA. Peaks at 1030 to 1085 $cm^{-1}$ corresponds to symmetric stretching mode of $PO_4^{3-}$ while peak at 564 $cm^{-1}$ indicates the bending mode of $PO_4^{3-}$. The large separation bands indicate the presence of crystalline phase. Solubility (% weight loss) was high in pH 4 for all three temperatures tested (55°C, 30°C and 5°C) indicating acidulation of HA at low pH. At higher pH, solubility was insignificant. The % weight loss correlates with the amount of $Ca^{2+}$ and $PO_4^{3-}$ ions dissolved in the solution. The calculated thermal expansion coefficient of HA was 17.436x $10^{-5}$ $°C^{-1}$ which is x3 higher than that of human teeth (i.e. 6.603x10-5 $°C^{-1}$). Compressive strength of synthesized HA pellets was between 19-23 MPa which is lower than the expected value of 100 MPa of natural bones. Conversion method adapted in this study is simple and easy compared to popular Sol-gel method. Synthesized HA was stable at high pH between 5°C to 55°C. Lower compressive strength and high thermal expansion coefficient obtained with synthesized HA suggests that the conversion method needs optimization to make the product suitable for biomedical applications.

**Keywords:** Rock Phosphate; Hydroxyapatite; High temperature sintering, Biomedical applications

# Synthesis and Characterization of Multilayer Graphene Oxide Membrane using Flake Graphite of Sri Lanka

K.D.H.U. Weerathunga, A.R. Kumarasinghe
*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*

It is important to gather information on high quality isolated flake graphite crystallite. Because nanomaterials synthesis from it may inherit properties deriving from its distinctive nature of origin. And this may not be possible to realize with the other forms of graphite varying according to its morphology. Such properties could be advantageous over other forms of graphite for specific applications. Therefor to synthesis and characterize the multilayer graphene oxide membrane (MGOM) fabricated using flake graphite of Sri Lanka will support any business venture who is interested on nanotechnology application using graphite. Graphene oxide was synthesized using two types of powders i.e. flake graphite powder where the coarse, flake, radial (KCFR) morphology is isolated from Kahatagaha veins and a vein graphite powder which is processed by Kahatagaha mines. This processed powder (KPF) has a flake morphology which is produced using rollers where the normal vein graphite is pressed to form very thin flakes. MGOM has synthesized using improved Hummers method. Obtained MGOM membranes were characterized using X-ray diffraction (XRD), Fourier transmission infrared technique (FT-IR) and scanning electron microscope (SEM) techniques. XRD and FT IR studies were done to precursor graphite powders to identify the impact of its crystallography for MGOM synthesized. According to XRD studies the two membranes gave its fundamental peaks for graphene oxide and FT-IR spectrums gave peaks for functional groups which must be there to decorate basal planes of graphene layers to produce graphene oxide. According to SEM studies the thickness of membranes varies in the range of 0.7 microns. In addition MGOM which synthesized via KPF showed morphology of graphite nanoplatelets.

**Keywords:** Graphite, Graphene, Graphene oxide, Graphite nanoplatelets

*Acknowledgment: Sri Lanka Institute of Nanotechnology is acknowledged for analytical support.*

## Technical Session XII

# Mineral Science and Technology

## Poster Presentations

# Establishing a Relationship between Silica/ Feldspar/ Ball Clay Content and Shrinkage Properties in Wall Tile Manufacturing

J.N. Kanagaratnam

*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*

The manufacturing of a walltiles contains the raw materials such as silica, feldspar, ball clay calcite, kaolin and tile grog. Silica content in ball Clay may vary from location to location. This variation may cause shrinkage problems while firing the tile body. Since ball clay is a plastic material and silica is not, higher the silica, lower the shrinkage will be. Yet the extent of the effect of silica content on shrinkage properties is unknown. The objective of this study was to establish a relationship between Silica/ Feldspar/ Ball Clay content and shrinkage properties of wall tiles. Homogenized master batch of raw materials were made by collecting the raw materials from the storage bins. They were dried in the oven to reduce the moisture. The indirect silica content of ball clay was measured by checking the residue. Different formulas containing different percentage of silica were prepared. The powder was then prepared by adding 6% of moisture. Two tiles from each formulae were pressed in the lab scale press (6″ x 6″). The green tile size was measured using a Vernier caliper. The tiles were then fired in the biscuit kiln and the final size of the fired tiles were measured. Using the data collected from the above procedure, a formulae for shrinkage and silica/ feldspar/ ball clay content was derived. The standards and limitations were established.

**Keywords:** Wall tile, Silica content, Ball clay, Shrinkage

**Technical Session XIII**

# Digital Electronics and Embedded Systems

## Oral Presentations

# Automated Oil Pumping System for Sewing Machines

J.M.S.M.B. Jayasundara[1], U.D. Samanthilake[2]
[1]*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Department of Engineering, MAS Holdings, MAS Active (PVT) LTD, Shadeline, Mahiyangana, Sri Lanka*

Various types of sewing machines are available in the apparel industry. On the surface of such a machine, there is a movable contact that touches with any other point, which need to be lubricated. Different amounts of lubricant oil are carried from the oil bath of a sewing machine and this oil should be changed time to time and usually that is done by mechanics manually. The manual way of the oil changing is a time consuming task and may require some special skills. An automated oil changing system such as implemented in this research has the ability to overcome the issue. This system consists of an oil filling system that can be operated with push buttons on a panel, as the inputs. The Arduino platform acts as the control unit while an oil pump is considered as the output. As a feature of this automated oil changing system, the oil bath can be filled automatically by pressing the buttons according to the type of the sewing machine. Different buttons available on the system enable the users to select the appropriate type of sewing machines. When the relevant push button is being pressed, input signal is received by the Arduino. The oil pump will turn on through the relay device with respect to the controlling program that has been uploaded to the Arduino. After filling the oil bath to the standard level, oil pump will turn off automatically. By using the automated system, the efficiency of the sewing machine maintenance process has significantly improved. As a result of this study, the best results were obtained in double needle machine based on the factorial analysis with multiple comparisons.

**Keywords:** Arduino, Sewing machine, Sewing machine maintenance

# Simultaneous Wall Following and Map Building Robot

D.M. Withanawasam[1], W.K.I.L. Wanniarachchi[2]
[1]*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Department of Physics, University of Sri Jayewardenepura, Colombo, Sri Lanka*

In this research, an autonomous differential drive mobile robot is proposed to follow the wall on its right side, while avoiding any obstacles on its way and builds the map of the moved path. The importance of the study is that it can be used in a quarantined building where it is unable to send a human directly, but is important to send some device to collect information about the area. The proposed method can also be used to replace prevailing automated guided vehicle (AGV) system. The wall following algorithm is based on the method that a person find the way in a dark building. Even though the person cannot see, the person can understand the surrounding in the hand distance by touching the wall and then the person pursues to follow the wall. The robot platform includes three ultrasonic range sensors, microcontroller board, a motor driver and a power source. The programmed microcontroller gathers the distance information of surrounding area through the ultrasonic sensors and control the individual motor speed and direction according to the given logic. The speed of the individual motor is controlled by the pulse width modulation (PWM) signals. The developed robot communicates with nearby computer via a Bluetooth connection to gather the relevant information such as ultrasound sensor and wheel motion data. The recorded data are used to map the path of indoor mobile for the robot navigation.

**Keywords:** Wall following, Mobile robot mapping, Microcontroller

# Development of Leader Follower Robot

B.C. Liyanapathirana[1], W.K.I.L.Wanniarachchi[2]
[1]*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Department of Physics, University of Sri Jayawardhanapura, Colombo, Sri Lanka*

This paper discusses the development of a leader follower robot based on visual tracking. In leader follower approach, one robot acts as a leader whose motion defines the path for the follower robots. The entire follower robots use the path defined by the leader to achieve a defined task or to attain a certain goal. The advancement of the technology of video acquisition has made devices better and cost-effective. Thereby, many applications those will effectively utilize digital video can be identified. Compared to still images, video sequences provide more information about how objects and scenarios change over time. The strategy copes with the tracking and following of a single object in a sequence of frames and the co-ordinate of the object can be determined. The object tracking video is recorded using a wireless camera and then transmitted into a computer. Then using the software artifact named 'Roborealm', the video is processed and analysed, hence the object can be detected and coordinates of the detected object is calculated. The object is tracked by plotting a square bounding box around it in each frame. Co-ordinates of the centroid of that bounding box is determined and those coordinates are used for an algorithm which was specifically developed for the motion control of the follower robot. Then the commands related to the motion of the leader robot are transmitted to the follower robot enabling it to follow the leader robot.

**Keywords:** Leader Follower, Video sequencing, Wireless, Tracking

# Automated Dispensary Mechanism for Government Hospitals

C. J. Rupasinghe, D.R.V.L.B.Thambawita
*Department of Computer Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*

Dispensing medications in a hospital is a time consuming operation. In usual practice, the pharmacist need to dispense tablets and capsules with a simple tray and spatula. A typical hospital dispensary has only a few number of pharmacists causing long patient queues, the situation can be commonly experienced in most of the government hospitals in Sri Lanka. This inspired to introduce the concept of automated medication dispensing for Sri Lanka. This research introduces an automated solution for medication dispensing in outpatient dispensaries. The key objective of the study was to reduce the time consumption of drug dispensing. A desktop application was developed to generate prescriptions and an automated drug dispensing has been implemented. The solution comprised of a software artifact and an electronic hardware unit. The software tool is connected with a fingerprint reader which is used for patient registration. Patients can register with the system when he or she comes to the outpatient dispensary at first time. The pill container has three main parts: initially the upper part of the pill container is fed with tablets to be counted, and the middle part for hold some amount of pills to fetch the rotating pill catcher. Then the lower part called rotating pill catcher for catch pills one by one and carry them to the exit gate of the pill container. This pill catcher rotate with the help of a stepper motor. An infra-red sensor keeps counting the number of pills which are being released through the exit gate. If the count is equal to number of pills in the prescription, the motored mechanism will stop. Furthermore, two mechanisms were adopted for the tablets counting process. The first mechanism is based on a vertically rotating wheel which have several openings to catch one pill at one time. The second mechanism is based on a horizontally rotating round plate which have openings to catch one pill at one time. The process which is based on the horizontally rotation plate has achieved a considerably accurate pill count by compared to the vertically rotating wheel version. It was noticed that the vertically rotating wheel model was blocked most of the times because it cannot hold exact one pill at a time. Therefore horizontally rotation plate can be introduced for as an effective pill counting mechanism.

**Keywords:** Pill catcher, Pill fetcher, Infra-red sensor

# Home Automation System

K.G.H.A. Somasiri[1], W.K.I.L. Wanniarachchi[2]
[1]*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Department of Physics, University of Sri Jayewardenepura, Colombo, Sri Lanka*

Home automation refers to the automatic and electronic control of household features, activities, and appliances. Some components of an automated home may include the centralized control of security locks on doors and gates, appliances, windows, lighting, surveillance cameras and HVAC systems (Heating, Ventilation and Air Conditioning). Most existing advanced home automation systems require a big and expensive change of infrastructure since majority of them rely on wired communication. So it is required to change the entire wiring system of the house or wire again for the new home automation system. Obviously, wireless systems may be reduce the burden. And most of the existing systems are only capable of turn ON and OFF the home appliances but do not facilitate to see the states of the load in real time. The main objectives of the research are to design and implement a home automation system that is capable of controlling most of the house appliance wirelessly through a user-friendly web interface and indicate the status of them individually while eliminating the necessity of re- wiring. Any PC or mobile that has internet facility can be used to control it. And also to show the real time status on the web page. In addition, this home automation system is capable of turn on and off lights, control different appliance connected to wall plugs, door locking and unlocking, Shading Level Control and monitor the status. Central control unit required to be connected to the internet all the time since a web server is run by an Arduino Ethernet shield attached to it. All the sub-units are connected to main unit wirelessly via RF transceivers and they communicate both directions. The system was successfully implemented and tested.

**Keywords**: Automation, Surveillance, HVAC, Ethernet shield, Transceivers.

**Technical Session XIII**

# Digital Electronics and Embedded Systems

## Poster Presentations

# Two-Wheeled Self Balancing Robot

S.M.B.P.B. Samarathunga[1], W.K.I.L. Wanniarachchi[2]
[1]*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Department of Physics, University of Sri Jayewardenepura, Colombo, Sri Lanka*

This paper presents a method to design and control a two-wheeled self-balancing robot by focusing on hardware description, Complimentary filter algorithm, system modelling and Proportional-Integral-Derivative (PID) back stepping controller design. In the system, signals from the digital Gyro sensor are filtered by a Complimentary filter before being fed to the Proportional-Integral-Derivative back stepping controller. The objectives of the proposed controller is to stabilize the robot while trying to keep the motion of robot to any direction. By experimenting, the values of Proportional-Integral-Derivative parameters such as, Proportional Gain Constant, Derivative Gain Constant and Integral Gain Constant have been obtained and applied for the Arduino board. The special software was complied to convert the digital data from the accelerometer to an acceleration magnitude vector. The magnitude is then compared to a predetermined mathematical function to infer the angle of tilt of the platform. The angle of tilt is then converted to angle of rotation for the gear motors to act on. Complimentary filter is used to filter the gyro data in order to reduce noise, drift, and horizontal acceleration dependency, for the fast estimation of angle. It was noticed that this approach promises much less lag than the low-pass filter alone, and not very processor-intensive. Tuning for Proportional-Integral-Derivative controller is depending upon the physical properties of the robot and the battery power, due to those reasons tuning the controller becomes a difficult task. Experimental results shows that the platform performed as expected. The two-wheeled robot was able to move towards any direction while keeping its balance.

**Keywords:** Complimentary filter, Gyro sensor, Arduino board, Accelerometer, Proportional gain constant

# Control the Temperature of an Electric Iron Using Fuzzy Logic Technique

K.W.S.Chathuranga, R.M.T.C.B. Ekanayake
*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*

The paper presents a fuzzy logic control technique which gives a major contribution to solve the problems those are categorized as difficult to solve with conventional control techniques. In addition, the fuzzy logic control technique delivers solutions faster than the conventional system. Temperature controlling is a very important task in many fields such as food preparation, cloths preparation, incubators, refrigerators systems that are used in experiments. As the outcome of the study, a fuzzy logic based-temperature control system was developed which is more appropriate for an electric iron. The system consist of a microcontroller, temperature sensor, a user interface circuit, display interface circuit and an output interface circuit. Fuzzy logic technique was implemented to achieve a controlled temperature output function. The temperature was measured with respect to time for the system comprised of the fuzzy logic based- temperature control system using the LM35 sensor. It was observed that, the time consumed to reach the stable temperature, which is defined according to a preferred set of values, was heavily depending upon the temperature value to be achieved itself. The same LM35 temperature sensor was used to obtain the final output of observable temperature. According to the results, the entire system was capable of achieving the stable value for the set temperatures. It can be concluded that, the achievement is because of using a fuzzy logic based-temperature control system for an electric iron.

**Keywords:** Electric iron, Fuzzy logic, Temperature control, Temperature sensor, microcontroller

**Technical Session XIV**

# Computing and Information Science

## Oral Presentations

# Detection of Dhool Number in Black Tea Manufacturing with Image Processing Techniques

S. Saranka[1], T. Kartheeswaran[1], D.D.C. Wanniarachchi[2], W.K.I.L. Wanniarachchi[3]
[1]*Department of Computer Science and Technology, Uva Wellassa University, Badulla , Sri Lanka.*
[2]*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka.*
[3]*Department of Physics, University of Sri Jayewardenepura, Nugegoda, Sri Lanka.*

The possibility to use digital images of tea particles as a tool to monitor fermentation of black tea processing is studied in this project. Copper green colour is the predicted colour used to measure the degree of fermentation; therefore, determining the fermentation level by observing the copper green using naked eye is error prone and affects the complete product outcome. Black tea processing takes several batches per day, and from each batch, there are three types of particles obtain after Roll breaker processes. According to the size of the particles these are named as dhool 1, dhool 2, and dhool 3. The duration of fermentation is varied by dhool number for a given batch due to varied sizes of tea particles. Therefore, it is important to identify the dhool number for a given digital image. The method used in this project is divided in to three main phases, image pre-processing, identification of the dhool number, and prediction of the fermentation level. Image processing techniques are used to extract features of tea leaves and Support Vector Machine (SVM) is used as the classifier to train the system and obtain accuracy in each stage. The results indicate higher accuracy in predicting the dhool 1 which is over 77% accurate while dhools 2 and 3 indicated accuracy levels of 69% and 73% respectively. Therefore, image processing techniques can be successfully used to predict the dhool number of a given batch of tea processing.

**Keywords**: Fermentation, Image processing, SVM

# Detection and Classification of Diseased Tomato Leaf Using Image Processing Techniques

Y. Mehendran[1], T. Kartheeswaran[1], E.P.S.K. Ediriweera[2]
[1]*Department of Computer Science and Technology, Uva Wellassa University, Badulla, Sri Lanka.*
[2]*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka.*

Tomato plants are highly vulnerable to fusarium wilt, verticillium wilt, and late blight. The symptom is yellowing of the lower leaves, which gradually wilt and die. The naked eye observation of experts is the main approach adopted for detection and the identification of plant diseases. We developed a method to detect and classify damages in leaves using image processing techniques. For this experiment, images downloaded from the internet were used. The disease regions were segmented using K-Means clustering and the classification of the disease was done with Support Vector Machine (SVM) by training with the selected features from the training set of images. The initial version has three classes such as Bacterial Wilt, Early blight and Healthy tomato leaves. The accuracy level for the identification and the classification of diseases was calculated for each category separately. The accuracy of the system for the selected nine features was calculated as 76.5%. Association among the features as Contrast, Correlation, Energy, Homogeneity, Entropy, Mean, Standard deviation, Skew, and Kurtosis gave the optimum accuracy. This system with high accuracy motivates the other researchers to extend the system with added functionality, which will be a farmer friendly software solution.

**Keywords**: HSI, K-means, Gray-level co-occurrence matrix, Support Vector Machine (SVM).

# Fuzzy Logic and Fingerprint Based System to Improve the Productivity of Teaching Process in Sri Lankan Schools

S.C. Jayawickrama, D.RV.L.B. Thambawita
*Department of Computer Science and Technology, Uva Wellassa University, Badulla, Sri Lanka.*

Education is an essential factor of life in global context. It takes a very vital role by maintaining a high literacy rate among countries in the world. Sri Lanka is a country intending to provide free education as much as possible in an efficient way. After some reforms of the education system in Sri Lanka, nowadays in school systems, there are 6 teaching hours which start from 7.30 a.m. to 1.30 p.m. The teaching hours are divided into 8 periods and organized in the daily timetable. Schools play a major role in preliminary stages of education. The deep study of the above problem has been done by analyzing the school teacher's attendance. There are some practical problems found in daily school routine by analyzing the current administration process of Sri Lankan schools. A computer-based approach can be designed to overcome this problem by designing a system. The productivity of the school can be improved by this approach and utilizes the teacher's maximum potential. A Fuzzy logic and fingerprint-based system has been done to improve the productivity in Sri Lankan schools. Currently, there are two main problems of assigning teachers for a free period and generate a quality timetable in Sri Lankan schools'. The fuzzy and fingerprint-based system can mark the teacher's attendance with the available period of the day and send some notification S.M.S. to the teacher. The system that has been designed is able to find the best-matched teacher among others to assign for free period. In addition, the timetable generation problem also can be solved by generating the given number of timetable and select the best effective teacher among others. The system were tested by teachers by assigning some real data and found the speedup is achieved by the system is more than 20 times. The automated timetable scheduling also made the process very faster than the existing methods around 100 times. The teacher who has done testing highly recommended the system for their schools and they confirm that the system will make their task easy.

**Keywords**: Fuzzy, Education system, Fingerprint

# A Morphological and Gradient-based Approach Classify Rice Grains

K. Niroji, S.H.D. Senanayake
*Department of Computer Science and Technology, Uva Wellassa University, Badulla, Sri Lanka.*

Rice is the seed of the monocot plants Oryza sativa (Asian rice). Rice grain recognition is very essential in agriculture for the management of rice grain types. Grain quality of rice varieties is determined by their physical characteristics. However, rice grain classification is an important component of computerized rice grain classification. This study proposes a computerized system for rice grain classification using digital morphological feature and shape based features. In order to achieve this goal, it translates into the identifying three target objectives such as to extract the features of rice grains, to classify the rice grains using k-Nearest Neighbour (k-NN) and Support Vector Machine (SVM) and to decrease the labor intension and improve the speed and precision of the Identification and classification compared to previous works. This study confirms the importance of basic (length, width, area, and perimeter) and morphological (aspect ratio, form factor, rectangularity, Equivdiameter) features. The four basic and four morphological features and Histogram of Oriented Gradients (HOG) features are used to classify ten types of rice grain varieties which are currently famous in Sri Lanka. These features are the input to the classifier for efficient classification and the results were tested with the k-NN and SVM classifiers separately.The k-nearest neighbour approach was used as a baseline classifier and then classified with SVM classifier. The proposed approach shows around 98.571% of classification rate when using HOG descriptors than basic and morphological features using SVM classifier as well as k-NN classifier. The experimental result demonstrates that the proposed method is effective and efficient. In particular, by comparing with the k-NN and SVM classifiers, when using HOG descriptors system increases the accuracy with compared to the other basic geometrical, morphological features under the case of no sacrificing the classification accuracy.

**Keywords**: Rice grains classification, Rice grains identification, SVM, geometric features, morphological

# Mouse Control System for People Who Have Lost Their Privileges of Using Both Hands and Voice

K.R.D Srimevan, I. K. K. B Ihalagedara
*Department of Computer Science and Technology, Uva Wellassa University, Badulla, Sri Lanka.*

The "NOHV Mouse" system has been developed to provide a technique of mouse control as an alternative input device with personal computers for people with hand and speech disability. The standard mouse can be difficult for people with some disabilities to use and has to face lot of challenges when using the computer, we have to know what capabilities such a person has to apply universal design to computer interfaces. The user can control the cursor with small head movements and performing clicks with default facial gestures in front of a webcam. The system tracked the computer user's head movements with a video camera and translates them into the movements of the mouse pointer on the screen and detect eye open/close for performing click events. NOHV Mouse provided a real time tracking system using image processing, face/eye detection techniques. The system used basics of face detection using Haar Feature-based Cascade Classifiers and extend the same for eye detection. It was tested with some users and according to their feedback, it took average 15 minutes to get the best usage of the system and understood functions well and interact with the system. According to the results, showed that this system (NOHV Mouse) successfully provided computer access for people lost their both hands and voice with some limitations.The primary goal of this project is to provide a low-cost approach and increase the human computer interactivity than existing solution in the same problematic situation.

**Keywords**: Real-time tracking, Face detection, Eye Detection, Haar Feature-based Cascade Classifiers, Image Processing.

# Identifying Hidden Patterns Related to Indices in CSE through Data Mining

S.M.M.P. Sathkumara, S.H.D. Senanayake
*Department of Computer Science and Technology, Uva Wellassa University, Badulla, Sri Lanka.*

The linkage between stock market operations and the economic growth has been tested by most of the economists in various countries. The key of success in stock trading is to buy and sell stocks at the right time for the right price. "Buy Low, Sell High" sounds easy, but it is so difficult to carry out since the direction of stock market in the near future is almost unpredictable. With the advances in data mining, it has now become possible to predict the future market direction based on historical data. By this research, I have tested & evaluated the performance of the stock market operations in Sri Lankan context using more than ten years data from 2003 to 2015. The main purpose of this research is identifying hidden patterns related to price indices in Colombo Stock Exchange (CSE) through data mining. In here I have used following attributes to achieve the main objectives of the research, All Share Price Index(ASPI) and twenty sector indices in CSE. The Price Indexes were used which are composite representation for whole stock market operations. Those twenty sectors are Banks, Finance & Insurance, Beverage, Food & Tobacco, Construction & Engineering, Chemicals & Pharmaceuticals, Diversified holdings, Footwear & Textiles, Hotels & Travels, Health care, Investment trusts, Information Technology, Land & property, Manufacturing, Motors, Oil palms, Power & Energy, Plantations, Stores & Supplies, Services, Telecommunication, Trading. The WEKA software is used to analyse the data. The empirical findings of this research finally gave three highest percentages among twenty sectors with the twelve high percentages. I have used 90 percent as the threshold value to find out those fifteen outputs. This study will be helpful to future researches and the potential stock market investors.

**Keywords**: Stock market, Data mining, Classification, Pattern recognition, Decision tree

# Data Mining Approach to Predict Climate Changes in Sri Lanka

K.H.S. Kumarasinghe, H.M.S.N. Ariyadasa
*Department of Computer Science and Technology, Uva Wellassa University, Badulla, Sri Lanka.*

Knowledge of climate data or weather data in a country is essential for business, society, agriculture and energy applications. Therefore, extracting some hidden knowledge relevant to business, society, agriculture and energy by using different techniques are essential to enrich the knowledge base. The technique, data mining can answer questions that have not traditionally been solved or very time consumed to resolve. Therefore, this technique can be used to predict climate changes by using available data. Climate change prediction is a vital application in meteorology. It is one of the most scientifically, technically challenging problem across the world in the last century. Many climate predictions like rainfall prediction, thunderstorm prediction, predicting cloud conditions are major challenges for atmospheric research. Predicting the climate changes is essential to help to precautious for the climate. This paper presents the data mining technique for predict precipitation changing patterns and temperature changing patterns using classification technique. The classification is done using decision tree algorithm with 50 years average data. The data were collected from WorldClim website, which includes climate data of many countries in the world. Data was collected from 10,000 random places in Sri Lanka. The data were in a satellite image format. Around 10,000 of random data samples were extracted using ArcGIS application including attributes Temperature, Precipitation, Altitude, Bioclim, etc. The standard Knowledge Discovery in Databases (KDD) process was applied to the dataset to discover the hidden pattern in climate. After removing data inconsistencies in the pre-processing stage, smoothing, generalization and aggregation were applied in the transformation stage. A data model for the climate data was developed and trained by using j48 decision tree classifier algorithm. WEKA was selected as the data mining tool and it was produced a decision tree relevant to the data set. The finding of this research deep-rooted again, the different altitude levels and precipitation levels affect the temperature norm.

**Keywords**: Climate change, Data mining, J48, Classification, Weka, Wordclim

# Pattern Recognition in Dengue Disease

H.M.K.V. Jayaratne, S.H.D. Senanayake
*Department of Computer Science and Technology, Uva Wellassa University, Badulla, Sri Lanka.*

Data Mining is one of the most motivating areas of research that has become increasingly popular in health sector. It is a well-known technique used by health organizations for classification of diseases. It plays an important role for uncovering new trends in healthcare sector which in helpful for all the parties associated with this field. Dengue is a life threatening disease dominant in developed as well as under developing countries like Sri Lanka. This is a virus born disease caused by breeding of Aedes mosquito. Datasets that are available for dengue describe information about the patients suffering with dengue disease and without dengue disease along with their symptoms like: fever temperature, WBC, platelets, severe headache, vomiting, metallic taste, joint pain, appetite, and haemoglobin. In this research various algorithm approaches are discussed of data mining that have been utilized for dengue disease prediction. In the proposed approach WEKA data mining tool was used to evaluate data and compare results. In this research, the dengue data set was classified, pre-processed and then compared the different data mining techniques in WEKA through explorer interfaces. According to the four experiments, several patterns could be obtained from dengue patients' details about district, admitted date, gender, age and hospital. According to the first experiment, the probability compared to the Matara district dengue patients and Gampaha district children who suffered from dengue disease live in very high populated areas and are highly using base hospitals. That means they use hospitals like Lady Ridgeway children's Hospital or Infectious Diseases Hospital (IDH) because there are specific hospitals for children and dengue patients in those areas. So the parents live in Negombo and Kelaniya areas are aware of that. Also, there is a high probability of Gampaha district male dengue patients who are living in very high populated areas and age is 60 or above use base hospitals in the second quarter of the year.

**Keywords**: WEKA, WBC, Data Mining

# An Artificial Neural Network Model for Rainfall Prediction on the Basis of Agro-ecological Regions (AER) in Sri Lanka

A.A.D. Surin, S.T.C.I. Wimaladharma
*Department of Computer Science and Technology, Uva Wellassa University, Badulla, Sri Lanka.*

There are many studies done for testing the capability of rainfall forecasting using artificial neural networks. In Sri Lankan context, this study presents another model that uses Agro Ecological Regions as the basis instead of currently popular administrative districts. An Agro Ecological Region represents a particular combination of climate, soil and relief, so this study tries to find out the advantage and accuracy of giving a weather report per each Agro Ecological Region. For the purpose, two locations from *WL4* region, Bandaranayaka International Airport (*VCBI*) and Galle weather station (*WMO43495*) were considered. The Artificial Neural Network was trained using 10 years of daily data from each selected station using split-sample method. The accuracy of predicting rainfall probability, rain or non-rain status is tested. Selected Artificial Neural Network is a pattern recognition, feedforward based neural network, which uses hyperbolic tangent function as the transferring function and back propagation method as the training algorithm. Mean temperature, mean dew point, mean humidity, mean sea level pressure, mean visibility and mean wind speed were selected as inputs for the neural network. According to the binary classification strategy, the status of each day was defined as rain or non-rain. Mean value of each weather parameter was compared with each locations, and there were no significant difference between the actual values and the predicted values. The estimated error rate of making predictions using the proposed model was less than 35%. According to the results obtained, this model tends to be giving more precise results compare to the district based weather forecasts. Keeping several classification parameters as targets and using more observatory points are the recommendations to improve the accuracy of the results of this forecasting model.

**Keywords**: Artificial Neural Network, binary classification, rainfall forecasting, climate, pattern recognition

# Optimization of Wireless Network Sensors Points using Genetic Algorithm

U. Priyatharsan, P.H. Sarawana
*Department of Physical Science, Vavuniya Campus of the University of Jaffna, Vavuniya, Sri Lanka.*

The supply of Internet services to a particular place is a difficult task whose difficulty increases as the number of equipment that will use it. Solving the problem involves the analysis of factors such as the location of the sensors network, in addition to the characteristics and constraints that have these and its location. Thus, an optimization problem that can be tackled by this type of problems called Facility Location Problem. This paper intends to apply techniques of genetic algorithms for solving the problem, obtaining a distribution of these sensors for an arbitrary city so that minimize installation costs without diminishing the quality of the signal. The problem area is divided into 6 sections and a block bounded by four blocks, resulting in 36 possible points of demand or service. Then, this sector comprises a possible total of 2880 points to be considered as potential places, of which 640 are light poles. Using a graph representation, each of these points is denoted by a node, the edges of the graph being the distance between nodes. A triangular matrix is generated with the distances between each pair of points in the model, using thealgorithm of Dijkstra's shortest path, which is accessed during the subsequent process of calculation. The criteria for determining the fitness of an individual is given by a function between coverage and cost of the sensors. After a certain number of sensors, increasing costs has a velocity greater than the increase in the number of users served growth. In the case of 110 sensors, option is getting coverage of 71.64%, optimizing the fitness of individuals, in the case of using sensors 200; we have coverage increased by 18.36%, an increase in the cost of a 44.05%. Further, results show that evolution in the quality of solutions in the case of 110 sensors.

**Keywords**: Genetic Algorithm, Optimization, Wireless Networks

# Real Time Traffic Light Time Analyzer

I. K. K Indika, D.R.V.L.B Thambawita
*Department of Computer Science and Technology, Uva Wellassa University, Badulla, Sri Lanka.*

In urban arrears of all over the world, traffic lights are used to manage the traffic. However, congestion becomes worst and needed to increase the performance of traffic lights by focusing on increasing the capacity of transactions and minimizing the waiting time. By this research, a new fuzzy rule set is proposed for the cross and three-way (T-junction) junctions considering a number of vehicles on a road, time to complete a cycle, waiting time of the each road and the traffic condition of the road. The image processing technique is used to get dynamic data. The fuzzy logic system has been implemented to get decisions dynamically for the cycle time, green color light time and time to cross vehicle by analysing the waiting times using fuzzy outputs and other dependent data. MATLAB is used for fuzzy logic and image processing to generate unique output for each traffic condition. The performance of the new system is evaluated by comparing the waiting times in between current cycles and fuzzy cycles. The results obtained shows that the system has almost higher performance (Between 13% and 47%) and it is increased when congestion is low. Use of dynamic time cycles according to vehicle velocity causes to increase the performance of it. It was identified that performance is higher when using short cycle times for less congestion while medium cycle time is preferred for high congestion. The output results show that fuzzy system is better than the existing system because its waiting time near junctions is less than fixed cycle method.

**Keywords**: Traffic congestion, Fuzzy logic, Delay estimation, Real time

# Nitrogen Level Measuring System for Rice Cultivation

K.L.K.R. Liyanage, M. Ramashini
*Department of Computer Science and Technology, Uva Wellassa University, Badulla, Sri Lanka.*

A major reason of the high production cost in rice cultivation is due to the fertilizer cost. Farmers apply fertilizer not based on the plant condition but on an exact date starting from seeding. This may lead to either over an application or under an application of fertilizer since the rice growth is not uniform throughout the crop area. Both of these cases would lead to nitrogen deficiency that gives a lower yield. Modern agricultural researchers discourage the use of traditional farming and encourage precision farming. Precision farming is described as the production inputs like seed, fertilizer etc. should be applied only when needed for the most economic production in order to obtain the highest output. One of the most effective tools to determine when to apply fertilizer in what amount is the Leaf Colour Chart (LCC). The colour matching is relative to the colour perception of a person. Therefore, the recommended way is to do the matching process by the same person. The usage of LCC is also limited to a certain period of a day due to the effect of sunlight. This research aims to develop a mobile application that automates the usage of LCC to overcome its limitations. The mobile application is capable of identifying a leaf sample to the LCC window it matches the most. The standard values are set according to the standards imposed by Rice Research and Development Institute. After a series of testing, it was found out that the results of LCC and the mobile application's readings show a minimum difference based on Z-test one proportion test.

**Keywords**: Leaf Colour Chart, RRDI, LCC, Nitrogen deficiency, Z-test one proportion

# Automated Conversion of Sinhala Sign Language in to Speech Form

L.A.H.S Kaushalya, I.K.K.B Ihalagedara
*Department of Computer Science and Technology, Uva Wellassa University Badulla, Sri Lanka.*

This concept would be highly beneficial for people who are not aware of the Sri Lankan sign language. This system will help them to record & interpret signs of audibly handicapped people without any help from the translator. Kinect sensor device was used to obtain static and dynamic movements of hand's fingers. But it must be pointed out that this sensor has less sensitivity for detecting finger movements which are very much related with dynamic signs. When hands moved, it was unable to get the clear boundaries of both hands. Therefore it concluded that this particular system is applicable only for the recognition of long movements of hand signals. The system is implemented using C# programming language and XNA framework. This system records frames of static and dynamic signs. After storing, it recognizes the relevant sign and subsequently transforms that into text and speech. Due to the limited sensing power possessed by the Kinect sensor it can be majorly used for recognition of long movement signals of sign language.

**Keywords**: C# Programming, XNA framework

# Medical Expert System for Analysing Heart Diseases in Sri Lanka

N.U. Weerawardana, D.G.R.V.L.B. Thambawita
*Department of Computer Science and Technology, Uva Wellassa University, Badulla, Sri Lanka.*

Heart disease diagnosis in Sri Lankan most commonly depends on a complex combination of clinical data and patient health status histories. Diagnosis of disease is a vital and intricate job in medicine. In the Sri Lankan situation, diagnosing heart diseases are getting too long time for the best treatment outcome. In Sri Lanka, 40 % of mortalities are due to cardiovascular diseases. This makes severe problems for the majority of the population. Delay in decision making and proper record making are the major problems for the majority. There is no way of analyzing symptoms before the patient reaches to a doctor. In this research, main investigations were developed a heart disease diagnosis system that can assist medical professionals in predicting heart disease status based on the clinical data of patients and developed subsystems for general public to make more aware about heart diseases. There are a lot of Artificial Intelligence (AI) techniques to determine diagnoses. After comparisons were made between those techniques, Rule-Base technique is chosen to diagnose heart disease. This research consists of two main parts as an expert system and a java web application. The expert system acts as inference engine with the expert knowledge of the specialists and java web application act as a user interface between users and the expert system. This system presents a web base Java application to make it accessible for all type of users. Main objectives of this system are diagnosing the heart disease effectively and predicting the disease type by symptom analyzing and heart-related medical product advertising by medical representatives.

**Keywords**: Expert system, Heart disease, Inference engine

# A Conceptual Model for Internet Based Carpooling Systems via a Visibility Assessment to Match the Requirements of Sri Lankan Community

H.N. Arnolda, D.R.V.L.B Thambawita
*Department of Computer Science and Technology, Uva Wellassa University, Badulla, Sri Lanka.*

Increasing traveling needs of the country has created a gigantic increase in a number of vehicles used. This has created negative effects on many aspects such as trade deficit increase, the increase in oil consumption, environmental pollution and heavy traffic congestion. Even though carpooling is considered as a well-known alternative to reduce congestion and pollution on roads its popularity is comparatively low. This research focusses on identifying a communication model that allow carpoolers to interact resolving failures in current systems with a proper incentive distribution. A questionnaire was conducted to clarify the social concerns involved in carpooling. The results were used to analyze the factors that limit users from using carpooling and to specifically identify the features that need to be inserted to the system. An integration of site's review system and peer-to-peer marketplaces which are widely used in sharing economies was used as the new model for internet based carpooling systems. Each signed up user has their own profile and the system provides many options to edit and maintain the profile these include basic information, photos, preferences, interests etc. All the users can enter vehicles to the system and it allow users to maintain vehicle profiles by inserting photos descriptions etc. Passengers looking for rides search for tours scheduled and vehicles looking for passengers can add the tour to the system. Each request passes through four stages. They are requesting, replying and pre-approving or pre-approving and confirming. After each agreed transaction, all parties can review and rate each other. This methodology for carpooling systems is more sophisticated and realistic than earlier research on carpooling modeling. It introduces internet based carpooling and interacting platform to eliminate identified limitations of current systems such as social concerns and strict schedules by inheriting methodologies used in successful sharing economy companies such as "Airbnb" and site review systems to provide better understanding between interacting parties.

**Keywords**: Sharing economy, Site's reviewing system, Carpooling, Peer-to-peer marketplaces

# Pattern Identification for Main Export Products in Sri Lanka through Data Mining

D.S.P. Darmasena, S.H.D. Senanayake
*Department of Computer Science and Technology, Uva Wellassa University, Badulla, Sri Lanka.*

Identifying the tendencies using data mining techniques is done by this research. Normally, this goes beyond the normal data analysis. This research identifies the effects which can cause to the Sri Lankan Gross Domestic Product (GDP) through many analysing tools. It means the tendencies in export sector of Sri Lankan economy has been examined through this. Export performance is one of the strongest areas of Sri Lanka's economy in the present time. Data mining can be done as predictive analysis through complete and intuitive set of data mining tools. Furthermore, the flexible platform extends prediction into any application. For this purpose, there are lot of learning methods has been followed by Export Development Board and interested parties. But a correct analysis of data has not been done by any of these parties and most of the analysis are done by manually. But in this research the WEKA tool was used to analyse data. So the accuracy will be very high. Different data has been collected through many resources. The information which has been collected is put into logic to create an algorithm.

**Keywords**: Data mining, Classification, Clustering, WEKA, Decision tree

**Technical Session XIV**

# Computing and Information Science

## Poster Presentations

# Mobile Phone based Information Systems & Services Adaptations of Upcountry Vegetable Farmers in Welimada DS Division

D.G.D. Perera, P. Sivashankar, R.P. Mahaliyanaarachchi, I.C. Hettiarachchi
*Department of Agribusiness Management, Sabaragamuwa University of Sri Lanka, Belihuloya, Sri Lanka.*

Information is becoming a major input in Agricultural production. Mobile phone based information systems and services act as a cheaper and effective agricultural extension mode by transferring information and technology to the farming communities efficiently and effectively. This study attempts to find out the awareness level, usage and attitudes of the up country vegetable farmers about the mobile phone based information systems in Welimada DS division. The research was conducted in Boralanda, Bogahakumbura and Keppetipola agrarian centers in the Welimada divisional secretariat division of Uva province. Cluster sampling method was used to collect data from 120 farmers. Descriptive analysis and non-parametric analysis (chi square) were performed to analyze the data. Rank based quotient used to analyze the ranked data. It was revealed that majority of the farmers (49%) have never heard about the mobile phone based information systems & services, 16% have good knowledge about it and use mobile phone based information. The 1920 toll free agriculture advisory service is the mostly used mobile phone based information service of the farmers. An association exists between awareness level of mobile phone based information systems and Experience of the farmers. Also there exists a relationship between usage level of mobile phone based information systems and experience of the farmers.There exists a relationship between usage of mobile phone based information systems and farmers attitudes on income & knowledge. Programmes should be implemented to increase the awareness and to express the timely importance of the mobile phone based information systems and services.

**Keywords**: Information, Mobile phone, Agriculture, Knowledge

# Pronunciation Training System to Enhance Sinhala and Tamil Language Skills

G.R.M.D. Gamage, D.R.V.L.B. Thambawita
*Department of Computer Science and Technology, Uva Wellassa University, Badulla, Sri Lanka.*

This is a pronunciation training system to enhance Sinhala & Tamil language skills. Most commercial pronunciation systems are developed in English and those systems are limited to people with English literacy. Language is never a simple issue of communication, in contemporary social and political practice everywhere, language goes much beyond its basic utilitarian purposes. In this sense, Sri Lanka has no exception. By now, Sri Lanka has ended an immensely destructive military conflict that had much to do with a crisis of identity linked as much to language as ethnicity and contested notions of binary-nationalisms and competitive interpretations of history. As a solution for language problem between Tamils and Sinhalese, this research idea comes out. This system aimed both Sinhala and Tamil languages and is developed pronunciation training tests for both languages. This system is the only pronunciation tool develop for both Sinhala and Tamil languages. This system has been tested in both Sinhala and Tamil. Firstly system pronounce the word and user can listen to the word and pronounce the word. Then system compares both audio files and gives a score. The main objective of this pronunciation training system is comparing two audio files and giving a score as a percentage. For that Fast Fourier transformation has been used. Fast Fourier transform converts time domain waveform samples into the frequency domain spectrum samples. This system is a very user friendly system for the user. Users can select language and the words according to the preference and preview the pronouncing word before pronouncing it. As well as graphically illustrate the frequency with the time of both original and user's sound. Therefore, users can get a rough idea about the original audio and pronounced audio.

**Keywords**: Pronunciation, Sinhala, Fourier

# Virtual Laboratory System for A/L Physics Units of Electricity

H.W.D. Maheshika, D.R.V.L.B. Thambawita
*Department of Computer Science and Technology, Uva Wellassa University, Badulla, Sri Lanka.*

Practical experiment, an important feature of science education receives little attention in the science curriculum for several reasons. In science subjects, laboratories perform an important role in students learning enhancement, particularly in physics education. Students take more interest in learning by performing and observing the experiments in a physics laboratory which improve and consolidate their learning. Therefore, we want to recognize the need for field and laboratory exercises in school science programs as they help to promote a science, technology and innovation culture in the country. However, due to financial problems and other deficient facilities in laboratories, most of the schools cannot establish a complete physics laboratory. However, the lack of laboratory resources in schools appears to be the main reason in rural areas. Also, lack of focus on practical work, teacher shortages and variable quality of teachers were equally affected to science education at the GCE A/L. But the syllabus of the GCE A/L science subjects is competency- based, student- centered and activity- oriented and aimed to develop personal, interpersonal and higher order thinking skills of the target student group. In this paper, we describe the design and implementation of a Virtual Laboratory, which can be proven as an important educational tool that deals with the lack of practical experience in education. It also fulfills the deficiency of physical equipment which appears in the real physics laboratory environment. The aim of VPL is the simulation of physics experiments with 3D interaction in an easy way and access to educational and research material is facilitated for both students and teachers as well. In order to evaluate the VPL, we invited students of different schools in rural areas. This virtual lab consisting of tools and simulators can be effectively replaced the use of the corresponding necessary equipment and will provide equivalent services to support students. Virtual labs offer some advantages in education and can supplement physical labs.

**Keywords**: Experiment, Virtual Laboratory, 3D Interaction

# Location Based Real Time Advertising System

W. U. R. De Mel, C.S.D. Ellepola
*Department of Computer Science and Technology, Uva Wellassa University, Badulla, Sri Lanka.*

Advertising is a single component of the marketing process. It is a part that involves getting the word out regarding the business, product, or the services the companies are offering. Advertising and marketing are key elements in a company's success. One cannot be used without the other. Advertising works based on statistics. So definitely there are some people who are not been reached through most advertisements. Providing advertisements to the relevant people who actually needed them is more productive. With the rapid growth of smartphone users in Sri Lanka, an opportunity is there to create a link between customers and businesses, making advertising more effective. Currently mobile advertising has become one of the fastest-growing advertising formats. However, the problem engaged with all of the formats including online advertising is that they are not actually giving priority for the customer's perspectives. Therefore, a system that is user friendly and allows the customers to search products according to their wish instead of viewing advertisements is more productive. This research is carried out to develop a framework between customers and companies who use Android OS based smart phones. Businesses can post advertisements tagged to specific geo locations and the customers can subscribe to the advertisements. The primary purpose of this research is to increase the productivity of advertising by giving real time location based experience to customers and also to companies. The customers can find the locations of a specific product in a short period of time without visiting each and every shop, and companies can share the advertisements with customers who actually need it in a cost effective way.

**Keywords**: Marketing, Advertising, Location Based Advertising, Smart phone users, Productivity

# Recommending a Usability Practices for Websites Developers and Designers

T.D. Madushani, S.T.C.I. Wimaladharma
*Department of Computer Science and Technology, Uva Wellassa University, Badulla, Sri Lanka.*

Websites are fundamentally designed to work for all people. Using these websites, people meet different kind of goals. When the web meets this goal, it is accessible to people with a diverse range of hearing, movement, sight and cognitive ability. Website creating which is compatible with accessibility standards is kind of best practices. These standards enable to extend group of information users such as people with disabilities, people who encounter incompatibility and technology problems. Considering the problems, World Wide Web Consortium (W3C) proposed worth standards called Web Content Accessibility Guidelines (WCAG). WCAG developed through the W3C process in cooperation with individuals and organizations around the world with a goal of proving a single shared standard for web content accessibility that meets the needs of individuals, organizations and governments internationally. A-Tester and 508-checker version 1.4 are the tools used for evaluation and they follow the guidelines from WCAG. When website is 508 compliant, they are accessible to all users. Using 508 checker can quickly check web page for 508 compliance and learn more about how to become 508 compliant across the entire organization. A-Tester checks the pre-enhanced version of a web page designed with progressive enhancement against *Evaluera*'s "WCAG 2.0 Level – AA conformance statements for HTML5 foundation mark-up". A selected set of websites from all over the world are evaluated using above tools and found the most common accessibility issues. Finally, an accessibility standards checklist is developed in order to minimize the mistakes made by the developers.

**Keywords**: Web usability, Accessibility, Disable people, Web accessibility standards

# Widespread Emergency Response System in Colombo District

H.V. Tamari, I. K. K. B. Ihalagedara
*Department of Computer Science and Technology Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*

Majority of fire emergency and rescue services struggle with the management due to the absence of efficient systems. In the current process of fire emergency and rescue management service, several issues have been identified. Therefore, the present study is suggested to overcome identified inconveniences by developing an efficient & effective automated system to manage time, resources and make correct & timely decisions. Data was collected from the both people who get and don't get the service from this department. Another new set of issues that contains in the current service were identified through the collected data. A method; Widespread Emergency Response System was developed to reengineer the current process using information technology. The objective of the research was to measure the effectiveness of the widespread emergency response system for Fire Rescue and Emergency Service. The literature survey was carried out in order to identify existing methods of controlling emergencies and understand their positive and negative features. Identified factors were applied to the proposed system. The system was developed with three mobile applications and controlled web application. A system which provides facilities to send emergency request with selecting emergency type was developed and after controlling process start user could view the route map and contact the service center. Control room officer assign the task through the system and allocated officer can view their task through the application. The system architecture was designed. The system was functional wise tested according to the test cases created. By using project network techniques, the collected data was analyzed from both current and developed systems. Overall and average values were used to determine more effective method. The results indicated that developed system has shown the less value. This system can be further developed and a method can be developed to find the location from the normal phone.

**Keywords**: Rescue, Automated system, Project network techniques

# Implementing a User Friendly Feed Formulation Software Application for Sri Lankan Poultry Famers

I. A. Kaluarachchi, I. K. K. B. Ihalagedara
*Department of Computer Science and Technology, Uva Wellassa University, Badulla, Sri Lanka.*

Poultry is a fast growing livestock sub-sector in Sri Lanka today. We have 50 years history of commercial poultry industry in Sri Lanka. With the introduction of open economy policy in 1980's this industry started to boost up and now it has become well established in our country. With the rapid growth of poultry sector it demands higher quality concentrated feeds and it opens up a new industry opportunity for large scale feed manufacturing ventures. Since poultry requires high quality concentrate feed our poultry famers have to depend on commercial compound feeds. Instead of having commercially manufactured feed, some poultry famers use self-mixed feeds as commercial feeds are costly. Starting from the resent past there is a growing tendency in famers in mixing their own feeds inside the farm.Since these self-mixed feeds are not up to standards in terms of nutrient levels and hygienic conditions. Poultry birds should be fed well balanced compounded feeds as modern poultry strains are bred for higher performances. This high performance can be achieved through proper feeding and management only. Developing a mathematical model which is to formulate the feed ration with optimal solution and implement with in software which can be used by poultry farmers to day to day manufacturing will be my solution. C# was used as the runtime environment to the application and Solver Foundation was used to simulate problems, User can change ingredients and get dynamic results as he satisfy with the ration mix ingredients. When using Traditional methods like trial and error method or Pearson's Square method user have to spend more than 10 min to hours to prepare one ration to specific bird type. But using this software user can prepare a ration in seconds.

**Keywords**: Poultry feed formulation, Object Oriented Programing, Solver Foundation, Linear Programing

# Systematic Approach to Maintain Civil Information for Grama Niladharis' In Sri Lanka

D.M.N. Chathurani, C.S.D. Ellepola
*Department of Computer Science and Technology, Uva Wellassa University, Badulla, Sri Lanka.*

Accurate statistics is an essential asset for developing countries because statistics are the guidelines in implementing development programs. When it comes to the Sri Lankan context statistics are maintained by the Department of Census and Statistics (DCS) which is the central government agency responsible for undertaking census and statistics. However, they are unable to provide accurate and reliable data as the census are carried out every 10 years in Sri Lanka. Apart from Department of Census and Statistics (DCS) Grama Niladhari Division is one of the major administrative units in the hierarchy of Sri Lankan Public Administration which undertakes census and statistics in Sri Lanka. The importance of the duty performed by Grama Niladhari in Sri Lankan statistics process is high. However with the existing system they are unable to maintain and provide statistics in a proper manner. Therefore, the present work aims to develop a reliable and more efficient Grama Niladhari management system with the use of highly developing technologies. A main purpose of computerization is to improve accuracy of civil registration data and thereby make vital statistics data more accurate, complete and timely.

**Keywords**: Water quality, Shrimp disease, Bacteriological problems, Water treatments, UV filters

# Sri Lankan Vein Graphite Classification Using Image Processing and Neural Network

E.M.C.G. Wickramasinghe[1], J.T. Cooray[1], S.T.C.I. Wimaladharma[2],
[1]*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Department of Computer Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*

Image classification is an essential task in pattern recognition applications. Rock and mineral images are some of the typical examples for natural images, and their analysis is more important in rock and mineral industry. Ore mineral classification is based on specific visual descriptors extracted from the images. These textures are used to identify their visual similarity and categorise them accordingly. This research primarily addresses the problem of automatic measurement of graphite ore textures by image analysis in a way that it is relevant to mineral processing in Kahatagaha Graphite Lanka Limited, Sri Lanka. Specifically, it addresses three major hypotheses: Automatic separation of graphite ore by image analysis provides a feasible alternative to manual curing by mineralogists and labourers, Image analysis can quantify process mineralogy by physical parameters and Image analysis provides potential benefits to process mineralogy and better retains the information of manual logging. Traditionally, minerals are visually recognized and manually outlined prior to the digitizing and subsequent analysis. The preciseness of the outcomes is affected by the conventional methods. This limitation can be overcome by using multichannel methods of classification with Artificial Neural Network, in which the minerals in multichannel digital images are accurately recognized based on their unique spectral or elemental signatures, established by a training stage prior to classification. The technique is applied here for model analysis of images, which are digitized using a standard digital camera. In all case studies of the analysis of graphite lumps, the resulting mineral modes are sufficiently precise to identify significant compositional heterogeneities between groups of samples. This model can be readily applied to automated vein graphite ore classification in mineral processing industry.

**Keywords**: Mineral classification, Image processing, Neural network, Vein graphite classification

**Technical Session XV**

# Humanities and Social Development

## Oral Presentations

# Impact of Migration Remittance on Consumption Expenditure Pattern in Tea Estate Households

B.M.S.K. Ekanayake, R.A.P.I.S. Dharmadasa
*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka.*

Migration can be identified as the flow or movement of people from the place of origin to the other surrounding, whether inside or outside the country for various reasons. In recent years, the outflow of Sri Lankan workers has shown an increasing trend. Sri Lanka is predominantly an agricultural country and Tea sector receives the highest priority in its development agenda. Due to labour migration, Sri Lankan Tea sector faces many consequences such as scarcity of labour. The migration remittance that they send can make several impacts on consumption expenditure pattern of labour households. Therefore, this research has been conducted to determine the effect of remittances on expenditure pattern of tea estate households in Badulla district collecting data from six tea estates. The sample consists of 205 estate worker households and 114 of them were migrant households. Data were collected by using a self-developed questionnaire covering consumption details and other demographic characteristics of the households. The data were analyzed using Working - Leser model within the Engle's curve framework. Ordinary least square (OLS) regression technique was used to estimate the model. OLS results indicate that remittances negatively contributes to food expenditure and expenditure on utilities and positively to non – food expenditure. This implies that migration and remittances are used as a short term coping strategies and hardly used as stepping-stone to productive investment options.

**Keywords:** Consumption pattern, Migration and remittance, Ordinary least square regression, Tea estate households, Working - lesser model

# Impact of Labour out-Migration on Technical Efficiency of Cinnamon Farmers in Kamburupitiya, Matara District

P.M. Belpage, R.A.P.I.S. Dharmadasa
*Department of Export Agriculture, Uva Wellassa University, Badulla Sri Lanka.*

This research examines the impact of labour out-migration on technical efficiency of cinnamon farmers using a sample of 150 Cinnamon farm families in Kamburupitiya DS division, Matara district, Sri Lanka. Technical efficiency was estimated using a stochastic frontier function with a Cobb-Douglas model, incorporating technical inefficiency effect model. Results indicate that mean technical efficiency of Cinnamon farmers of the total sample is 77.61%. Still, there is a remaining potential to develop the output levels without increasing input levels by 22.39%. Land extent, labour and fertilizer cost increase the Cinnamon production and education of household head and household size increase the efficiency of farmers in the total sample. Mean technical efficiency of migrant households and non-migrant households are 95.05% and 75.27% respectively when considering no effect from migration. Nevertheless, the mean technical efficiency of migrant households decreases up to 73.74% after concerning the migration impact. Age of household head and extension services will increase the efficiency and experience of household head decreases the efficiency of migrant households while education of household head will increase the efficiency of non-migrant households. For the migrant households, even though 72% of migrants are sending remittances, it will not increase the Cinnamon production. This could be due to the fact that either over use of remittances on Cinnamon or not using remittances as an input for Cinnamon. Number of migrants has a significant effect on increasing the inefficiency. These results clearly show that migration has a negative impact on production and efficiency of Cinnamon. These findings recommend that family members should use remittances in effective manner to compensate the negative effect from migration and there should be actions to reduce the number of migrants from that area.

**Keywords:** Out-migration, Technical efficiency, Cinnamon farmers, Stochastic frontier analysis

# Youths Intension towards Migration

M.J.M. Infaz, R.A.P.I.S. Dharmadasa
*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka.*

Migration can be identified as movement of people from their roots to other surroundings, whether inside or outside of the country. While migration is a normal element, the scale of movement experienced in some developing countries can produce undesirable or desirable effect for the whole society. Moreover, youth's intention towards migration is also very important to manage the youth migration and human capital available to the local labor market in Sri Lanka. However, there is no research carried out regarding the youth's intension towards the migration. Therefore, this research examines the youth's intension towards the international migration. Youth sample was selected through snow ball technique from the youth of 18 to 29 age categories of three selected Divisional Secretariat divisions of Ampara district in Eastern province of Sri Lanka, who have an idea to migrate. The questionnaires were answered directly by the youth and the total of 151 questionnaires was analyzed using descriptive techniques. The results reveal that individual's gender have some influence on their intention to migrate, while the occupation and their income level also have influence on migration intension. Gender has some influence on individual's migrate age. The occupation and their income level have influence on their intension towards the migration. There are relationships between the gender and the education qualification with the country those who willing to migrate. The education qualification has some influence on the expecting income. Considering the intention, most of the respondents have an idea in the developing stage of migration process and male shows highest intention than female in most of the choices, because the social and economic factors influence on male individuals towards the migration.

**Keywords**: Youths intension, International migration, Socio economic characteristics

# Regional Poverty in Sri Lanka: A Multidimensional Approach

P.H.T. Kumara[1], G.H. Abyeweera[2], K.M.R. Siriwardhana[2]
[1]*Department of Public Administration, Uva Wellassa University, Badulla, Sri Lanka*
[2]*Department of Management Sciences, Uva Wellassa University, Badulla, Sri Lanka*

The reduction of monetary poverty in Sri Lanka is commendable in recent years, yet literature questions the reality of this achievement. One of the major criticisms in this regard is the measurement method applied (monetary approach) in estimating poverty in Sri Lanka, Hence, this study applied the Multidimensional Poverty Index developed by Alkire and Santos in 2010 in order to estimate the regional multidimensional poverty in Sri Lanka. In analysing the regional multidimensional poverty, three indices, namely the multidimensional poverty headcount index, the intensity of deprivations, and the multidimensional poverty index, were estimated at national, provincial, and district levels. The micro datasets compiled from Household Income and Expenditure Survey 2009/10 conducted by Department of Census and Statistics of Sri Lanka were used for the analysis. The study found that multidimensional poverty in Sri Lanka is a regional phenomenon, in that multidimensional poverty in the estate areas is significantly high. The study also found that the levels of multidimensional poverty vary according to the location of the household (sector, provinces, and districts). In addition, living standards dimension of the Multidimensional Poverty Index has contributed to the most of the multidimensional poverty in Sri Lanka, irrespective of the areas of living. However, there are differences between the contributions of 'health' and 'education' dimensions to the Multidimensional Poverty Index, depending on the area of living. The contribution of the health dimension to the Multidimensional Poverty Index is high in the urban areas and in richer regions while the contribution of the education dimension is high in the rural and estate areas and in the poorer regions. Therefore, priority should be given to the improvements of health care and services in the urban areas and of education in the rural areas while the improvements in the living standards dimensions are required irrespective of the area.

**Keywords:** Alkire-Foster method, Multidimensional poverty, Poverty, Spatial poverty, Sri Lanka

# An Inventive Teaching Method to Enrich the Knowledge in Grammar Amongst The GCE A/L Students in Gampaha District

T.A.C.J.S. Bandara[1], S. Pathiratne[2], P.A.B.H Amarathunga[3]
[1]*Department of Sinhala, Faculty of Arts, University of Colombo, Colombo.*
[2]*Faculty of Computing, ESOFT Metro Campus.*
[3]*Faculty of Business Studies and Finance, Wayamba University.*

Grammar instruction can take many forms and can be carried out with various pedagogical goals in mind. The investigators have tried to explore an Inventive Method of integrating grammar lyric, song, and music to teach grammar. The researchers during the process of teaching Sinhala to the learners, varying from the age group of thirteen to fifty, have come across various problems in teaching grammar. The pedagogical potential of songs in teaching grammar has been enormously realized in the foreign but not in the Sri Lankan context, particularly in Gampaha District. The purpose of the research was to develop the students' knowledge in grammar, using grammar songs in the classrooms. And the Objectives are a) To compare the effectiveness of traditional methods and the Inventive Teaching Method in developing the students' knowledge in grammar. b) Analyse the effect of teaching Method on the experimental group in the pre-test and post-test in learning grammar. c) Examine the effect of traditional teaching on the control group in the pre-test and post-test in learning grammar. The study has been carried out with the A/L Arts students in Gampaha District, Sri Lanka. It was decided to have a manageable sample of 50 students. The pre-test and post-test questionnaires were developed by the researchers. The Results show that, from the scores that the treatment given to experimental group has produced positive result on the performance of the students. Therefore, it may be concluded that both the groups differ significantly. Also test showed that students performed better in the Post-Test compared to the Pre-Test. The ANOVA test for the control group and the experimental group concluded that the students who belong to the experimental group scored higher than the students who belong to the control group. The results of the studies reported in the study could influence the use of songs in grammar teaching and learning to Sinhala language learners. The findings indicate that the Inventive approach has a definite pedagogical value at the school level of grammar learners in Gampaha District, Sri Lanka

**Keywords:** Gampaha, Grammar, Teaching, Songs, Sinhala language

# Time Series Analysis of Colombo Tea Auction Price Data

M.R. Hameem[1], R.A.I.P.S. Dharmadasa[1],
K.M.K. Jayawardana[2]
[1] *Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka.*
[2] *Sri Lanka Tea Board, Colombo 03, Sri Lanka.*

Tea is a Market Commodity which has an Economic value. Manufactured Tea is sold through three main Marketing Channels in Sri Lanka; Public Auction, Direct Sales, Private Sales. More than 95% of Made Tea in Sri Lanka is marketed through Public Auction. The Colombo Tea Auction is considered to be the most influential Price decider of Made Teas in Sri Lanka. It is a Market driven Auction and Price fluctuations of the Auction is decided according to the bids placed by Buyers. The issue involved with Price changes over a period of time affects the Manufacturers and the Tea Industry as a whole. According to Price Data, Tea Auction Prices have been on the rise throughout the past decade (2005-2014). This study focuses on using Univariate (Price is considered the only variable whilst effect of other variables are considered null) Time Series Analysis techniques to determine the Trends of Price Data changes in Colombo Tea Auction related to its Locations of Origin; High grown, Medium grown, Low grown and All Island. The study is used to determine the best fit Auto Regressive Integrated Moving Average (ARIMA) models related to each Price category and use the models to Forecast Price Data. The ARIMA models with the Seasonal factor (SARIMA) were found to be the most appropriate models. The Best Fit Models were; High Grown: ARIMA $(1, 0, 0)\ (1, 0, 1)^{50}$, Mid Grown: ARIMA $(1, 0, 0)\ (1, 0, 0)^{50}$, Low Grown: ARIMA $(1, 0, 0)\ (1, 0, 1)^{50}$ and All Island: ARIMA $(1, 0, 0)\ (1, 0, 1)^{50}$. S Curve method was used to compare Forecasts of ARIMA model Forecasting. ARIMA forecasts were similar to the S Curve values. Seasonal factor in ARIMA is a result of 50 weekly sales dates and its effects on the Price Fluctuation. High Grown and Low Grown Price Fluctuation were the most influential on All Island Price Fluctuations. Due to the Forecast results with positive values the Colombo Tea Auction rising Price in the future is expected to be unchanged.

**Keywords**: Price, Location of origin, Time series analysis, ARIMA, Forecasting

# An Evaluation on Fisher Women Contribution for Household Economy in North-western Province of Sri Lanka

D.W.L.U. De Silva, K.P.G.L. Sandaruwan, H.D. Wimalasena,
K.H.M.L. Amaralal, M.M.A.S. Maheepala
*National Aquatic Resources Research and Development Agency (NARA), Crow Island, Mattakkuliya, Colombo 15.*

The fisheries sector is concerned as a sector that has high gender discrimination all over the world because it is highly dominated by males. However, a fishery woman provides a significant contribution for the wellbeing of their family which is not clearly visible. This study was conducted to assess the level of contribution of fishery women to the family economy. The study was carried out in North western province (NWP) and relevant data were gathered by administrating a pre tested questionnaire during the year 2014. The total sample was 197. Data were analyzed using SPSS ver.20. Although women engagement in active fishing at the sea was nil, with aquaculture marginal (only 2%) they provide supportive services such as net clearing and sorting of fish. These services are not earned direct income but save Rs. 25,492 for their family in a year. Dried fish production and selling as well as fresh fish selling were major income earning activities of fishery women in NWP and earned annually Rs. 5,460 and 10,920 respectively. Hence, fisher women have contributed Rs. 41,872 annually to their family income by cash or non-cash form.

**Keywords**: Barriers, Empowerment, Economic contribution, Fisher women, North western province

# Identification of Factors that Affect the Grade of the Mathematics Subject at Ordinary Level Examination with Reference to Uva Province

J.M.D.R. Jayawardana, M.M.C.M. Mayadunne, K.W.S.N. Kumari
*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka.*

In Sri Lanka, education has to play a key role in social and economic sectors. The Ministry of Education in collaboration with the other relevant ministries is working relentlessly to achieve the development of the education sector. Mathematics is one of the main subjects in the education section in Sri Lanka which is used to select students for their higher education. According to a previous research, it was found that the average pass rate at the ordinary level examination is 37% in our country, and it is around 31-32 in the less developed provinces such as North-Eastern, North-central, Uva and Central. To attempt the decisions in education sector in Uva province in future, it is really important to identify the significant factors that affect the ordinary level Mathematics subject. The main objective of this study is based on identifying the main factors which can affect the results of Mathematics subject. In this study, data were acquired by using multistage systematic sampling method.Generalized Linear Model (GLM) was fitted to final marks of the grade eleven students to identify the main factors that affect the final grade. It was noted that students' attendance to school, performing mathematics exercises, getting help from their parents, grade five scholarship and time spend for the mathematics subject at home were significantly affecting the students' results of the ordinary level Mathematics subject. According to the factor analysis results, it was found that the factors of the fitted model significantly affect the students' marks in Mathematics subject.

**Keywords:** Mathematics, Education, Ordinary level, Generalized linear model

# The Trend and Behaviour of Unemployment Rate in Uva Province during Last Decade

P. Ramwickrama, K.W.S.N. Kumari
*Department of Science and Technology, Uva Wellassa University, Badulla, Sri Lanka*

Sri Lanka was subjected to lot of economic and political changes in the latter part of the war and in the post war period including the changes in the labour force structure, and therefore, the behavior of unemployment rate. Therefore, this study attempts to evaluate the trend and behavior of unemployment rate in the Uva Province and their socio–economic consequences since its least income and lower literacy status compared to national figures. To see if this status of the province is a result of unemployment of the residents in the province, the study was done in two phases where firstly, provincial and national unemployment rates for ten years were compared using time series analysis. Second, a survey with the questionnaire filled by respondents' method for a sample of 150 was carried out. The analysis revealed there is no difference of unemployment rate in Uva Province and Sri Lanka. But, they showed totally different trends. For Sri Lanka, the estimated trend equation is $Y_t = 9.33+0.595t-0.0842t^2$ and for Uva Province, it is $Y_t = 18.25-2.694t + 0.1584t^2$. The survey resulted most of the sample has the attitude that improving educational qualifications will help them to be employed. 39.33% of the sample passed GCE A/L examination. 44% of the people under study expected government employments. There was no difference between each economic region (i.e. Urban, Rural and Estate) and the availability of employments. According to the survey, 46.67% of the sample, stated the family background is the most influencing reason for them to be unemployed. However, in general the attitude change of the younger generation has caused the increase of unemployment since 1999. Basically the highest contribution to the national GDP from Uva Province is by Agriculture, which is quite different from other regions. With industrialization, the younger generation has directed more towards industrialized employments instead of Agriculture related employments. According to national statistics, since 1999 population in “Looking for a job” category for the Uva Province has increased. Also, the survey results shows most of the younger people in the sample are willing to migrate from the province for more industrialized jobs. Therefore, this study suggests increasing the employment opportunities within the province including Agriculture sector.

**Keywords:** Unemployment rate, Time series analysis, Socio–economic consequences, Industrialization

**Technical Session XV**

# Humanities and Social Development

## Poster Presentations

# Factors Affecting on Income Generation from Kandyan Home Gardens

Y.H.G.D.B. Premasinghe[1], H.K.S.G. Gunadasa[1], M.A.P.K. Seneviratne[2], R.M.P.S. Rathnayaka[1]

[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka.*

[2]*Department of Export Agriculture, Peradeniya, Sri Lanka.*

Great population growing rates, growing land division and constant mono-cropping have caused in low farm efficiency and food uncertainty in Sri Lanka. Most of the households in Kandy district continue Kandyan home garden structure in addition to their plantations. These home gardens are recognized to considerably contribute to food production and the cash revenue generation of the farm households, there is inadequate of quantitative information on the profits of Kandyan home gardens in the country. The main purpose of this study was therefore to identify the factors affecting on income generation from Kandyan home gardens. The study was conducted in Udunuwara and Yatinuwara divisional secretariat divisions in Kandy district. A household questionnaire survey was used to collect data about household income and other related characteristics. One hundred and fifty (150) households were selected for the survey based on stratified random sampling technique. Data were collected by interviews at household level. Results of the multiple regression analysis revealed that the Income From Kandyan Home Gardens (IFKHG) significantly determined by the factors of gender of the householder, main income of the householder, time spent in the home garden, number of crop types in the home garden and expenses derived from the home garden, family size and interest to work in the home garden at 5% significant level. Age of the householder, gender of the respondent, land area, family size, time spent and number of crop types represent the positive relationship with the income from Kandyan home gardens. Education level of the householder, main income of the householder, interest to work in the home garden and expenses derived from the home garden represent the negative relationship with income from Kandyan home gardens. This study will have a potential to increase livelihoods significantly specifically if farmers take the steps to make production more sustainable.

**Keywords**: Kandyan home garden, Income, Household

# Study on Socio-Economic characteristics of Income diversified Tea Smallholders in Badulla District

S.H. Chamalka, R.A.P.I.S. Dharmadasa
*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka.*

This study focused on investigating socio-economic characteristics of Income diversified tea smallholders in Badulla district. In this study income was categorized into four categories namely, income from only tea cultivation, income from tea and other agricultural activities, income from tea and non-agricultural activities and income from tea, other agricultural activities and non-agricultural activities. Income generating only from tea is 15%, income generating from tea and other agricultural activities is 53.33% and it is the highest percentage. Income generating from tea and non-agricultural activities is 15.33% and income generating from tea, other agricultural activities and non-agricultural activities is 16.33%. In this sample, the highest portion is male household heads (92.32%) and the rest (7.59%) is female household heads. Highest proportion of small holders who have generated their income by tea and other agricultural activities belongs to 45 – 60 age group. Majority of the tea small holders have completed their secondary education (Grade 6 to 11) and most of the smallholders who have diversified their income belongs to this group. Majority of the households are having 3 to 5 members in their families. As well as highest diversification rate can be seen in the families who are having 3 to 5 members. Highest percentage of diversification can be seen in small holders who are having 0.5 to 1 acres. Small holders who are having more than 20 year experience have highest percentage of income generating from tea, other agriculture and non-agriculture. According to findings highest number (205) of tea small holders are not engaging with non-agricultural activities. Small holders who have the ownership of their lands has more diversification rate comparing the small holders who have not owned a land. Income generating only from tea cultivation is in higher level in households which has migrant members.

The obtained results have important policy implications which imply that programs targeted to engage people in other income generating activities would augment their income sources. As measures from the part of the government reducing the rate of interest for private enterprising in the rural sector, development of rural infrastructure and improving information facilities at the rural areas are suggested.

**Keywords:** Income diversification, Tea small holders, Socio-Economic characteristics

# Introducing "Lean Manufacturing" to Improve the Performance of the Teabag Section

B.M.D. Deepashika[1], W.A.J.P. Wijesinghe[1], K.P.M. Kahandage[1], S. Gamage[2]
[1]*Department of Export Agriculture, Uva Wellassa University, Badulla, Sri Lanka*
[2]*HVA Foods PLC, 39A Linton Road, Kandana, Sri Lanka*

As the lean manufacturing is novel concept to the Sri Lanka, there is no proper awareness of it among the industry. The main objective of this study was to find the improvement of introducing "Lean Manufacturing" to the teabag section of an export firm. Therefore a value stream map and a process map were developed and a Pareto analysis was conducted to identify the major wastes. Those were, waiting for tea and materials, defects of the tea bags and excess motion of the workers and the major root causes were frequent material changing, defects of materials and keeping machineries and raw materials in separate places. To rectify those issues suitable suggestions were implemented. Then several performance indicators were selected to evaluate the before and after condition of the teabag section for 30 days with same order condition. Finally it is concluded that, those indicators, waiting time, excess motion, and defect tea bags were reduced by 45.06 %, 62.41 % and 6.51 % respectively and effectiveness and overall equipment efficiency was increased by 10.5 % and 5.5 % respectively after implementing lean manufacturing in the teabag section.

**Keywords:** Lean manufacturing, Wastes, Performance


**RESEARCH COMMITTEE**

**OF**

**UVA WELLASSA UNIVERSITY OF SRI LANKA**

# UWU Research Awards 2014

**Full article published in a Refereed Non-indexed Journal**

1. Dr. P.B. Ratnaweera (Department of Science and Technology)

**Full article published in a Refereed Indexed Journal**

1. Dr. E.D.N.S. Abeyrathne (4 papers; Department of Animal Science)
2. Dr. D.K.D.D. Jayasena (4 papers; Department of Animal Science)
3. Dr. W.A.J.P. Wijesinghe (2 papers; Department of Export Agriculture)
4. Dr. H.M.S.K. Herath (1 paper; Department of Export Agriculture)

**Researcher having the highest citations for the year (One Award for Each Department)**

1. Department of Animal Science - Dr. D.K.D.D. Jayasena
2. Department of Export Agriculture - Dr. W.A.J.P. Wijesinghe
3. Department of Science and Technology - Dr. H.M.J.C. Pitawala

**Vice Chancellor's Award for the Most Outstanding Young Researcher of the year**

Dr. D.K.D.D. Jayasena (Department of Animal Science)

**Vice Chancellor's Award for the Most Outstanding Senior Researcher of the year**

No applicants for the year 2014