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Part I – Abstract

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Oral Presentations



Section A

101/A

Validity of anthropometric equations to predict body fat in exclusively breast-fed Sri Lankan infants aged 4-6 months, against ^{18}O dilution technique

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Anthropometric equations for predicting body fat based on the measurements of body weight, length, width, circumference, and skin-fold thickness have been developed since the early 1920s. In spite of the evolution of newer techniques, anthropometry is still the most widely used methodology to estimate the amount of fat in a human body. Validation of the body fat measured by the anthropometric equations against reference methods has been reported from both developed and developing countries. However, only a few of these have been conducted on infants. This study was designed to assess the validity of published anthropometric equations to determine body fat in exclusively breast-fed (EBF) Sri Lankan infants against the isotope dilution values.

Body composition was measured in term, healthy, EBF babies (n=25), aged 4-6 months, using the ^{18}O dilution technique. Infants' body weight, length, skin-fold thicknesses (biceps, triceps, sub-scapular and suprailliac) and mid upper-arm circumference were measured following standard procedures. Infants' body fat was calculated using sixteen anthropometric prediction equations specified for infants and children, found in the literature. Bland and Altman pair-wise comparison method was used to evaluate the agreement of body fat generated using the anthropometric prediction equations against the ^{18}O dilution values as the reference.

Mean (\pm SD) age, body weight and length of the infants were 4.5 months (0.8), 6.5 kg (0.9) and 64.7 cm (2.8) respectively. Mean body fat and % body fat (%BF) were 1.9 kg (0.5) and 29.5% (6.1), respectively as determined by ^{18}O dilution. Equations of Hoffman *et al* (2012) and Durnin and Rahman (1967) resulted in totally unphysiological values [i.e. 279.6 (27.1) and -153.3 (7.9)] on Sri Lankan infants. When compared to the %BF of all infants measured by the ^{18}O dilution method, only the Bandana *et al* (2010) equation resulted in a higher value (33.8% vs. 29.5%). The %BF predicted by the other equations were lower (ranged from 16.8% - 25.6%) than the isotope dilution value.

Most of the commonly used prediction equations yielded a bias which was not constant but a function of the %BF and therefore are not applicable for body fat measurements among Sri Lankan infants. Only three prediction equations [Bandana *et al* (2010), Goran *et al* (1996), and Durnin & Wormsley (1974)] yielded a constant bias but with wide limit of agreements. Durnin & Wormsely equation showed the smallest bias when compared to the ^{18}O values with the narrowest limits of agreement. It was evident that the accuracy of some of these equations is a function of gender.

As none of the commonly used equations tested were found appropriate for the measurement of body fat among Sri Lankan infants, development and validation of new prediction equations are warranted.

Keywords: Body fat, ^{18}O dilution, anthropometry, skin-fold thickness, infants

Acknowledgement: International Atomic Energy Agency research grant IAEA-SRI-16826



102/A

Prevalence of known risk factors and socioeconomic status of male patients with acute myocardial infarction

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The objective of the study was to determine the socioeconomic characteristics and the prevalence of known risk factors among ST- elevated myocardial infarction (STEMI) patients.

One hundred and three male patients who were admitted consecutively with first acute STEMI to Teaching Hospital, Karapitiya for one year duration were interviewed and data on known cardiovascular risk factors (CVRFs), demographic and socioeconomic characteristics such as education, occupation and income were collected. Further, hospital and personal records were used in collecting data on known CVRFs. Anthropometric measurements were obtained. The socioeconomic status (SES) was defined according to the Barker & Hall guidelines.

Age of the patients ranged from 32 to 69 years and mean age was 54 ± 8 years. Smoking in 59 (57.3%), diabetes mellitus in 14 (13.6%), hypertension in 20 (19.4%), dyslipidaemia in 100 (97.1%), metabolic syndrome in 53 (51.5%), cerebrovascular disease in 2 (1.9%), family history of premature CAD in 2 (1.9%), obesity in 2 (1.9%) and overweight in 10 (9.7%) patients were reported. Majority of them were in the normal range of BMI 65 (63.1%). Among the patients 98 (95.1%) were married, less had extended their education to the university or similar type of higher education 7 (6.8 %) and a few were involved in professional category of 8 (7.7%) occupations. Thirty eight (36.8%) of them had no regular income. Over 50% of patients were in the lower social class categories (categories 4 and 5). Dyslipidaemia and smoking were the most prevalent known cardiovascular risk factors among male patients with acute STEMI; however the prevalence of obesity was less. Majority of them were from low socioeconomic background.

Keywords: Myocardial infarction, cardiovascular, risk factors, socioeconomic status, males

Acknowledgement: University Grants Commission, Sri Lanka.



103/A

Prevalence of known risk factors among patients with coronary artery disease

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Understanding the pathophysiological role of risk factors in the development of coronary artery disease (CAD) is important. Dyslipidemia, hypertension, family history of CAD and diabetes are identified as independent risk factors for the disease. It is reported that more than 50% of patients with CAD lack any of the conventional risk factors whereas some reported these risk factors play a significant role in CAD. The present study attempted to determine the prevalence of dyslipidemia, hypertension, family history of CAD and diabetes among the patients (n=102) who were awaiting Coronary Artery Bypass Graft at the Cardiothoracic unit of Sri Jayewardenepura General Hospital. Among these patients 67 were males (age 56 ± 9.6 yr) and 35 (age 58 ± 7.7 yr) were females. Data on dyslipidemia, hypertension, family history of CAD and diabetes were gathered using an interviewer administrated questionnaire. The descriptive statistics were analysed (SPSS 16.0 version). Dyslipidemia was the most prevalent (87.3%) risk factor followed by hypertension (70.6%), family history of CAD (53.9%) and diabetes (53.9%) in the study sample. A majority of the individuals presented three (33%) or two risk factors (32%) while 22.5% from the total sample presented all four risk factors. When considering the different combinations of risk factors hypertension, dyslipidemia, family history of CAD was the most common combination in the group with 03 risk factors. A majority of males and all of the rural females were dyslipidemic. In the total sample the percentage distribution of diabetes was significantly ($p=0.005$) high among urban residents. However, females residing in urban areas in addition to having diabetes ($p=0.01$) were hypertensive ($p=0.02$). The data indicate that a majority of the patients with CAD had at least two of above risk factors and dyslipidemia was the major risk factor among 88% of the study population irrespective of residency.

Keywords : Coronary artery disease, risk factor, diabetes, dyslipidaemia, urban

Acknowledgement: National Science Foundation grant NSF/RG/2011/HS/18.



104/A

Mechanisms of gastroprotection by ethyl acetate fraction of hot water extract of *Trichosanthes cucumerina* Linn.

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Trichosanthes cucumerina Linn (Family: Cucurbitaceae), locally known as Dummella is commonly found in Asian countries including Sri Lanka. In Sri Lanka, the aerial parts of *Trichosanthes cucumerina* (T.C) are used as a remedy for gastric ulcers. In a previous study, it was found that the ethyl acetate fraction of hot water extract of T.C aerial parts (EAF; 75 mg/kg) possesses marked gastroprotective properties as evidenced by its potential to inhibit the formation of gastric lesions induced by absolute ethanol in rats. The aim of the present study was to evaluate the mode of gastroprotective activity mediated by EAF on production of (a) histamine (b) mucus in stomach (c) acidity and (d) volume of gastric juice.

Forty male and female Wistar rats were divided into five groups with equal male female ratios and maintained under standard conditions. For investigating the antihistamine effect, groups 1-3 were orally administered EAF (75 mg/kg), reference drug Clopheniramine (0.40 mg/kg) and distilled water (control) respectively. After 1 hour histamine dihydrochloride (200 µg/mL) was subcutaneously injected and the area of the wheal formed measured. Effects of EAF on gastric acidity, volume of gastric juice and mucus content were evaluated using groups 4-5 against a distilled water control using standard protocols. EAF showed potent anti-histamine activity with a significant ($p \leq 0.05$) reduction (25.6 %) in the wheal area of the rats when compared with the control. Administration of the EAF significantly ($p \leq 0.05$) increased the amount of mucus produced by the rat gastric mucosa (control vs treatment: 198.6 ± 9.2 vs 402.1 ± 5.8 µg/stomach). Further, compared with the control, rats treated with EAF showed a significant ($p \leq 0.05$) reduction in free acidity (45 %) and total acidity (48 %) in the gastric juice. pH of the gastric juice increased from 3.2 to 6.1. However, there was no significant difference in the volume of gastric juice. In conclusion, EAF mediates gastroprotection *via* inhibiting histamine production and decreasing the acidity of gastric juice and enhancing mucus content in stomach.

Keywords: *Trichosanthes cucumerina* Linn, gastroprotection, antihistamine effect, gastric juice, Wistar rats

Acknowledgement: National Research Council (NRC) Grant No: 12-23



105/A

Characterization of the sibling species status of *Anopheles culicifacies* breeding in polluted water bodies in Trincomalee District of Sri Lanka

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Anopheles culicifacies, the major vector of malaria in Sri Lanka, is known to breed in clean and clear water. However, recent findings have confirmed breeding in waste water containing drains. However, no study has been conducted to identify whether it is vector or non vector siblings. Therefore, the objective of the study was to identify the sibling species status of *An. culicifacies* breeding in waste water containing drains. *An. culicifacies* adult samples (Reared from larvae) were obtained from the Padavisiripura Entomological team attached to Tropical and Environmental Diseases and Health Associates (TEDHA) Malaria Elimination Program in the Trincomalee District. The collected mosquito specimens were processed for the extraction of genomic DNA individually. The PCR amplifications were carried out using different primer combinations for differentiating species A from D, species B from C, species B from E, and species B, C, and E from each other. The results obtained from the gel electrophoresis were compared with the marker, and band sizes of 359 bp, 248 bp, 95 + 248 bp, 166 + 359 bp and 178 + 248 bp were used to identify the sibling species A, B, C, D and E respectively. The molecular biological identification of the field caught *An. culicifacies* samples indicated that only 6.25% (1/16) represented sibling species B. About 93.75% (15/16) of the samples were *An. culicifacies* sibling species E. According to the results, the majority of the species belongs to sibling species E which is considered as the vector sibling species of *An. culicifacies*. This is the first time that *An. culicifacies* E breeding in waste water was confirmed by a molecular method. However, malaria control programs focus on rural communities as a result of bio-ecology of *Anopheles* mosquitoes. Therefore, unusual breeding habitats such as waste water collections may mislead the current vector controlling programs. These results reconfirm that *An. culicifacies* has adapted to breed in water bodies including waste water collections. Since a majority of them belong to sibling E, which is considered as the vector, this may adversely affect the current malaria elimination program. Therefore, new strategies should be adopted to control malaria vector breeding in these unusual breeding habitats under the current malaria elimination program in Sri Lanka.

Keywords: *Anopheles culicifacies*, malaria, vector, sibling

Acknowledgement: Global Fund for Aids, Tuberculosis and Malaria (GFATM) (Round 8).



106/A

Increased serum nitrite levels and low serum IgM levels in severe dengue (dengue hemorrhagic fever) patients

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Identification of dengue hemorrhagic fever (DHF) at an early stage of the disease could unravel many issues in clinical management of severe dengue. Thus, the main objective of this study is to seek the prognostic value of Serum nitrite, a secondary stable intermediate of nitric oxide in severe (DHF) and mild dengue fever (DF) patients along with its association with serum IgM antibody levels. Clinically confirmed DHF (n=40) and DF (n=60) patients were selected from Colombo North Teaching hospital (CNTH), Ragama, excluding patients with previous dengue episodes and other infectious and non-infectious diseases. Blood samples were collected at different stages of disease; admission (A), critical (C) and discharge (D). Disease was confirmed by detection of NS1 antigen and IgM levels were measured using commercially available quantifying ELISA kit. Griess assay was carried out for deproteinized sera to seek the nitrite levels. Results showed significantly higher serum nitrite level in DHF-A (mean \pm SD, $1.535 \pm 0.705 \mu\text{M}$) compared to DF-A ($1.240 \pm 0.475 \mu\text{M}$, independent sample t test, $p=0.027$). ROC curve analysis between DF-A and DHF-A showed 62.6% area under the curve ($p=0.036$). Cut off value for serum nitrite in DHF-A was determined as $1.255 \mu\text{M}$ with 63.9% sensitivity and 60.5% specificity. Moreover, DHF-A has significantly higher nitrite value compared to DHF-D (paired sample t test, $p=0.006$). Thus, these results postulate that high levels of nitrite in DHFA may be due to high production of nitric oxide associated with pathogenesis of severe dengue and higher expression of inducible nitric oxide synthase enzyme (iNOS). Analysis of IgM revealed significantly higher levels of antibodies in DF ($75.71 \pm 47.42 \text{ U/ml}$) compared to DHF ($52.21 \pm 36.20 \text{ U/ml}$) ($p=0.045$) patients, implying IgM may be playing a protective role in DF. However, no significant association was obtained between IgM and nitrite levels in each patient category. Nevertheless, other studies have shown that in severe dengue, antibodies produced against NS1 antigen could bind endothelial cells which enhance the release of nitric oxide causing cell apoptosis. Lack of association between IgM and nitrite levels observed here indicate that there may be other mechanisms contributing to DHF.

Keywords: Dengue hemorrhagic fever, reactive nitrogen species, IgM antibodies, prognostic markers, pathogenesis

Acknowledgement: National Science Foundation, Grant No. RG/2014/HS/04



107/A

Evaluation of the spatial and temporal trends of dengue outbreaks in Akurana, Central Province, Sri Lanka

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Renowned as the world's fastest growing vector borne disease, dengue has become one of the major health issues in Sri Lanka leading to an alarming concern due to recent outbreaks throughout the country. Despite the immense efforts taken by the relevant authorities to reduce the rate of mortality, the average number of dengue cases recorded in each year remains around 30,000-35,000 without being changed significantly over time in Sri Lanka. Investigation of the trends in spatial and temporal distribution patterns of dengue is often treasured in the drafting and implementation of management/action plans to ensure effective management of dengue epidemics at regional scale. Thus, a statistical and geo informatics based analysis of the recent trends in dengue distribution was carried out to identify spatial and temporal trends in distribution patterns of Dengue in the Akurana Medical Officer of Health (MOH) area. Monthly records of reported dengue cases from 2010 to 2014 of the Akurana MOH area were obtained and were subjected to a scatter plot analysis in MINITAB (version 14.12.0) to identify the temporal patterns in the recorded dengue cases. Spatial maps of the recorded dengue case distribution in each GND for each month and for the whole study period were prepared by using Arc GIS 10.1. The spatial and temporal variations of dengue outbreak distribution within the Akurana MOH (at GND level) were analyzed to identify the recent trends in dengue incidence. Akurana, Bulugathenna, Dippitiya, Dunuwila, Konakalagala and Neeralla localities could be identified as areas with relatively high risk to dengue outbreaks throughout the study period, while localities such as Balakanduwa, Delgasgoda, Delgasthenna, Malgamadeniya, Marahela, Palleweliketiya and Udaweliketiya emerged as areas with low risk. As suggested by the results of the paired-Chi square test [$>X_{2(30, 0.95)} = 43.773$], the emergence of dengue outbreaks indicated a significantly declining trend of recorded dengue cases in most of the GNDs (Aswadduma, Delgasgoda, Kurugoda, Malgamadeniya, Palleweliketiya and Walahena etc.) during the recent years. The evaluation of the trends in temporal and spatial distribution of dengue outbreaks at the localized level, could be recommended as a useful tool in the planning and implementation of action plans to control the rise of dengue, while evaluating the efficacy of already implemented control measures at regional scale.

Keywords: Dengue, GIS, temporal and spatial trends

Acknowledgement: National Research Council funded Dengue Mega Project (NRC TO 14-04)



108/A

Male isolation of dengue vector *Aedes* mosquitoes for sterile insect technique by spiking blood with ivermectin

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There is an increasing demand for exploration of the potential for applying the Sterile Insect Technique (SIT) in area-wide integrated vector management (AW-IVM) in many countries. However, because female mosquitoes, unlike male mosquitoes, can transmit disease, means to eliminate them from the mass production process are a critical pre-requisite. In addition, the efficiency of the SIT programme could be increased by not releasing female mosquitoes due to the fact that sterile males can then only focus on wild females to achieve mating. Therefore, mosquito SIT programmes success will depend on exclusive release of sterile males, which is impossible on a large scale without efficient sex separation methods.

Many different sex separations for different stages of mosquitoes are currently being attempted to successfully establish a sexing mechanism for the above purpose. Among them, the mostly attempted methods broadly include genetic sexing methods, molecular methods, mechanical methods and behavioral methods. For all blood feeding mosquitoes, sex separation could occur at the adult stage by spiking blood with insecticides (malathion, dieldrin) or other mosquito toxins (ivermectin, spinosad), as behavioral tools.

In this study, a veterinary preparation of ivermectin (Ivotec, 1% w/v) which is used to treat dogs infested with the filarial worm *Dirofilaria repens* in Sri Lanka was used as a tool for sex separation of adult *Aedes albopictus* and *Aedes aegypti* mosquitoes by feeding on spiked blood. In an initial attempt by spiking blood with 5 parts per million (5 ppm) ivermectin, 40% of the blood-fed females could survive beyond 24 hours post feeding. However, when the dosage of ivermectin was increased to 7 ppm the survival rate decreased below 40%. Since there had been high mortality of both females and males even in the control cages in which mosquitoes were blood-fed without ivermectin it was suggested that the age of the mosquitoes used may be a factor for high mortality of mosquitoes in the control experiment. When the experiment was repeated with 7 ppm ivermectin in blood using 4-5 day old mosquitoes more than 65% mortality could be observed within 12 hours post feeding in the experimental cage with a significant difference in mortality compared to the control ($p < 0.001$). However, at 18 hours post feeding 100% mortality could be observed in ivermectin in blood fed *Ae. albopictus* females. When 4-5 day old female *Ae. aegypti* were blood spiked with 7 ppm ivermectin 100% mortality could be seen only at 24 hours post-feeding.

These observations suggest that repeated spiking blood with 7 ppm ivermectin for 24 hours could be used as a successful method for male isolation of adult dengue vector *Ae. aegypti* and *Ae. albopictus* mosquitoes. This techniques may be used for implementation of SIT for AW-IVM for dengue control.

Keywords: Dengue, *Aedes*, sterile insect technique, ivermectin, male isolation



109/A

Study on possible risk factors affecting transmission of dengue in high risk areas of dengue in Gampaha District, Sri Lanka

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Dengue is an important mosquito-borne vector-borne disease in Sri Lanka with 37,000 reported annual cases during the last five years. The second highest prevalence of dengue was observed in the Gampaha District in the Western Province during the past ten years. The objective of this study was to identify possible risk factors affecting transmission of dengue in selected high risk areas of dengue in the Gampaha District. The study was conducted in four high risk Medical Officer of Health (MOH) areas of dengue based on the annual number of dengue cases being greater than 250 during the last ten years. In each MOH area, one Grama Niladhari (GN) division with the highest dengue incidence was selected as the study area. In each study area, a cluster of 75 households was selected and a house-hold and entomological surveys were carried out in March, 2015. Eriyawatiya (Kelaniya MOH), Welikadamulla (Wattala MOH), Akbar town (Mahara MOH), and 3-Kurana (Negombo MOH) were selected as study areas. There was a population of 1234 in 300 house-holds from all four study areas. Average number of dwellers per household was 4.11. Most of house-holds were individual type houses with a small garden (98%) and the average size of a homestead was 14.92 perches. The main source of water was piped water, but 2.02% dwellers were using ground well or tube well water for daily purposes other than cooking and food processing. Some people accumulated water in containers (8%). The main waste disposal method was by collecting tractors of municipal councils and 1.02% families collect their waste and destroy it. The main dengue vector mosquito species present in the study areas was *Aedes albopictus* (98%-101/104). The identified main breeding places of the mosquitoes were plastic containers, discarded bottles and tins, roof gutters, plant axils and refrigerator drain pans. Dwellers in these areas have a considerable knowledge of the dengue disease and preventive measures, but disfavor perusing preventive measures. Possible risk factors affecting transmission of dengue in study areas may be crowded conditions due to small houses and homesteads, poor water and waste management systems, availability of a large number of water filled containers and vector species, disfavor to pursue preventive measures by themselves and depending on control methods conducted by the government. Continuous encouragement is needed for people to follow control measures.

Keywords: Dengue, Gampaha, vectors, risk factors

Acknowledgement: National Research Council (NRC TO 14-04)



Section B

201/B

Multivariate discrimination of exotic coconut varieties for stem and inflorescence morphology

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Characterization of conserved germplasm is of primary importance for the effective use of genetic resources and refines conservation strategies. Currently, there is a pool of *ex-situ* conserved exotic coconut varieties at Bandirippuwa genebank, Sri Lanka. This research aims to characterize exotic coconut varieties with morphological descriptors as an initial step to incorporate them in the national coconut breeding programme.

Six coconut varieties; namely, Rennell Island Tall, Malayan Yellow Dwarf, Andaman Ordinary Tall, Markham Valley Tall, Indian West Coast Tall, Laccadive Ordinary Tall were studied. Morphological data were scored for stem (girth at 20 and 150 cm) and inflorescence (numbers of female flowers, spikelets with and without female flowers, lengths of central axis and spikelets) as outlined by Bioversity International. Statistical analytical methods; principal components and cluster analyses were performed in Minitab 17.

The first 2 Principal Components (PCs) for stem and inflorescence traits cumulatively explained 98.3% of the variation among accessions. All the scored characters showed more or less equal loadings with positive correlations except spikelets without female flowers for PC1 while female flower distribution recorded the highest loading with a negative correlation for PC2. The dendrogram and the score plot for the accessions indicated the formation of four distinct groups of phenotypes with Rennell Island Tall and Markham Valley Tall grouping together, Andaman Ordinary Tall and Laccadive Ordinary Tall forming one cluster and Indian West Coast Tall and Malayan Yellow Dwarf forming separate individual groups. Accordingly, the dwarf coconut Malayan Yellow Dwarf clearly separates from the rest and tall coconuts with Pacific origin; Rennell Island Tall and Markham Valley Tall grouped together while the tall coconuts from India separated from the rest.

The six exotic varieties show clear diversity for stem and inflorescence morphologies and they have been grouped according to their different origins. Furthermore, the measured traits were informative for describing the stem and inflorescence diversity of the varieties studied. The diversity displayed in the studied coconut germplasm indicates the high potential of these coconut varieties to enrich the gene pool of coconut and thereby provide potential parent varieties for the national coconut breeding programme.



202/B

Effect of different fertilizer levels on physical yield, parameters of *Withania somnifera* (L.) Dunal from three different growth stages

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Withania somnifera (L.) Dunal. (Solanaceae) possesses many therapeutic values and hence it is widely used in Ayurveda and traditional systems of medicine for triggering of both physical and mental health. Even though this plant plays a vital role in human health, information on effect of different fertilizer levels on growth parameters are scattered or lacking. Therefore, the present study was undertaken to compare the growth parameters of *W. somnifera* cultivated in three different fertilizer levels at just before flowering, just after flowering and fully maturity stages. Data on growth parameters including plant height, plant spreading, girth of the stem, number of leaves, number of branches, number of flowers and number of pods per plant were recorded in just before flowering, just after flowering and fully maturity stages. Data were analyzed using the General Linear Model (GLM) procedure of SAS statistical package followed by Duncan's multiple range test (DMRT) for mean separation. The results clearly demonstrated that growth data (plant height, plant spreading, number of branches, number of leaves, number of flowers, plant girth, leaf area, root diameter and root length) of all 3 growth stages were significantly ($P < 0.05$) different in plants treated with organic or inorganic fertilizer compared to the control. Further, significantly higher growth parameters were observed in all three growth stages, in plants treated with organic fertilizer compared to the plants treated with inorganic fertilizer or control treatments. In addition to the growth parameters, higher yield parameters (fresh weight, dry weight and fresh to dry weight ratio) were also exhibited in plants treated with organic fertilizer. Remarkably, higher growth and yield parameters reported from plants treated with organic fertilizer over the inorganic fertilizer and control may be because organic fertilizer increases the soil physical, chemical and biological properties.

Keywords: *Withania somnifera*, Solanaceae, fertilizer application, yield and growth parameters



203/B

Evaluation of the trends in seasonal variation of rainfall in Mannar, Sri Lanka

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As a country with an agriculture based economy, Sri Lanka has to pay more attention to the climate extremes and variations in rainfall patterns. Evaluation of the regional variations in rainfall patterns (especially in rainfall seasonality, severity and frequency of wet and dry events) that reflect the trends in climate, is of essence for effective and sustainable management of the available water resources. Therefore, the variations in rainfall seasonality of Mannar District Secretariat Division (DSD), that lies within DL₃ and DL₄ agro ecological zones of the dry zone was evaluated by devising the Gumbel approach. Daily rainfall data for fifty three years (1961 to 2013) from the Mannar rain gauging station were collected from the Department of Meteorology. Monthly cumulative rainfall values were calculated and were subjected to a frequency analysis employing the Gumbel approach under two major periods of calendar years as 1961 - 1985 (past years) and 1986 - 2013 (recent years), while considering the four rainfall seasons identified in Sri Lanka. The first inter monsoon rainfalls indicated a reduction of the magnitude of low intense rainfall events along with an increment in the return period of the intense rainfall events. Meanwhile, the rainfall patterns in the second inter monsoon indicated an increasing trend of return periods of high intense rainfall events in recent years than in past years. A declining trend in the maximum average monthly cumulative rainfall and frequency of occurrence of intense events of rainfall could be recognized in the Southwest monsoon and Northeast monsoon periods in recent years (1986-2011) compared to the past (1961 to 1985). Thus, frequent occurrence of severe and extreme dry events that could significantly affect both availability and available quantity of water could be expected in Mannar, resulting in potential impacts on environmental, economic and social sectors. Especially as a locality that often experiences severe droughts, any further increment in the frequency of occurrence of dry events (as predicted by the study) could significantly affect the economic, social and environmental aspects. Therefore, timely planning and management of water resources in Mannar, based on the observed present and expected future trends (increasing dryness) in climate patterns (especially in rainfall patterns) could be recommended to compensate for the possible extreme variations in rainfall.

Keywords: Climate Change, dry zone, Gumbel approach, Mannar, rainfall seasonality



204/B

Identification of potential risk of zinc contamination in tomatoes through fungicide application in Hanguranketha, Sri Lanka

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Heavy metal contamination of foodstuffs is a topic of considerable concern nowadays because of increasing health hazards. The objective of this study was to identify the potential risk of Zn contamination through fungicide usage upon farmers at Hanguranketha, Nuwara Eliya. The wet and soggy climate and high vegetable production lead to the selection of this region to research. A field survey using a pre tested questionnaire was carried out to collect data from randomly selected (ISO 2859-1 1989 (E) sampling method) 120 vegetable farmers (20 from each village) in six villages (Kottala, Karalliyadda, Maliyadda, Adikarigama, Damunumeya and Dehipe) in the Hanguranketha DS Division. During *Yala* 2014 tomato (28%) was the major vegetable in the area other than cabbage, beans, knol kohl and brinjol (25, 27, 10, and 10% respectively), mancozeb (73%) and maneb (27%) were identified as the major fungicides applied by the respondent farmers. The identified fungicide samples were bought from the local market and analyzed for Zn by Flame Atomic Absorption Spectrometry. The obtained Zn values of samples were used to calculate the potential Zn contamination in the Hanguranketha DS Division.

Based on the number of fungicide applications by farmers, the possible level of Zn contamination by mancozeb and maneb were calculated as 59.13 and 9.62 mg/kg in 1 kg of tomato. These levels do not exceed the Maximum Permitted Level (MPL) which is 100 mg/kg. However analysis of village-wise fungicide applications revealed that tomatoes grown in Adikarigama have been exposed to higher levels of Zn than the MPL from application of mancozeb (116.2 mg/kg), whereas tomatoes from the other five villages showed lower levels (Avg 47.71 mg/kg) of exposure to Zn. For maneb, all the values (Avg 9.62 mg/kg) were lower than the MPL. The number of sprays per season was increased significantly ($p < 0.05$) in Adikarigama (mancozeb 6.2 and maneb 5.86) than in the other villages. This significantly affected the calculation of mancozeb contamination potential. It was concluded that the level of Zn contamination of Hanguranketha is lower than the Maximum Permitted Level, and therefore, the risk is less.

Keywords: Fungicide, contamination, zinc, tomato, Maximum Permitted Level



205/B

Efficacy of liquid organic fertilizers on growth and yield of *Abelmoschus esculentus* (Okra) and *Alternanthera sessilis* (Mukunuwenna)

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Liquid organic fertilizers (LOFs) are environmental friendly, cost-effective alternative products introduced to the agricultural market to minimize the adverse effects of synthetic fertilizers. This study aimed at developing LOFs using widely abundant weeds (*Tithonia diversifolia*, *Gliricidia sepium*, *Leucaena leucocephala*) in combination with poultry manure or fish waste to evaluate the efficacy of formulated LOFs on growth and yield of *A. esculentus* (L.) Moench and *A. sessilis* (L.) DC. Six combinations (F₁: Poultry manure + *Tithonia diversifolia*, F₂: Poultry manure + *Gliricidia sepium*, F₃: Poultry manure + *Leucaena leucocephala*, F₄: Fish waste + *Tithonia diversifolia*, F₅: Fish waste + *Gliricidia sepium*, F₆: Fish waste + *Leucaena leucocephala*) were prepared as water extractions. In each combination 360 g of weed leaves, 240 g of poultry manure or fish waste and 100 g of coconut husk ash were mixed with 6.0 L of well water in closed plastic containers. Combinations were aerated for two hours daily for a period of six weeks to facilitate decomposition. Based on the highest nutrient contents (N, P, K, Ca, Mg and Zn), F₁, F₂ and F₄ were selected for the foliar application. Well water was used as the control and commercial LOF "Maxicrop" was used as the standard. The field and pot trials were conducted in complete randomized block design maintaining five replicates for each treatment. LOFs were applied once a week on *A. esculentus* "Haritha" cultivar for a period of two months, to evaluate the growth performance in terms of number of fruits, number of flowers, leaf area, shoot height and stem circumference. Similarly, LOFs were sprayed once a week on *A. sessilis* for a period of two months, to evaluate the growth performance in terms of number of branches, length of plant, leaf area, plant fresh weight and number of internodes. Comparison of growth parameters over time was performed by one way analysis of variance using MINITAB 16 software. Prepared fertilizers significantly ($p < 0.05$) increased the growth and yield of both plant species. F₁ resulted in the highest number of fruits in *A. esculentus* compared with F₂ (21 ± 1.32) and F₄ (15 ± 1.63), while F₂ produced the highest biomass in *A. sessilis* in terms of plant fresh weight (11.6 ± 0.30 g) compared with F₁ (9.6 ± 0.22 g) and F₄ (9.2 ± 0.10 g). Therefore, F₁ can be considered the best LOF for *A. esculentus* and F₂ the best LOF for *A. sessilis*.

Keywords: *Abelmoschus esculentus*, *Alternanthera sessilis*, growth performance, liquid organic fertilizers



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SSR Marker based genetic relatedness of some finger millet (*Eleusine coracana*) accessions of Sri Lanka

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Finger millet (*Eleusine coracana* 2n=4x=36) of family poaceae is a cereal cultivated in the arid and semi-arid regions of the world including Sri Lanka. It contains a higher amount of protein, fat and minerals than rice, corn and sorghum and tolerates adverse agro-ecological conditions. Therefore, continuous efforts are required for the improvement of this crop. The genetic studies of finger millet are useful in breeding programs to improve the productivity of the crop. This study was conducted to reveal the genetic diversity of twenty one finger millet germplasm accessions having the same accession name as "Kurakkan" collected from seven districts of Sri Lanka using fourteen SSR (Simple Sequence Repeats) markers published by Dida *et al* 2007 which have been used for African and Indian finger millet accessions. This study is the first time they are used for Sri Lankan accessions. DNA was extracted from 14 day old leaves, PCR amplified and alleles of the amplified products were visualized on polyacrylamide gels. Gene diversity and Polymorphic Information content (PIC) were calculated using PowerMarker version 3.25 (Liu and Muse 2006). Cluster analysis was performed with Neighbor joining method and the Treeview software (TreeView 1.6 version for WXP) was used to construct the tree diagram. Of these markers, five markers (UGEP 11, UGEP 18, UGEP 31, UGEP 78, UGEP 90) were monomorphic and the other nine markers (UGEP 03, UGEP 05, UGEP 10, UGEP 12, UGEP 15, UGEP 81, UGEP 102, UGEP 106, UGEP 110) were polymorphic. The highest distance was observed between K1 (Nuwara Eliya District) and K18 (Badulla District) followed by the distances between K1 and K8 (Anuradhapura district); K8 and K12 (Kurunegala District); K12 and K13 (Kurunegala District) and between K17 (Badulla District) and K19 (Kurunegala District). Genetic similarity was observed between K12 and K19 from Kurunegala District; K11 and K2 from Anuradhapura District; K5, K6 (Polonnaruwa District) and K15, K20 (Kurunegala District). Dendrogram constructed on the basis of SSR polymorphism revealed the pattern of genetic relatedness among 21 finger millet germplasms by grouping fifteen of them into 2 main clusters and separating the remaining six accessions from those two clusters showing their genetic distance with the rest. The present study unveils the genetic relatedness of these germplasm accessions and genetically distinct individuals could be utilized in crop improvement programs. An increased number of markers is used to identify the true genetic diversity of these accessions.

Keywords: Finger millet, genetic diversity, SSR, polymorphic information content

Acknowledgement: NSF Research Grant number 2011/BT/09 and Deputy Director Plant Genetic Resource Centre, Gannoruwa.



207/B

Pharmacognostical aspects of seven *Ocimum* morphotypes available in Sri Lanka

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The genus *Ocimum* comprises therapeutically important medicinal plants which are heavily used in traditional systems of medicine. Although this genus has a great value for its medicinal properties, available information on Sri Lankan grown *Ocimum* species is scattered or lacking. Therefore, the present study was undertaken to investigate significant pharmacognostic aspects of seven *Ocimum* morphotypes grown in Sri Lanka by means of physicochemical parameters, phytochemical constituents and bioactivity. Phytochemical and physicochemical studies were conducted as per WHO guidelines. Brine shrimp toxicity assay was conducted as per Michel *et al.*, 1956. Results revealed that the physicochemical parameters were within the range accepted by the WHO guidelines. The phytochemical screening test revealed the presence of secondary metabolites such as flavonoids, alkaloids, saponins, tannins, steroidal glycosides in all *Ocimum* morphotypes tested. Thin layer chromatographic profiles after spraying with three spray reagents, vanillin-sulfuric, ferric chloride and anisaldehyde-sulfuric exhibited the presence of different chemical compounds at different R_f values. Some R_f values were common to all morphotypes while some exhibited distinguishing spots with different R_f values, 0.59 for vanillin-sulfuric, 0.57 and 0.71 for ferric chloride and anisaldehyde-sulfuric respectively. All morphotypes exhibited a certain toxicity. The findings of the current study are of vital importance for quality control and standardization of *Ocimum* species.

Keywords: Morphotype, pharmacognosy, *Ocimum*, phytochemicals, physico-chemicals, thin layer chromatography



208/B

Variation of phytochemicals, antioxidant capacity of different parts of *Ocimum tenuiflorum* L. (Lamiaceae) grown in two agro climatic regions in Sri Lanka

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Ocimum tenuiflorum L. (Lamiaceae) is a therapeutically important widely used medicinal plant in traditional systems of medicine for religious purposes and spiritual sanctity in many Asian countries. The present study compares the total phenolic content (TPC), total flavonoid content (TFC) and total antioxidant capacity (TAC) of leaf, bark, flower and seeds of *Ocimum tenuiflorum* harvested at three consecutive pruning stages grown in two agro climatic regions. TAC, TFC and TPC were determined using standard protocols. Total antioxidant capacity of leaf, bark, flower and seed extracts significantly ($p=0.05$) increased from first pruning to third pruning irrespective of agro climatic regions. Antioxidant potential and total flavonoid content of different parts of *O. tenuiflorum* cultivated in the low country intermediate-zone (IL_{1a}) and low country dry zone (DL_{1b}) varied as leaf > bark > flower > seeds. Even though the TPC significantly varied among different parts as well as pruning stages, a relationship was not observed either for the agro climatic region or pruning intervals. The results of the present study are of vital importance for the determination of suitable agro climatic region, optimum harvesting stage for higher phytochemicals, bioactivity and optimum therapeutic properties of *O. tenuiflorum*.

Keywords: *Ocimum tenuiflorum*, Lamiaceae, total antioxidant capacity, total phenolic content, total flavonoid content



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Influence of *Clidemia hirta* and *Chromolaena odorata* leaf extracts on seed germination, seedling growth and growth performance of *Raphanus sativus* L. (Radish)

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Clidemia hirta (Katakaluwa) and *Chromolaena odorata* (Podisinnomaran) were introduced into Sri Lanka as ornamental plants but now they have become invasive species. The present study was aimed at finding the influence of *C. odorata* and *C. hirta* extract on seed germination, seedling growth and their potential uses as a liquid fertilizer to enhance the growth and yield performance of local Radish (*Raphanus sativus*) cultivar "Beeralu". In the laboratory different concentrations (25, 50, 75, 100 g L⁻¹) of aqueous leaf extracts which was prepared separately by pooled samples of randomly selected plants of *C. odorata* and *C. hirta* were tested for seed germination and seedling growth of Radish using petri dishes (four replicates for each treatment containing 20 seeds in each petri dish) and seed trays (eight replicates for each treatment and sand as the growth medium) by adding 10 mL of the test extract. Distilled water was used as the control. Different concentrations (25, 50, 75, 100 g L⁻¹) of leaf extracts were tested with five replicates for each concentration, for growth and yield performance of *R. sativus* seedlings using pots containing 3 kg of solarized soil mixture in the pot experiment. The pots were treated with 300 mL of the extract every other day. The pots were arranged according to the randomized block design in an open environment in the Warakapola area and root and shoot fresh weights, leaf area, girth of the roots, length of the leaves and roots, number of leaves were recorded 45 days after seed sowing. Data were analyzed with MINITAB 16 statistical software (ANOVA ($p < 0.05$) and Tukey's pair wise comparison tests). The laboratory experiment results showed that seed germination, root and shoot lengths of Radish were significantly reduced by both leaf extracts compared to the control. Higher degree of seed germination inhibition and the shortest mean shoot and root lengths were recorded with increasing concentrations of extracts and therefore inhibition was dose dependent and it could be due to the presence of allelochemicals in the leaf extracts. In the field experiment addition of leaf extracts on germinated seedlings indicated significantly higher mean shoot and root biomasses in the presence of 75 g L⁻¹ *C. odorata* and 25 g L⁻¹ *C. hirta* treatments than their control (One way ANOVA, $p < 0.05$). Higher concentrations of *C. hirta* extracts (>50 g L⁻¹) have shown reduction in the yield performance of *R. sativus*. In *R. sativus* higher growth and yield performance was recorded in *C. odorata* 75 g L⁻¹ treatment.

Keywords: Allelochemicals, *Clidemia hirta*, *Chromolaena odorata* germination and growth performance, *Raphanus sativus*



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Constituents of essential oil, antioxidant activity, phenolic and flavonoid contents in different parts of *Pogostemon heyneanus* Benth. (Lamiaceae)

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Pogostemon heyneanus Benth.(Lamiaceae) is an industrially important, medicinal plant cultivated for essential oils used in modern perfumery and cosmetic industries. Therefore, the present study was undertaken to determine the distribution of constituents of essential oils, total antioxidant capacity (TAC), total phenol content (TPC) and total flavonoid content (TFC) in different parts (leaf, stem and root) of *Pogostemon heyneanus*. Powdered materials of leaf, stem and root were distilled in a Clevenger-type apparatus for 5 hrs. Gas chromatography-mass spectrometric (GC-MS) analysis was carried out to identify the components of essential oils. TPC, TFC and TAC of leaf, stem and root were determined by colorimetric Folin-Ciocalteu method, aluminium nitrate method and Ferric Reducing Antioxidant Power (FRAP) assay respectively. More than 90% of the total oil profile was identified and it was found that the essential oil composition was quite different in all three parts of the plant. Patchouli alcohol was presented in all the plant components leaf, stem and root in higher percentages as 44.56 ± 1.2 , 20.72 ± 1.23 and 5.76 ± 1.00 respectively. Caempferol was found as the main component in roots (80.49%). Significantly higher TPC, TFC and TAC were observed in leaf extracts. The order in increase of TPC, TFC and TAC in *P. heyneanus* was leaf > root > stem. Presence of higher constituents of essential oil, TPC, TFC and TAC in *P. heyneanus* leaves, scientifically validate the traditional claim of harvesting of *P. heyneanus* leaves for better therapeutic value. The higher TPC and TFC in leaf demonstrated the value of leaf for the development of effective drugs instead of root and stem.

Keywords: *Pogostemon heyneanus* Benth, Lamiaceae, antioxidant capacity, essential oil, phenolic content, flavonoid content



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Stabilization of rice bran using saturated steam and development of rice bran incorporated cracker

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This study was focused on stabilizing rice bran obtained from BG-352 (white rice) and AT-362 (brown rice) varieties. Rice bran of these two varieties was exposed to saturated steam for 5, 10, 20 and 30 minutes and subsequently dried at 70 °C to get the safe moisture content 8 - 10% before storing under ambient conditions in sealed polypropylene bags. Crackers were developed by incorporating stabilized rice bran for identifying the most appropriate incorporation levels with acceptable sensory attributes. Development of free fatty acid (FFA) and peroxides of stabilized rice bran were evaluated for 90 days in order to determine storage stability. Crackers developed by substitution of wheat flour with stabilized AT-362 rice bran at 15%, 20%, 25% and 30% were evaluated for sensory characteristics; appearance, color, texture and overall acceptability. Proximate composition of both rice bran and bran incorporated crackers was estimated. FFA and peroxide values revealed that the best stabilization methods for BG-352 and AT-362 bran were achieved by steaming for 30 and 20 minutes respectively. There was no significant difference between steaming of AT-362 bran for 20 and 30 minutes in terms of FFA and peroxide development ($P \geq 0.05$). According to the proximate analysis, bran from BG-352 rice variety contained 31.44% carbohydrates, 22.18% fat, 13.18% moisture, 12.01% fiber, 11.89% protein and 8.69% ash. Values obtained for bran from AT-362 were 37.04%, 22.14%, 10.56%, 9.23%, 11.91% and 9.12% respectively. Sensory evaluation revealed that crackers with acceptable sensory properties can be obtained by substituting wheat flour with 25% of stabilized rice bran. Proximate composition of the crackers prepared with 25% of bran was 60.15% carbohydrate, 14.31% fat, 11.09% protein, 6.18% moisture, 4.34% fiber and 3.93% ash. Finally, these results suggest that rice bran can be stabilized effectively by saturated steam for longer shelf life and also, there is a potential for incorporating stabilized rice bran in the cracker making process.

Keywords: Rice bran, stabilization, saturated steam, storage stability, bran crackers



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Development of high caloric nutritional porridge formula rich in pro-vitamin A and iron for primary school children

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Malnutrition is a major problem among school children in Sri Lanka. This is mainly due to the consumption of ready to eat foods with low and imbalanced nutritional value. The aim of this study was to produce high caloric nutritional porridge rich in pro-vitamin A and iron, and to evaluate the nutritional quality of the developed porridge. Selection of raw materials was done by considering the availability, nutritional value and the organoleptic properties of the ingredients. After conducting the sensory evaluation in several formulations, the best formula which fulfills the main objective of the study, was selected for further study. This formula contains pachchaperumal, rathu heenati as two traditional rice varieties (*Oryza sativa*), medeeri (*Panicum miliaceum*), soybean seeds (*Glycine max*) and green gram seeds (*Vigna radiata*) as the grain mixture. Pumpkin (*Cucurbita maxima*), gotukola (*Centella asiatica*) and spinach (*Spinacia oleracea*) were selected as the vegetables due to their high β carotene and iron content. Common spices (pepper, mustard, curry leaves, coriander, fenugreek, cumin seeds, garlic, red onion, ginger, cinnamon, table salt) used to prepare porridge at household level were used as the spicy mixture. All the ingredients were separately washed, cleaned, dried (mc < 10%) and ground to 0.5 mm particles. Vegetables were steam blanched for two minutes before dehydration and leafy vegetables were dipped in colour preserving solution (1% SMS, 1% MgCO₃ and 3% Citric acid solution at pH 3.0 – 3.5) for five minutes. Three formulae were made by mixing the ingredients according to the ratios, and using sensory evaluation the best formula was selected. Due to the moisture content and water activity difference of raw materials, two packages were introduced, as Met Pet/ LDPE aluminum foil for the spicy and vegetable pack and Pet/ LDPE transparent foil for the cereal pack. For the selected formula, proximate analysis (AOAC methods 2012), vitamin, mineral, microbiological analysis and storage studies were conducted. The final product was sensory approved with regard to all sensory attributes (taste, colour, texture, mouth feel, palatability and overall acceptability). The caloric value, protein, fat, dietary fiber, available carbohydrate and ash content of the selected product (per one serving: 200 mL) were 78.53 kcal, 3.17 g, 3.92 g, 1.94 g, 7.63 g, 1.94 g respectively. Further, the selected product contained 1.1 g, 16.4 mg, 6.4 mg, and 1.2 mg of Na, Ca, Fe and Zn respectively. It also contained 30.0 μ g, 8.6 mg and 0.4 mg of β carotene, vitamin B₃, and vitamin B₆ respectively. The moisture content (8.49%), water activity (4.98) and the microbial count were monitored and these parameters were within the recommended standard range during the two months of storage.

Keywords: High calorie, nutrition, porridge



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**Development of banana fingers coated with leaf gum of true cinnamon
(*Cinnamomum verum*)**

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Banana fingers were prepared with matured unripe Ash banana (*Musa acuminata*) to be used as a supplement to potato fingers. Ash plantains were hand peeled and cut into rectangular shape strips (1/2 x 1/2 x 5 cm) and dipped in a 800 ppm solution of sodium metabisulphite for 5 mins. Banana strips were subjected separately to 8 treatment combinations in a two-factor factorial design with three variables at two levels: i.e. blanching process, chemical leavening and edible coating with *Cinnamomum verum* leaf extract. Fresh mature cinnamon leaves with petioles were washed, dehumidifying dried and blanched in hot water at 100 °C for 10 mins and rapidly cooled with cold water. 2 g of leaves were macerated by blender with 50 ml of cold water and filtered through to extract a viscous solution of leaf extract/gum. The raw banana strips were divided into two portions and one portion was blanched in boiling water for 2 mins. The other portion was untreated. The blanched portion was divided into four portions in order to prepare four treatment combinations by dipping two of them in a sodium bicarbonate solution at 500 ppm and the rest in pure water. Two of them from each treatment were coated with viscous cinnamon leaf extract. The same procedure was adopted for the unblanched portion of banana fingers. All eight treatments were replicated thrice and were partially fried at 150 °C and frozen at 0 °C - (-18 °C) for 6 h in order to form ice crystals in the banana fingers. These eight treatments were fully fried at 180 °C for 90 sec in vegetable oil and the organoleptic properties were measured against potato fingers using an untrained sensory panel of 30 individuals to select the best combination of treatments. Proximate analysis, shelf life tests and a consumer survey to evaluate the acceptance were also carried out. Commercially available potato fingers were used as the control. The blanched, NaHCO₃ treated and leaf gum coated sample was found as the organoleptically acceptable sample. The selected banana finger sample contained 48% moisture, 18.40% total fat, 1.23% protein, 1.30% crude fibre and 2.27% ash. The potato finger samples showed 58% moisture, 15.14% total fat, 2.57% protein, 1.30% crude fiber and 1.8% ash. During the shelf life analysis of two months, undesirable change in colour, taste, smell and crispiness were not detected in the fried product prepared from partially fried frozen banana fingers. Consumers rated the taste, smell, crispiness and mouth feel of the newly developed banana fingers as better than those of potato fingers. Consumers preferred the colour and appearance of potato fingers than the newly developed banana fingers. However, banana fingers have a high potential to be a substitute for imported potato fingers in the fast food industry.

Keywords: Banana fingers, edible coating, organoleptic properties



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Development of a non-meat vegetable based sausage using locally available raw materials

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Frequent consumption of processed meat products due to busy life styles of human has been a trigger factor for cancer, obesity, and cardio vascular diseases. In addition to the traditional meat based sausages, gluten and vegetable based non-meat sausages are available in different markets in the world. The main objective of this research was towards the development of vegetable based sausage using locally available, seasonal and low-priced vegetables in Sri Lanka.

Cucurbita maxima and *Ipomoea batatas* (Sri Lankan varieties) were used as the main substitute for meat. Optimal ratio of vegetable to emulsion was revealed through a six-stage recipe optimization process. Finally, the three samples, which were labeled as 278, 672 and 358, were developed with the different recipes and the best sample was identified through a sensory analysis.

Sensory evaluation was carried out using a seven-point hedonic scale and the results were evaluated using Mood Median test.

There was no significant difference between the three samples according to the sensory evaluation results for odour, taste, texture, mouth feel, colour, appearance and overall acceptability with the probability values of 0.009, 0,023, 0.000, 0.000, 0.000, 0.000 and 0.000 respectively. According to the pairwise comparison 358, 672 and 278 samples had the highest, average and lowest rank values respectively. Sample 358 which was ranked highest consists of 20% *Cucurbita maxima* and 10% of *Ipomoea batatas*. Although the sample was compatible with the microbiological and chemical requirements of Sri Lankan standards, the stability of the sausage was also considered for a period of one month according to the rapid method.

The production of an alternative vegetable based sausage to the traditional sausage is possible with *Cucurbita maxima* and *Ipomoea batatas*, instead of meat.

Keywords: Sausages, non-meat, vegetables



215/B

Characterisation of the floristic structure and composition of an upper montane rain forest, Thotupolakanda

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Detailed overstorey and understorey floristic structure and floristic composition of an upper montane rain forest, Thotupolakanda was investigated during this study. Due to floristic heterogeneity, vegetation was studied in the following strata; lower elevation (2200 m – 2270 m), middle elevation (2270 m - 2340 m) and higher elevation (above 2340 m) with stratified random sampling method. Vegetation structure was surveyed with vertical distribution, girth class distribution and life form distribution with 31 plots, each 10 m × 10 m in size. Plant species higher than 1 m and gbh greater or equal to 10 cm were considered as overstorey vegetation. The remaining plants in the understorey vegetation was sampled with two randomly selected sub plots (1 m × 1 m) in each main plot. The floristic richness and endemics were also studied. The identity of the collected plant specimens were confirmed with the National Herbarium, Peradeniya.

During the study 1824 individuals were enumerated and 108 species of 64 genera belonging to 39 families were revealed. The overstorey consisted of 42 plant species and understorey consisted of 66 plant species. Poorly distinct two strata were recognized in the lower elevation as canopy (6 m –12 m) and sub canopy (1 m – 5 m). No clear stratification was distinct at higher altitude and draft vegetation was recognized from the middle elevation. Girth class distribution of stems showed the typical reverse “J” shaped curve with girth of most of the individuals within 11 cm – 20 cm at each elevation level while very few individuals attained girth more than 70 cm. Both plant height and gbh decreased with increasing altitude. Life forms recorded in the overstorey were trees and shrubs while herbs, shrubs, epiphytes and climbers were in the understorey. The prominent life form in the overstorey and understorey was trees and shrubs respectively.

Compared to the species richness in the overstorey vegetation, higher species richness was recorded in the understorey vegetation. The highest understorey species richness was recorded in the middle elevation. Of the total recorded plant species 48% are endemic to Sri Lanka. The overstorey comprises 67% and understorey comprises 46% endemic species. Critically endangered possibly extinct endemic plant species *Hedyotis quinquinervia* (Rubiaceae) was rediscovered after 107 years in Sri Lanka during this study.

Keywords: Floristic composition, floristic structure, overstorey, Thotupolakanda



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Construction of a model to predict stem carbon of *Eucalyptus grandis* Wall ex. Maiden grown in upcountry, Sri Lanka

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Eucalyptus grandis is an important timber species in plantation forestry in Sri Lanka. *E. grandis* was selected for this study, assuming that maintaining of *E. grandis* plantations for carbon trading projects would provide an additional market value for this species with the current interest on global climate change mitigation, as forest plantations play an important role in carbon sequestration and carbon trading. However, there is no proper mechanism to estimate the amount of sequestered carbon in *E. grandis* stems. The primary objective of this study was to construct a precise model to predict stem carbon content of *E. grandis* individuals with the intention of calculating the value addition for *E. grandis* timber. To collect data, four study sites were selected from Nuwara Eliya (Kandapola and Bogawanthalawa), Badulla (Haputhale) and Ratnapura (Pinnawala) Districts to represent upcountry, intermediate zone and wet zone where *E. grandis* is confined to. Each plantation was divided into three strata and a 0.05 ha circular sample plot was laid out in each stratum. Each individual in the plot was measured for total tree height, canopy height and diameter at breast height. Plantation age was recorded from FORDATA database of Forest Department of Sri Lanka. Core sample from the stem at breast height was extracted and carbon content was calculated using loss-on-ignition method by oven-drying at 105 °C and igniting at 450 °C. The carbon content in the stem was estimated by aggregating this value. Simple linear regression method was used in model construction using MINITAB statistical package. The selected explanatory variables for the model construction were tree diameter at breast height (DBH) and total tree height (TTH) of individuals. The constructed model to predict stem carbon content of *Eucalyptus grandis* is;

$$\log \text{ Carbon content of the stem} = - 2.88 + 2.19 \log \text{ DBH} + 1.40 \log \text{ TTH}$$

The final model is able to predict the stem carbon content of *E. grandis* up to 98% reliability. According to model validation, the model could be used in the real world. Results of comparison of actual, predicted and assumed carbon content showed that there is a significant difference between the three methods ($P=0.001$). The assumed carbon content, obtained assuming 50% of the biomass is carbon, is significantly different from actual carbon content obtained by laboratory experiment and predicted carbon content, obtained by the constructed model. However, there is no significant difference between actual carbon content and carbon content predicted using the model. A majority (86%) of the collected samples contained a greater stem carbon content than the assumption that 50% of the biomass is carbon. These results indicate that use of the constructed model to predict stem carbon content of *E. grandis* will provide more precise results than the 50% assumption which is in practice at present.

Keywords: *Eucalyptus grandis*, carbon sequestration, carbon trading, model, plantations



217/B

Rationale behind the decision making of agricultural land allocation of farmers in the Northern region of Sri Lanka

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The decision of land allocation is one of the critical factors which influence the food security of a nation. When land is allocated, the productivity and sustainability have to be considered because land availability is becoming scarce. Hence, this research seeks to find out the crucial factors associated with land allocation which influence the farmers' decision in the Jaffna peninsula of the Northern region. A structured questionnaire designed and pretested with selected respondents was administered to the sample farmers. Primary data were collected from a sample of 306 farmers randomly selected from seven AI divisions located in the region. The multivariate regression model was employed to reach the objectives of this research. The compiled data were analyzed within the framework of seemingly unrelated regression (SUR) by employing the econometric software STATA 11. The model equations for vegetable, fruit and tuber crops were statistically significant at 1% α level and for cash crop it was at 5% α level. Around 10% to 22% of the variation on farmers' decision regarding land allocation was explained by the model. The results revealed that educational level, farming experience, contact with extension, gifting land, household's capital and access to credit showed a positive and significant impact on farmers' decision making on land allocation for crops. Only family labour imparted a negative impact on land allocation. The recommendation is that if the aim is to motivate the farmer in vegetable cultivation the element of liquidity has to be enhanced. To meet this condition low interest credit facility could be arranged, relevant constituents could be supplied at a reasonable price and farmers could be motivated to cultivate the remaining land in their possession. When a formal credit facility is arranged it should be tagged with longer grace periods to help ease the burden of a loan and motivate them further in crop farming. If the fruit crop production in the region is increased, it would motivate the farmers in the Puttur and Urumpirai areas. Further facilitation of a better farm level education which may provide information and knowledge regarding proper crop management strategies, cropping systems such as intercropping, crop rotation and multi cropping will increase farm land utilization, efficiency and productivity of land. Exchange of family labour between farm families to fulfil labour needs also reduces the cost of hired labour and increases the land utilization to provide a variety of crops. Finally, where household labour is abundant, the recommendation is to allocate more land for vegetable cultivation. This will enable them to enhance their income. To facilitate better participation of women in the use of land, it is recommended that the Government, NGOs and agribusiness companies assist especially female headed households in providing them agricultural inputs, modern implements, micro financing and markets. This would increase the participation of females in agricultural production.

Keywords: Land allocation decision, multivariate regression, seemingly unrelated regression, Jaffna peninsula



Section C

301/C

A method to determine the incidence of decomposing in the traditional rock and wall paintings of Sri Lanka

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Research in painting conservation needs accurate, efficient and non-destructive methods to determine the rate of composite decomposing actions without disturbing the painting. Decomposing results in a change of visual characteristics that can be directly measured. In this study, attention was focused on assessing whether the measurements of such characteristics identify the rate of decomposition to an acceptable accuracy. Samples that simulate the traditional Sri Lankan rock and wall paintings, made by several techniques, were used for the study. Two categories of painting samples were considered, namely the samples with clay ground and organic paint and samples with lime based ground and mineral paint. These were subjected to destructive interventions in order to accelerate the decomposing processes and generate defects within a short period of time. Continuous heating up to 60 °C, alternative cooling and heating, introducing moisture at a rate of 3 mL per 24 hours per sample, introducing 0.1 M NaCl and MgSO₄ solutions and inducing mechanical stresses at 100 Pa and 1000 Pa for clay and lime based samples are among the destructive interventions used. Four (04) indirect parameters were used to measure the rate of decomposing of samples. Testing in the wind tunnel and the actions of moisture, temperature and illumination were these parameters. One sample of a painting was kept in open air and another one was subjected to testing. Measurement of the changes in color and visual defects tested the rate of decomposition. The Mach and Reynolds numbers used in the wind tunnel testing were 1.25 and 5x10⁶. The amount of moisture, temperature and illumination used for the purpose were 5 mL, 30 °C and 200 lx respectively. The Pearson product-moment correlation coefficients for variations measured were 0.86 and 0.94 respectively and the results proved the existence of a relationship between the parameters.

Keywords: Rock and wall paintings, decomposition, painting conservation

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302/C

Engineering students' learning styles and their perceptions to become professional engineers

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Students' enrollment for engineering studies has significantly increased recently with the establishment of private institutes of engineering education in the country. Owing to this rapid growth, a significant increase in engineering graduates entering the workforce of the country in the near future is envisaged. Student's knowledge, skills and attitudes are the most important aspects to be considered in order to train them as competent, professional engineers in the future. Hence, the facilitators in the teaching and learning process should understand the students' perspectives and their learning styles and how these could be accommodated in multidisciplinary engineering studies.

In this study attention was thus focused on investigating newly enrolled engineering students' perspectives and their learning styles based on Kolb's learning theory. A questionnaire survey was conducted with 116 randomly selected students to obtain relevant information for the study. Female enrollment in engineering studies was 13.8% while male enrollment was 86.2% of the total sample of students that represented different disciplines of Civil (21.55%), Mechanical (18.97%), Mechatronic (10.34%), Electrical and Electronic (25.86%) and Computer (23.28%) Engineering. Kolb's learning styles inventory distributed among the selected study groups was considered in order to identify the students' learning styles. According to Kolb's inventory analysis, 7.1% of male students and 2.6% of female students were "assimilators", i.e. those who are best at creating theoretical models. They are learners who take in new information abstractly and transform it through reflective observation. 20.7% of male students and 4.3% of female students were categorized as "divergers", i.e. who are best at viewing concrete situations from different perspectives. They are learners who grasp the experience concretely and transform it through reflective observation. 19.8% of male and 3.4% of female students in study group were categorized as "convergers", i.e. who are best at finding practical uses for ideas and theories. They are learners who perceive new information abstractly and transform it through active experimentation. 38.8% of male and 3.4% of female students were "accommodators" i.e. who enjoy carrying out plans and involving themselves in new challenging experiences. They grasp the experience concretely and transform it through active experimentation. Based on Kolb's learning style, learners in the "convergers" category can be considered as dynamic engineers who are capable of abstract thinking and having the strength on practical application of ideas and functioning of facts gathered by practical experience.

Kolb's learning style inventory is very important to assess the students' learning styles and the students enrolled in different engineering disciplines indicated different learning styles, perspectives and attitudes. The majority of students were not in the "convergers" category which is the learning and teaching model well suited for engineering profession. The facilitators' responsibilities are to design engineering curricula and evaluation methodologies to accommodate all learning styles to reduce the dropout rate in the learning process and to increase the students' interest in engineering studies.

Keywords: Kolb's learning theory, engineering, learning styles



303/C

High cycle and low cycle fatigue to estimate the remaining life of steel bridges

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High cycle fatigue (HCF) caused by low amplitude loading is considered as a major cause of bridge failures and it is generally checked at the design stage of bridges. However, a number of fatigue failures have been reported in the past which cannot be explained by HCF phenomena. Detailed studies on such failures have revealed that high amplitude loading due to earthquakes and cyclones is one of the causes of failure. During events of such high amplitude loadings, structural members of bridges may be subjected to stresses in the plastic range causing low cycle fatigue (LCF) damage which may lead to sudden failures. The commonly used approach of damage prediction is based on Von Mises Strain, Coffin-Manson Strain-Life Relationship with Miner's Rule. However, Von Mises Strain does not accurately represent the fatigue behavior in multiaxial HCF and LCF. Also, HCF and LCF interaction is not accurately represented by the Coffin Manson Curve. Further, Miner's Rule does not predict accurate results in variable amplitude loadings as it is not able to capture the loading sequence effect. In view of these considerations, this study was conducted with the objective of developing a new combined high and low cycle fatigue model to predict the life span of structures, including bridges subjected to combined effect of high and low amplitude loadings. The model developed consists of modified Von-Mises Equivalent Strain as the damage indicator and fatigue damage computations were carried out using a sequential law that can simulate the load sequence effect. The verification of the proposed model was then carried out, based on experimental test results of a selected structural material. The results of the study indicate that the proposed fatigue model predicted fatigue life more accurately than the previous model based on the Miner's Rule.

Keywords: High cycle, low cycle, fatigue, steel bridges



304/C

Modeling of vertical density distribution in a normal geological fault by the Backus and Gilbert method

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Modeling of gravity anomalies by the powerful Backus and Gilbert method was so far limited to modeling of bodies with constant densities and in this study, the possibility of extending the Backus and Gilbert method to model gravity anomalies due to bodies with increasing density and applying it for a special case of a geological fault was investigated.

A normal geological fault is formed as a result of breaking of a large earth structure into two blocks and subsidence one relative to the other. The void created by the subsidence of the block will normally be filled with sediments. The density contrast between the sediments (ρ_s) and the block that did not subside (ρ_c) produces a gravity anomaly. The feasibility of modeling a normal geological fault with increasing densities with depth by the Backus and Gilbert method was examined by inverting gravity anomaly data obtained from an artificially simulated hypothetical geological fault of known dimensions and a known density distribution. It was then compared with the results obtained for the relevant features of the hypothetical fault. For the numerical study, the anomaly was first modeled in terms of a body of constant density by the inversion of the Backus and Gilbert method for gravity modeling. The following steps were then carried out.

1. In the initial trial, the rectangular cross sectional shape was divided into a number of semi-infinite slabs.
2. The density contrast of each slab was determined by the Backus and Gilbert method, together with the singular value decomposition method.
3. The semi-infinite slabs having positive density values or density values close to zero were neglected by taking their thickness equal to zero.
4. A value for the density of remaining semi-infinite slabs was assigned and the gravity anomaly due to the new body was calculated and compared with the "observed anomaly". If the agreement was not acceptable, steps 2 and 3 above were repeated until a suitable agreement was obtained.

For the test example, the model obtained by the use of the above method consisted of five consecutive slabs of equal density contrast of -0.3 g/cm^3 . To model a body with increasing densities, each slab of the model was divided into five horizontal strips so that the whole model was divided into 25 strips. The density for each strip was assigned a value assuming a linear increase of density with depth. The results indicate that the Backus and Gilbert method can be used to successfully model gravity anomalies caused by geological faults.

Keywords: Backus and Gilbert method, geological fault modeling



305/C

Structural use of palmyrah timber in Sri Lanka

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Palmyrah is a palm tree commonly found in the Northern and Eastern Provinces of Sri Lanka. It is usually a large tree growing up to 30 m in height and with a straight circular trunk of up to 1.5 m in circumference. Valuable timber can be obtained from tall, strong palms of at least 50 years old. Wooden planks obtained from palmyrah palm are used for a variety of structural elements such as roof truss members, purlins and reepers.

A study was carried out to determine the physical and mechanical properties of palmyrah timber. A range of tests- Static Bending Test, Compression Tests (parallel and perpendicular to grains), Shear Test (parallel to grains), Cleavage Test, Tension Test (parallel and perpendicular to grains) were carried out to identify the strength class and the suitability for use as structural components in roof structures. The tests were carried according to the British Standard BS 373:1957 on testing small clear specimens.

Based on the test results, the strength class was identified by the bending strength, tension parallel to grains, tension perpendicular to grains, compression parallel to grains and compression perpendicular to grains. The density and mean density were comparatively high and satisfy the minimum requirements of D50 strength class. Stiffness values also satisfied the minimum requirements of D50 strength class from Characteristic Values for Strength Classes (BS EN 338). Therefore, palmyrah timber can be classified as D50 strength class for structural purposes.

Keywords: Palmyrah timber, structural properties



306/C

Web based labour market observatory system

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Finding the most suitable job according to one's qualifications and capabilities is a dream of the youth. Yet, it is noticed that this is not an easy task due to a variety of reasons such as complexity of advertisements, time limitations in getting firsthand information on vacancies, diversity of vacancy appearing modes etc. Hence most youth end up in spending their time unsuccessfully in searching for job opportunities or accepting sub optimal job positions. With the advancement of technology, the modes of advertising of job vacancies have changed and the World Wide Web (www) has become the most dynamic job advertising mode.

Labour Market Information (LMI) bulletin published bi-annually by the Technical and Vocational Education Commission (TVEC) is a good source of information for job seekers, which is a systematic collection of job vacancies on the labour market requirements in Sri Lanka. The main and primary source of data collection for the LMI Bulletin is the manual search of newspaper advertisements carried out by the Information System Division of TVEC since 1999. This has become an obsolete method and a Web Based Labour Market Observatory System (LMOS) was developed that operates as a back end system to capture job market information from the www for the LMI bulletin and it can act as a portal for job market vacancies from the user point of view. The LMOS is able to rank the vacancies according to the user requirement and contain aggregated information from other sites such as topjobs.lk, ikman.lk and ikmanjob.lk. These are value added features of the LMOS system compared to other job advertising sites.

LMOS has three (03) user categories namely jobseeker, employer (company) and the admin (TVEC) depending on the role played. A jobseeker can register with the system and upload his/her Curriculum Vitae (CV) and search the system for job vacancies based on job category, location, salary and with more details such as qualifications, and programming languages known. A registered employer can make a request to upload new vacancies and can view the CVs for potential candidates. Admin has the authoritative power in uploading new vacancies and generating reports for the LMI bulletin.

The system operates based on two main processes, namely, web extract process and user search process. In the web extracting process, the LMOS mines the selected job advertising sites and extracts data by filtering the relevant using web content mining techniques as per the user request. For registered job seekers, an email alert is sent when a matching job is captured by the system. The system evaluation is done by two sets of users, one by the TVEC and the other by the system users through two separate questionnaires. The TVEC was highly satisfied with the new simplified mechanism for capturing online advertised jobs for the LMI bulletin and job seekers found the LMOS as a time saver for being a job vacancy portal and email alerts were a very appealing feature of the system.

Keywords: www, labour market observatory system

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307/C

Investigations on coastal environment and fisheries infrastructure in Jaffna Peninsula

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Prior to the conflict that prevailed in the North and East, the northern Jaffna Peninsula had been one of the most productive fishing regions in the country. Its contribution to the national fish production had declined since the mid 1980s due to the disruptions caused to the fisheries activities by the conflict. The fishery infrastructure facilities in the region are in a dilapidated state, due to damage caused by the conflict and years of neglect, and are in need of restoration and development.

The Jaffna Peninsula is relatively sheltered from the Southwest monsoon and the nearshore wave climate in the region is mainly influenced by the less severe Northeast monsoon. Apart from the coastline along the northern and eastern sides of the Jaffna Peninsula and the northern coastline of the Karainagar Island, other coastal areas on the western side of the Peninsula are relatively sheltered from the northeast monsoon due to the shallow depths and protection provided by land masses. Many of the fishery infrastructure facilities in the area are in the form of open jetties/piers, mainly without breakwater protection. Rehabilitation of these would be a significant initial step in improving mooring facilities for smaller boats. The possibility also exists for a fishery harbour facility for the use of larger fishing craft which may also require dredging of access channels for the operation of such boats. The coastal region along the northern side of the Peninsula is characterized by rocky/sandy beaches and limestone reefs located close and parallel to the coastline. The reef provides protection against coastal erosion due to wave action and naturally sheltered basins for the mooring of fishing vessels. Many such basins exist along the northern coastline. The improvement of fisheries infrastructure at landing sites for the operation of mainly the smaller fishing craft in the area along the northern coastline of the peninsula could generally be achieved by strengthening the natural protection provided by the reef formation. Raising the crest level of reef formation and strengthening of its seaward slope with the use of larger armor may be needed to provide effective protection. Deepening of access channels and the basins may also be required at some of the sites and, in such situations, due attention needs to be paid for possible adverse environmental issues associated with any dredging of reef formations. A possibility also exists for the use of excavated and cleared material for use in the strengthening of protection measures. The coastline in the eastern side of Jaffna Peninsula is directly exposed to the wave conditions during the Northeast monsoon period. A sandy, straight coastline exists in the area and the analysis of available information and community consultations revealed that there is a significant seasonal variation of the beach profile which indicates high levels of sediment transport. In view of such a dynamic nature of the coastline, construction of coastal structures is likely to cause coastal erosion/accretion issues and such constructions without extensive investigations and appropriate mitigation measures may cause severe adverse impacts.

Keywords: Coastal environment, fisheries infrastructure, Jaffna peninsula



308/C

Tsunami Hazards: effectiveness of early warning in impact mitigation

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Most Sri Lankans were not aware of tsunamis prior to the Indian Ocean Tsunami (IOT) in 2004, which caused widespread destruction in coastal areas of the country. Although such hazards have not been frequent in Sri Lanka, the IOT and the alerts and warnings issued since then have clearly indicated the exposure of the country to tsunami hazards.

Undersea earthquakes are the most common cause of tsunamis, and, in view the location of Sri Lanka relative to such earthquake prone zones in the Indian Ocean, it can be considered that the country is potentially exposed to tsunamis generated along the Sunda Trench and the Makran Fault, located to the East and Northwest respectively. As none of these zones are located in coastal waters of Sri Lanka, the tsunamis to which the country is potentially exposed can be considered as far-filed tsunamis as opposed to near-filed tsunamis. The propagation times associated with these tsunamis, which are usually in excess of one hour before reaching the coastal waters of Sri Lanka, allow adequate time to issue alerts and early warnings for public evacuation and other precautionary measures to mitigate the adverse impacts.

The assessment of the public response to the tsunami alerts and early warnings issued plays an important role in the identification of the effectiveness of a tsunami early warning system. Such assessments have been carried out earlier and the preliminary findings have been presented. The results of a detailed analysis of such a study are presented here. The study has been carried out in 2011 in the form of a questionnaire survey conducted mainly in the coastal areas of the country.

The analysis indicated that although the majority, 76 %, of the population in coastal areas of the country was not aware of the causes of tsunamis prior to the IOT, a large majority, 77 %, is currently aware of undersea earthquakes as the most common cause of tsunamis. To a lesser extent the public is also aware of the other potential causes of tsunamis. A significant majority, 78 %, was aware of the difficulty in predicting potential tsunamis in the future. A majority, 63 %, identified early warnings as an effective mitigation measure. The results indicate that the warnings have been received by a majority of more than 70 % of the public. The clarity of the warning was also confirmed by a majority in the order of 80 % of the community. Early warnings have been conveyed by a variety of modes and the results indicated that the electronic media/communication (radio, television and telephone) as the predominant mode. The social interaction of the communities also played an important role with a significant level of the public receiving the warning from the neighbors. The public response to the tsunami warnings issued was assessed in terms of the % of the public evacuated, time taken for evacuation and the awareness on safe locations for evacuation. The results indicate that the majority of public, in excess of 60%, evacuated after receiving the warning and a majority, in excess of 65%, was also aware of places of evacuation. A favorable public response to the warnings issued and the effectiveness of the early warning system was thus revealed by the results.

Keywords: Tsunami, impact mitigation, early warning

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309/C

Automated mechanism to detect glyphosate in well water

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Chronic Kidney Disease of unknown etiology (CKDu) is a crisis in the dry zone of Sri Lanka. Farmers in this region use chemical herbicides in paddy fields and glyphosate is one of the herbicides widely used. The amount of glyphosate used in the fields varies according to the wish of each farmer and the lack of awareness of farmers of the risk of this compound leads to excessive accumulation of chemicals in the soil. The excess fertilizers and herbicides ultimately end up in groundwater aquifers from which water is extracted for drinking. The complex of glyphosate can be considered as one of the suspects in the CKDu in the dry zone. Water analysis is mostly carried out in laboratories which cause delays in the results due to time taken for sample collection and transport. *In situ* measuring devices could reduce the delays due to sampling transportation and analysis.

According to potable water standard SLS 614:2013 stipulated by the Sri Lanka Standards Institution, the permissible phosphate level in drinking water is 0.05 mg L⁻¹. Analytical methods used to identify the orthophosphate in this range involve separation and detection. Of the different methods available for detecting phosphate concentrations in water, such as micro-column with ammonium molybdate, liquid waveguide capillary cell with vanadomolybdate and ion chromatography, ion chromatography is widely used to detect glyphosate. However, the vanadomolybdate method is more reliable for the onsite tests than the other recommended methods.

In this study, attention was focused on designing a sensing device for automated detection of glyphosate in water. Extracted water samples were mixed with the reagent of vanadomolybdate and the color development was measured using a light source with photo detector. A reference signal was used to compare the signal emitted by the sample. Signals from the photo detectors were transmitted to the microcontroller to indicate the glyphosate concentration level to the user. The development of this device would be useful to identify the risk of consumption of water extracted from any suspected source.

Keywords: Glyphosate detection, well water



310/C

The potential of using recycled bricks as a material in sub base applications

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A significant proportion of waste materials in landfills is construction and demolition (C & D) waste material. Recycled bricks are a type of C & D waste that can be considered as a viable substitute for natural construction materials in engineering applications such as in road sub-base construction. Recycled bricks can also be a suitable alternative material in pavement applications. Typically, quarried materials are used in pavements base/sub-base layers and, at present, such materials are obtained mainly from gravel excavations. However, such resources are depleting rapidly due to increasing demand for high quality pavement materials and, as a result, replacement of traditional gravel materials with alternative materials is increasingly preferred from both environmental and economic perspectives. An investigation was thus conducted to assess the potential of using recycled bricks as a material in sub-base applications.

A series of extensive geotechnical laboratory tests was undertaken on crushed bricks blended with gravel in the varying proportions of 100%, 50%, 30% and 15%. Particle size distribution tests (Sieve analysis) were carried out for all the blends. Atterberg limit tests, Modified Proctor compaction tests and 4-day soaked CBR at 98% MDD (Modified) tests were also carried out. The geotechnical properties obtained by the tests were compared with ICTAD requirements of sub-base specifications for pavement base and sub-base applications. The results revealed that the grading of all the blends tested satisfied the grading requirement for sub-base construction as per ICTAD specifications. The addition of gravel increased the maximum dry density and the CBR value of the blends. The 100% recycled brick sample achieved a maximum dry density of 2020 kg/m³ and a CBR value of 113% and satisfied the standard requirement. In addition, the blend of 50% crushed bricks and 50% gravel also satisfied the Atterberg limit dry density (1779 kg/m³) and CBR value (32%) requirements of ICTAD standards. The findings suggest that the two blends of recycled bricks and gravel can be satisfactorily used as a pavement base or sub-base material and the usage of recycled bricks as a substitute material for gravels, either partially or fully, as a sub-base material can be recommended.

Keywords: Recycled bricks, geotechnical properties, sub base applications



311/C

Investigation of chloride ion penetration resistance of silica fume mix concrete

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Sri Lanka, being an island with well developed coastal areas, has a large number of reinforced concrete (RC) structures in the coastal zone. Chloride attack on such concrete structures has become a significant issue in the construction sector and it has become necessary to curtail the adverse effects of chloride ions which lead to corrosion of reinforcing steel and subsequent reduction in the strength, serviceability, and aesthetics of structures and finally the failure of structures. The level of chloride ion penetration is related to concrete permeability and with increasing permeability, an increase of chloride ion penetration occurs. Studies have indicated that the addition of materials such as fly ash, ground granulated blast furnace slag and silica fume in certain proportions in the mix reduces the penetrability of concrete. Hence, a possibility exists for the retardation of chloride ion penetration under such conditions. In this study, the chloride ion penetration resistance of silica fume mix concrete was examined.

The physical properties of silica fume (fineness, specific gravity and water absorption) were determined in the study. Concrete mix of Grade 25 was tested according to the BS Mix Design Method. Specimens with Ordinary Portland Cement (OPC) concrete and specimens with OPC replaced by silica fume at the levels of 5%, 10% and 15% by weight of cement were tested. Compressive strength tests (according to BS 1881-116-1983) were carried out on concrete cubes of size 150 mm x 150 mm x 150 mm. Workability was measured by the slump test, compacting factor test and VB test. Chloride Ion Penetration test was carried out according to the procedure given in ASTM C-1202. The results indicated that the workability reduces with the increase of silica fume for Grade 25 concrete. The compressive strength of silica fume mix concrete decreased with the increase of silica fume content in the concrete. However, the results of Chloride Ion Penetration test revealed that the addition of silica fume reduced the chloride ion penetration indicating a reduced level of chlorine attack in concrete.

Keywords: Chloride penetration, silica fume, concrete



312/C

Detection of artificially ripened bananas

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Bananas are a main source of vitamins and minerals among various kinds of tropical fruits. However, its consumption is becoming less due to intentional chemical usage for artificial ripening which causes serious health hazards. Ripening is normally a natural process through which the fruits gradually become sweet, colored, soft and palatable. Fruit sellers artificially ripen the fruit to meet customers' demand and to overcome transportation and distribution issues.

Ethylene is the major ripening agent produced naturally within the fruits which initiates the process of ripening. However, ethanol, methanol, ethylene glycol, ethephon and calcium carbide are used to ripen fruits artificially. The use of calcium carbide has been banned in many countries due to its high toxicity. Ethephon has been used in Sri Lanka for artificial ripening of mostly bananas, papaw and mangoes. When ethephon (2 chloroethylphosphoric acid) is used for ripening of fruits, ethylene gas is released which helps to accelerate ripening. Ethephon is hazardous and there are no reliable methods to detect such chemically treated fruits in the Sri Lankan market.

This research proposes a design of an electronic device which will automatically carry out the detection process and provide an indication of the concentration of the applied chemicals. The detection is done electronically by measuring the conductivity of the water in which the banana is rinsed. The design consists of three main units, detection unit, controller unit and power supply unit. In the testing, the banana sample is rinsed with distilled water and the conductivity of the rinsed water is measured by using a conductivity sensor. The reading is then displayed on a digital screen with the indication on the presence of chemicals to assess whether chemically treatment has been carried out. The testing process is automated by using a microcontroller.

The preliminary testing was conducted for two types of artificially ripened bananas (Ambul and Suvandel) with known ethephon solutions. Significant differences were recorded in comparison with the readings obtained for naturally ripened bananas. The detection method can also be extended to other fruits to investigate the use of ethophone or artificial ripening. It is expected that the proposed device would be useful for inspectors of food and consumer safety for detecting illegally ripened bananas without destructing of the fruit.

Keywords: Bananas, artificial ripening



313/C

Technical feasibility of operating Organic Rankine Cycle with waste heat

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Sri Lanka has to rely on thermal power generation for reliability of the national electricity grid, especially during droughts or dry seasons, due to frequently changing climatic patterns. For thermal power generation, the country is entirely dependent on imported fuels and therefore, it is vital that the thermal power plants of Sri Lanka should be operated in a cost effective manner. The exhaust gas temperatures of thermal power plants are usually in the range of 290 °C – 320 °C which indicates that a considerable amount of thermal energy is wasted without being used. This study was undertaken at a power station where a part of this energy is recovered and used to produce saturated steam using waste heat boilers, which are used for heating heavy fuel oil used for gas turbines in order to increase the efficiency. The practical limitation of recoverable heat from exhaust gasses can be determined by the sulfur dew point of the fuel which is usually 135 °C. The study was conducted with the objective of recovering the maximum possible heat from the exhaust of a diesel engine and utilizing the recovered heat to operate a power plant based on the Organic Rankine Cycle, with the working fluid being toluene, which is best suited for low temperature heat sources. The Organic Rankine Cycle was optimized using Engineering Equation Solve Software based on the constraints imposed by the sulfur dew point of the fuel and the pinch point temperature difference. The study established the parameters of the Organic Rankine Cycle as: pinch point temperature difference - 2.011 °C, turbine power - 570.6 kW, condenser pressure -0.07 bar, mass flow rate of toluene - 3.298 kg/s and thermal efficiency - 20.95% for optimum conditions.

Keywords: Organic Rankine cycle, waste heat



314/C

Sludge of water treatment works: Are disposal practices sustainable?

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Sludge of water treatment works remains an inescapable byproduct of the treatment process. Sludge, which is regarded as a waste, is in a particulate or gelatinous form consisting of varying concentrations of microorganisms, organic and suspended matter, coagulants and other chemical elements. The nature of sludge depends on the type of coagulant and other chemicals used for treatment. In a conventional water treatment plant, the main source of sludge is the clarification stage. Some additional sludge may also be generated from the settlement of filter backwash water. Direct discharge of water treatment sludge to water bodies affects water quality and aquatic biota of the receiving water body. The handling and disposal of sludge is a significant challenge for the management of a water treatment facility.

A detailed review of existing legislations demonstrates that water treatment sludge is classified as an industrial waste. Thus, the management and disposal should be carried out in compliance with the relevant environmental regulations and it will be a licensable activity in the near future according to the environmental regulations. The National Water Supply and Drainage Board (NWSDB) is the main water supplier in the country. However, inadequate attention is currently drawn for the treatment of sludge and, therefore, investigations are needed for alternative treatments, reuse techniques and disposal routes for treatment plant generated sludge. This study examined the existing sludge disposal methods of water treatment plants in Sri Lanka in order to identify cost effectiveness and conformity to environmental regulations of the management methods of sludge produced in water treatment plants of the NWSDB.

A questionnaire survey was conducted to obtain the information on characteristics, treatment and disposal of sludge from 35 water treatment plants in Sri Lanka maintained by the NWSDB. Special attention was paid to the capacity, raw water source and quality, water treatment process/method used, chemicals used in the treatment process, especially coagulation, quantity and composition of sludge produced by water treatment plants, methods of handling and treatment of sludge, ultimate sludge disposal method and beneficial uses and cost of sludge treatment and disposal, if available.

According to the results, treatment works associated with rivers or reservoirs generate a higher amount of sludge while most of them use alum as coagulant. Altogether 61 % of the treatment plants directly discharge the sludge into inland surface waters with no treatment while 36 % of the treatment plants use the sludge as fill material or for land filling. It was revealed that sludge from only one treatment plant, namely the Thirukkivil treatment plant, is used for agricultural purpose. Sludge production is an inevitable outcome of potable water treatment and it is evident from the study that sludge is mostly released into the waterways, and no sustainable practises are adopted at present. Investigations are thus needed for developing recycling techniques such as producing burnt bricks, cement blocks for sustainable reuse of sludge.

Keywords: water treatment sludge, disposal methods, sustainable practises, burnt bricks



315/C

Assessment of exposure of Sri Lanka to tsunami hazards from Sunda Trench

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Considering the geographical location of Sri Lanka and the undersea earthquake prone regions in the world, it is clear that the country is exposed to tsunamis generated along the Sunda Trench located to the East, as indicated by the Indian Ocean Tsunami (IOT) in 2004 and subsequent tsunami alerts. Due to the IOT, more than two thirds of the coastline in Sri Lanka in the northern, eastern, southern as well as relatively sheltered western areas were subjected to inundation. However, it was clear in the aftermath of the tsunami, that the degree of damage along the coastal belt was not uniform, with some areas suffering severe damage and other areas suffering a lesser extent of damage, while in certain other areas, often not far away, there was no damage at all. The level of exposure of coastal areas thus exhibited a considerable variation even along a short stretch of the coastline. In view of these circumstances, it is important to assess the risk of potential tsunamis in order to develop an effective early warning system with information related to the impacts of tsunamis. A study was thus carried out using numerical modeling techniques, taking into consideration the different stages of tsunamis due to undersea earthquakes, namely, generation, deep water propagation, shallow water transformation and inundation. The results of the study can be used to develop a database containing information that can be effectively utilized by a tsunami early warning and evacuation system for potential tsunami scenarios which could affect Sri Lanka in the future. The results include maximum wave heights with respect to locations and arrival times at selected points along the coastline for a range of potential tsunami scenarios generated along the Sunda trench.

Keywords: Sunda trench, tsunami, early warning, impact mitigation,

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316/C

Automated identification system for student assignment cover pages

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Student assignments are a major part of the teaching and learning process in most universities and higher educational institutes. Similar to the other universities, many assignments are carried out by students attached to the Open University of Sri Lanka (OUSL). However, difficulties are sometimes experienced by the students in submitting the assignments for assessment due to restrictions related to handing over during the specified period for submission.

Therefore, a study was conducted with the objective of minimizing the difficulties that occur due to the existing assignment submission and sorting processes at OUSL. The Faculty of Humanities and Social Sciences (HSS) was selected to conduct the study. At the Faculty of HSS, the students assignments are (manually) collected, student details are recorded and receipts are issued to students, which is a time consuming process that can usually be conducted during regular working hours. It has become evident that an automated cover page identification system could be effectively used to expedite the assignment submission process.

In order to introduce an automated identification system, a unique cover page is an essential requirement. The study on the automated system was focused mainly on identification of the documents which are assignment cover pages as it provided a facility for the sorting process. This process included an image processing based Optical Mark Recognition (OMR) system. In OMR technology, the sheet design is one of the most important parts of the system as the performance depends on the characteristics of the OMR sheet type. In the design process of the cover page, a standard OMR sheet design technique was used. The designed cover page consisted of cages to mark the relevant details of the assignment cover page such as student registration number and course code. In the identification process, the image extraction was done to obtain information easily using image processing techniques. For the image processing feature extraction, an open CV software was used. Before the feature extraction, the noise of the image was removed, dilated and filtered. After the feature extraction of the captured image, the algorithm to identify information included in the cover page was processed. For this purpose, blob detection was used. After detecting the boundaries of the marked positions, the proposed system detects centroids of each mark. The centroids can vary on some specific range as they are marked by users within a cage provided and the marks within such cases are to be identified.

The identified values, such as student registration number and course code are sent to a database to compare with pre-entered details of the students. If identified values match the database values, then the system will identify it as a valid assignment cover page and, if not, an error message will be displayed. For assignments identified as valid, the student will get the feedback on a receipt which is generated with the information provided by the database. It is expected that with the introduction of the automated system, many of the difficulties related to assignment submissions experienced by students will be eliminated.

Keywords: Automated identification system



317/C

An improved design of a string hopper machine to suit the local requirements

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String hoppers are a popular food in Sri Lanka and recent trends indicate a significant increase in the demand for string hoppers from food outlets. Catering for such high demands using the traditional hand press has become a tedious process and a strong need exists for mechanized or automated string hopper preparation mechanisms/machines. In Sri Lanka, string hoppers are prepared using the traditional string hopper presses or with modern hand operated lever type presses which are tedious and time consuming processes. However, there are several types of mechanized string hopper machines also available in Sri Lanka. One such type is a rotary type machine which has a piston connected to a rack having the capacity to produce around 100 string hoppers at a stretch. The main disadvantage of this machine is that the cylinder needs to be removed after each batch of string hoppers for re-filling, which tends to fatigue the operator with prolonged usage. There are many power operated machines used for the preparation of string hoppers and these are mainly manufactured in India. These machines mainly employ compressed air for actuation. The disadvantages of these types of machines are that the string hoppers produced can be irregular in shape and the need for separate equipment for supply of compressed air which makes the machines relatively expensive. The re-design of a string hopper machine was thus carried out, taking into consideration the deficiencies identified in machines currently used and the affordability to a medium scale string hopper producer. A string hopper machine which is electrically powered and having a piston-cylinder type feeding mechanism was proposed and designed, also overcoming the need of bulky additional equipment such as air compressors. A 5 cm extruding die, a mold rotator and a cutting mechanism were incorporated in the design to make the spread of string hoppers more uniform. Also, the machine can be manufactured using locally available materials, making it more affordable than its counterparts, especially for medium scale string hopper producers in Sri Lanka.

Keywords: String hopper machine, improved design



318/C

Enhancing academia–industry linkage through liaison centers

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There is a strong linkage between the academia and the industry in developed countries. Research activities conducted by the lecturers in academia make them different to teachers and the research outcomes implemented in the industry will lead to benefits to society. The industry produces goods and services with the prime objective of maximizing individual profit but it also provides benefits to the society and enriches lives of the public.

The main output of a university is the intellectual labour and but once a graduate engages in work, there is a tendency to lose the linkage with the academia. It could result in fading out their professional development. On the other hand, although the universities continue research, it may be difficult to find a proper partner to implement the research findings in the industry or to provide financial support. Ultimately, development of the industry may not reach full potential and slow down the progress of the economy of the country. However, there are socio-cultural reasons hindering development of a strong linkage between the academia and industry as observed in the recent past and it is evident that there is a necessity for both parties to work together.

In view of these circumstances, a qualitative research study was conducted to obtain the views of stakeholders to assess the current academic-industry linkage. In the study, a survey was conducted with semi structured open ended questions as it is required to give the freedom for both academia and industrialists to express their views without framing them to a set of specific questions. As a case study, direct interviews with the lecturers from the Faculty of Engineering Technology were conducted and their responses were recorded and verified. Senior Managers from the Industry were also contacted and their views were obtained. The study focused on four key characteristics of a relationship shown in literature such as vision, trust, benefit and attitude. Based on Content Theory and Thematic Analysis, the intricacies of meaning within these characteristics were captured. Narrative summary for each characteristic based on details provided by the respondents was tabulated.

The results of the study revealed that it is hard for a one to one direct interaction of industry and academia to exist and as such it is recommended that a unit is established in the industry to liaise with a similar unit set up in the academia to strengthen the linkage. The two units should possess the same work culture and work towards synchronization to generate a synergic effect. It is a coherent interface for like-minds to comfortably work on a shared vision with trust for mutual benefit.

Keywords: Academia–industry linkage



Section D

401/D

Comparison of the efficiency of different Genomic DNA extraction methods for selected rice varieties of Sri Lanka

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Rice is a staple food for people of many Asian countries. The rice genome is already mapped and characterized, and it is the smallest of the major cereal crop genomes. DNA extraction is a very important step nowadays in the genomic studies of rice. An efficient, unique and less time consuming DNA extraction protocol is needed for the molecular level study of most rice varieties. Extracted DNA should be very pure and of high quality too. Therefore, this study was targeted to compare the efficiencies of various DNA extraction techniques available to isolate DNA from selected rice varieties in Sri Lanka. The DNA extraction methods developed by Bousquet *et al.*, Cheng *et al.*, Doyle *et al.*, and Michiels *et al.* were applied to five different local rice varieties, grown in different parts of Sri Lanka, namely, Moodaikaaruppan, H4, Periyavellai, 500-1 and IR8. Based on the quantity and quality of the extracted DNA, tested by measuring the absorbance of DNA at 260 nm using a Nanodrop® ND-1000 spectrophotometer and measuring the ratio of A260 / A280 and electrophoresis on an agarose gel, the efficiency of the extraction method chosen varied among these selected five rice varieties. Among the methods used, the method introduced by Cheng *et al.*, yielded an acceptable quality of amplifiable DNA with satisfactory concentrations for all the selected five Sri Lankan rice varieties.

Keywords: DNA extraction, rice varieties, gel electrophoresis



402/D

**Anti-cholinesterase activity of bark and leaf extracts of Ceylon cinnamon
(*Cinnamomum zeylanicum* Blume) *in vitro***

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Ceylon cinnamon (CC) (*Cinnamomum zeylanicum* Blume) known as 'true cinnamon' in the world has been used as a spice in Sri Lanka for centuries. Although cinnamon bark is reported to have many biological activities, its anti-cholinesterase activity is less investigated worldwide. Further, anti-cholinesterase activity of leaf of CC is not reported to date. The present study therefore, evaluates the anti-cholinesterase activity of bark and leaf of Ceylon cinnamon *in vitro*.

Freeze dried 95 % ethanolic and 1:1 (v/v) dichloromethane: methanol (DCM:M) extracts of mature bark and leaf of authenticated CC were used in this study. Anti-cholinesterase activity was evaluated using acetylcholine esterase (AChE: 50, 100, 200, 400, 800 µg/ml; n = 4) and butyrylcholine esterase (BChE: bark 6.25, 12.5, 25, 50, 100 µg/ml; n = 4; BChE: leaf 25, 50, 100, 200, 400 µg/ml; n = 4) enzyme inhibitory assays described by Elman *et al*, 1970 with some modifications in 96-well micro plates *in vitro*. Galantamine was used as the reference drug (AChE: 0.39, 0.78, 1.56, 3.12, 6.25, 25 µg/ml; n = 4; BChE: 12.5, 25, 50, 100, 200 µg/ml; n = 4).

Both bark and leaf extracts of CC showed dose dependant AChE and BChE inhibitory activity. However, BChE inhibitory activity is significantly high ($p < 0.05$) compared to AChE inhibitory activity both in bark and leaf extracts. The IC_{50} values of ethanol and DCM:M bark extracts for BChE inhibitory activity were 36.09 ± 0.83 and 26.62 ± 1.66 µg/ml respectively and it is significantly high ($p < 0.05$) compared to the reference drug galantamine (74.80 ± 3.53 µg/ml). The IC_{50} values of ethanol and DCM:M leaf extracts for BChE inhibitory activity were 340.60 ± 18.23 and 261.96 ± 11.56 µg/ml respectively. Both ethanolic and DCM:M extracts of bark and leaf demonstrated significantly low ($p < 0.05$) AChE inhibition compared to the reference drug galantamine (IC_{50} : ethanol bark: 804.88 ± 48.69 ; DCM:M bark: 966.68 ± 63.18 ; ethanol leaf: 810.96 ± 79.98 ; DCM:M leaf: 879.35 ± 68.00 ; galantamine : 2.52 ± 0.17 µg/ml respectively).

It is concluded that both bark and leaf of CC possess AChE and BChE inhibitory activity and BChE inhibitory activity is more prominent compared to AChE inhibitory activity. Further, anti-cholinesterase activity of bark is high compared to leaf. Properties observed indicate the possibility of using CC in functional foods for prevention and dietary management of Alzheimer's disease. Interestingly, this is the first study to report anti-cholinesterase activity of leaf of any cinnamon species worldwide.

Keywords: Ceylon cinnamon, anti-cholinesterase activity, bark and leaf extracts



403/D

Bioremediation potential by probable 'nitrogen-fixing' actinobacteria residing in the root nodules of *Casuarina equisetifolia* for cadmium removal under *in vitro* conditions

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Frankia and many of the nitrogen fixers found in the nodules of the Casuarinaceae lineage, belong to actinobacteria, which are largely a group of aerobic, filamentous, gram-positive bacteria which harbor high G+C content in their respective genomes. Actinobacteria have been earmarked for their bioremediation potential and have been identified as strong candidates superior to fungi and gram-negative bacteria in their capacity to remediate polluted environments. It is important to ascertain the contribution of actinobacteria in sites of environmental pollution, namely areas of heavy metal contamination such as agricultural land with strong fertilizer usage, industrial effluents and waste disposal sites. The potential role of *Frankia* and auxiliary actinobacteria colonizing actinorhizal plants, in bioremediation, is largely unknown, with the exception of a few of studies.

A study was carried out, to assess the cadmium tolerance of *Frankia* and co-colonizing actinobacteria inhabiting root nodules of the actinorhizal tree *Casuarina equisetifolia*. The actinobacteria, *Frankia*, *Micromonospora* and *Streptomyces*, were isolated from root nodules of *Casuarina* plants and identified preliminary by colony and mycelial morphology. It is of significance that this is the first reported isolation of *Streptomyces* from *Casuarina equisetifolia*. Furthermore, the actinobacteria were able to grow on N-free media, signifying that all three actinobacteria were likely nitrogen fixers. The isolated actinobacteria were demonstrated to possess cadmium lowering capacities of up to 10 mg/l. It appears that actinobacteria from root nodules of *Casuarina equisetifolia* are diazotrophs with capabilities to lower cadmium from an external medium. A comprehensive molecular characterization of the three diazotrophs using *nif*, 16s rDNA and *glutamine synthetase* gene sequences is being carried out at present.



404/D

Hypoglycaemic effect of aqueous leaf extract of *Passiflora suberosa* L. in normal mice: possible mechanisms of action

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Aqueous Leaf Extract (ALE) of *Passiflora suberosa* (wild passion fruit/ indigo berry) was recently identified to significantly ($p < 0.01$) decrease blood glucose levels at 1st (10%), 3rd (20%) and 5th (24%) hours post treatment with a single dose (50 mg/kg). Therefore, in the present study the mechanism of action of the hypoglycaemic effect of ALE of *P. suberosa* was investigated in normal male mice (ethical clearance no: 25/14). Distilled water (control) or ALE of 50 mg/kg was orally administered to normal mice (n=9/group) for 30 consecutive days. To determine mechanisms of action; glucose absorption from the mice intestine, glycogen content in liver and skeletal muscles, glucose uptake by diaphragm and beta cell proliferation in islets of Langerhans were determined on day 31. Further, the lipid profile and toxicity effects of ALE were determined. The treatment produced a significant ($p < 0.05$) reduction in glucose absorption (by 79%: compared to control) from the intestinal lumen. Further, the chronic administration of ALE significantly ($p < 0.05$) increased the glycogen content in the liver (by 61%) and skeletal muscles (by 57%), and it did not increase the glucose uptake by diaphragm or beta cell proliferation in islets of Langerhans. The decreased cholesterol levels (by 18%), additionally contributes to its use as an antidiabetic agent in hyperglycaemic conditions. Furthermore, ALE did not induce any overt toxic signs, renotoxicity (pathology) or hepatotoxicity (ALT and histopathology) in normal mice. Present findings suggest that *P. suberosa* may exert its blood glucose lowering ability presumably through enhanced transport of blood glucose to peripheral tissues or by inhibition of intestinal glucose absorption or by both.

Keywords: Aqueous leaf extract, mechanisms of action, *Passiflora suberosa* L.



405/D

DNA barcoding of Sri Lankan Anopheline mosquitoes reveals its usefulness in identifying sibling species

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“DNA barcoding” is a powerful tool for species identification and used in studying evolutionary relationships among species. The objective of this study was to characterize *Cytochrome c Oxidase subunit I* (*COI*) and Internal Transcribed Spacer 2 (*ITS2*) sequences of morphologically identified *Anopheles* species collected from two different areas in Sri Lanka and to distinguish sibling species using DNA barcodes.

Anopheles peditaneatus, *An. nigerrimus*, *An. jamseii*, *An. tessellatus*, *An. annularis*, *An. pallidus*, *An. barbirostris*, *An. vagus*, *An. subpictus*, *An. culicifacies* and *An. varuna* were collected from Jaffna in the Northern (N) Province and Wariyapola in the North Western (NW) Province. *COI* sequences (52) of 3,3,7,1,2,6,1,6,8,8, and 6 and, *ITS2* sequences (21) 4,3,6,0, 1,5,0,2,0,0,0 were respectively generated from the PCR positive samples of DNA extracted from the above species (10 individuals from each species). The *COI* sequences showed high genetic variation compared to that of *ITS2*. Two of the morphologically identified *An. peditaneatus* specimens had sequences similar to that of *An. nigerrimus* which show high resemblance in morphological features to *An. peditaneatus*. Based on *COI* sequences, *An. subpictus* samples from N Province were identified as *An. subpictus* B and samples of *An. subpictus* from NW Province had sequences similar to sibling species A. Analysis of *COI* and *ITS2* sequences confirmed the presence of *An. annularis* sibling species A in the N Province. *An. barbirostris* sequence obtained from the N Province was different from the previously described sequences of *An. barbirostris* complex suggesting the existence of a different molecular type. Sequences of morphologically identified other anopheline species confirmed their identity with GenBank entries from South and Southeast Asian countries. However cytologically identified sibling species B and E of *An. culicifacies* could not be separated using *COI* and *ITS2* markers. The present study indicates that DNA barcoding is useful in identifying sibling species and proves that Sri Lankan *Anopheles* species have a close evolutionary relationship with the South and Southeast Asian counterparts.

Keywords: *Anopheles*, *COI*, DNA barcoding, *ITS2*, Sri Lanka

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406/D

Sympatric gene clusters in microsatellite marker depicted population genetic structure of *Anopheles culicifacies* s.l. (Diptera: Culicidae) sibling species E in Sri Lanka

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The understanding of the vector population genetic structure is important in malaria vector control and prevention of re-occurrence programs. However, the genetic structure of the major malaria vector mosquito, *Anopheles culicifacies* in Sri Lanka has not been investigated yet. Therefore, this study was carried out to understand the population genetic structure of the malaria vector *An. culicifacies* sibling species E in Sri Lanka. Cytogenetically identified mosquitoes collected from six different localities during 2010-2012 were genotyped using eight microsatellite markers developed for sibling species A in the complex and tested for the Hardy-Weinberg equilibrium, linkage disequilibrium, isolation by distance and Bayesian clustering algorithm. Six microsatellite loci were highly polymorphic across localities with high allelic richness (1.000-10.432). Five localities deviated from Hardy Weinberg equilibrium ($P < 0.006$) with heterozygosity deficits after the Bonferroni correction. Genetic differentiation in population pairs ($F_{st} : 0.03331 - 0.23184$) was not supported by the isolation by distance model ($r^2 = 0.3057$, $p = 0.0180$). Bayesian clustering analysis identified the presence of three gene clusters in the population studied. Percentage of individuals of each cluster was varied in six localities. Isolation by distance was not detected in any pair of cluster. Possible barriers to the gene flow in the topography of Sri Lanka were not recognized, suggesting that the force to gene clustering in the population could be due to ecological and microhabitat conditions of the localities. The sympatric occurrence of all three gene clusters was observed and it supports the fact that differentiation of clusters has taken place over a long time and the variation in percentages of individuals in each cluster could be due to the ecological variations in sampling localities.

Keywords: *Anopheles culicifacies*, gene clusters, microsatellite markers, population genetic structure

Acknowledgement: National Research Council grant (09-21).



407/D

Isolation and characterization of *Rhodomicrobium vannielii* from Winogradsky column

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Purple non-sulfur bacteria (PNSB) are a group of Gram-negative anoxyphototrophic bacteria. This group is recognized by its capability of growing in diverse environments, physiological versatility and ecological importance as active participants in the carbon, nitrogen and sulfur cycles. They draw interest because of their wide range of growth modes which include photoautotrophic, photoheterotrophic and chemoheterotrophic modes. With these characters, PNSB have potential applications in bioremediation and anaerobic treatment in waste treatment processes. PNSB are pigmented with bacteriochlorophyll-*a* and carotenoids. The characteristic salmon pink to red color of the PNSB is due to the Spirilloxanthin series of rhodopsin as the major carotenoid and small amounts of Beta carotene. Absorption spectra of PNSB have maxima at 378, 461, 488-490, 522-525, 800-807 and 869-872nm.

The present study was aimed at isolation of PNSB from the Winogradsky column and identifying them using morphological, cultural and biochemical methods. The Winogradsky column is a model environment which develops highly diverse groups of microorganisms, usually in stratification, and it was used in this study for easy isolation of PNSB from samples of mud.

A Purple non sulfur bacterium was isolated using Glutamate-malate selective medium and identified as *Rhodomicrobium vannielii* according to the characters described in the Bergey's manual of systematic bacteriology; Volume 3 (Staley et al, 1989). The cells were motile, Gram negative, ovoid to spherical in shape and did not form intracellular sulfur globules. When incubated anaerobically under light, the isolate produced a red pigment. Spectral analysis for chlorophyll and carotenoids was done using a spectrophotometer and Thin Layer Chromatography (TLC). The presence of bacteriochlorophyll-*a* and carotenoids was indicated by the presence of a majority of peak maxima at 363, 476, 774 nm. There were two spots in the TLC of which the R_f values were 0.40 and 0.85, which indicated the presence of chlorophylls and carotenoids.

Keywords: Winogradsky column, *Rhodomicrobium vannielii*, anoxyphototrophic bacteria



408/D

Pathogenic *Leptospira* spp induce higher superoxide anion production by HL 60-derived neutrophils

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The superoxide anion (O_2^-) is the first free radical produced in phagocytes which enables pathogen killing and also generates other microbicidal reactive oxygen species (ROS). The induction of high O_2^- production by phagocytes as a virulence factor for pathogenic *Leptospira* is not known. The objective of this study was to assess the induced O_2^- production by human neutrophils exposed *Leptospira* and compare the differences in the level of O_2^- produced by HL-60 derived neutrophils interacted with pathogenic and saprophytic *Leptospira* spp. HL-60 cells were treated with dimethyl sulfoxide to differentiate in to mature neutrophils. Saprophytic *Leptospira biflexa* serovar Patoc and pathogenic *L. Interrogans* serovar Pyrogenes were grown in Ellinghausen-McCullough-Johnson-Harris media containing 10% heat inactivated rabbit sera. Intracellular O_2^- production of neutrophils interacted with bacteria in the presence of sera from leptospirosis patients (n=30/group of severe and mild leptospirosis patients) and healthy subjects (n=20) was assessed using quantitative nitroblue tetrazolium assay. Both anti-leptospiral IgM and IgG levels were measured in test sera prior to the assay. In the presence of normal and also patients' sera, neutrophils interacted with *L. Interrogans* Pyrogenes produced significantly high O_2^- levels than that of *L. biflexa* (p<0.05). When *Leptospira* density was varied for neutrophil-bacteria interactions, low *Leptospira* densities induced higher O_2^- productions compared to the high concentrations (p<0.03). Moreover, analysis of O_2^- production by neutrophils in the presence of patients' sera showed that, opsonization of both saprophytic and pathogenic *Leptospira* by IgM or IgG had not induced a significant difference in the level of O_2^- produced (p = 0.012). These results suggest that, the increased O_2^- production induced by *L. Interrogans* Pyrogenes could be a virulent factor in pathogenic *Leptospira* spp which may contribute to the pathogenesis of severe leptospirosis.

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409/ D

Use of Cytochrome *b* Oxidase as molecular evidence in delineation of *Anopheles subpictus* (Diptera: Culicidae) species complex in Sri Lanka

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Anopheles subpictus is an important secondary vector of malaria in Sri Lanka which was recently identified to be a species complex of two sibling species, *An. subpictus* A and B based on Internal Transcribed Spacer 2 (ITS2) and Cytochrome *c* Oxidase I (*COI*) sequence data. The present study was conducted to check the usefulness of the mitochondrial gene Cytochrome *b* Oxidase (*Cyt b*) to discriminate *An. subpictus* s.l. in the island. *Cyt b* is typically used for species identifications but it has never been explored on *An. subpictus* species complex in Sri Lanka. Wild caught mosquitoes were morphologically confirmed for *An. subpictus* using standard taxonomic keys. A number of thirty mosquito specimens were used for the molecular analysis. Approximately 460 bp sized region of *Cyt b* gene was amplified, sequenced and analysed. The resulting sequences belonged to ten *Cyt b* gene haplotypes and were deposited in GenBank, under accession numbers KT285491-KT285500. Phylogeny constructions of the mosquitoes were estimated using PhyML v3.1 and MrBayes v3.2.2 software. Phylogenetic relationships inferred from Maximum Likelihood and Bayesian analyses revealed that the study generated sequences come under two clades and they were in fact the species A clade and species B clade which was consistent with the current sibling species designation of *An. subpictus* A and B in Sri Lanka. Therefore, as the present phylogenetic analysis is in agreement with prior taxonomic work of *COI*, *Cyt b* can be considered to be a good phylogenetic marker to discriminate the *An. subpictus* species complex in Sri Lanka as species A or species B.

Keywords: *Anopheles subpictus*, sibling species, Cytochrome *b* Oxidase

Acknowledgement: Grant ASP/RE/06/2010/018 of University of Sri Jayewardenepura and NRC research grant: 09-21.



410/D

Use of *white* gene sequences to further diversify the *Anopheles subpictus* (Diptera: Culicidae) species complex in Sri Lanka

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Vector control is an essential component in elimination of malaria in Sri Lanka in which the proper identification of vector mosquitoes from non-vector mosquitoes is insisted. *Anopheles subpictus*, an important secondary vector of malaria in Sri Lanka, was recently identified as a species complex of two sibling species, *An. subpictus* A and B. The objective of this study was to further investigate and confirm the status of *An. subpictus* species complex in Sri Lanka based on *white* gene sequences. This single copy nuclear gene *white* is used in systematics studies in constructing phylogenetic relationships at species level. This study reports sequence comparisons of the *white* gene in *An. subpictus* in Sri Lanka for the first time. Adult F₁ mosquitoes of *An. subpictus* from different isofemale progenies belonging to five different localities in the island were used as specimens (n=30). A partial region of *white* gene was PCR amplified and sequenced. There were fourteen haplotypes of *white* gene which were submitted to GenBank under accession numbers, KP733780-KP733793. Phylogenetic relationships among the mosquitoes were estimated using PhyML v3.1 and MrBayes v3.2.2 software. The Maximum Likelihood and Bayesian analyses revealed similar tree topologies with two distinct, strongly supported, monophyletic clades which were consistent with previous studies, as Species A clade and Species B clade. However, this putatively conserved single copy nuclear DNA marker *white*, reliably indicated additional polymorphism in terms of further clustering of the two main clades. In this context, bayesian inference gave more robust support on these sub clades with all posterior probabilities exceeding 0.78. Present investigations on *An. subpictus* species complex in Sri Lanka confirm the presence of two distinct sibling species A and B based on *white* gene sequences. Furthermore, the *white* gene phylogeny together with the fourteen *white* single copy nuclear gene haplotypes unravels clues of a hidden diversity that may exist in the species complex. In conclusion, molecular evidence from this study indicates the likelihood of the presence of a yet undiscovered sibling species for *An. subpictus* s.l. in Sri Lanka.

Keywords: *Anopheles subpictus*, sibling species, *white* gene

Acknowledgement: Grant ASP/06/RE/2010/018 from the University of Sri Jayewardenepura and NRC research grant 09-21.



411/D

Molecular identification of root knot nematodes (*Meloidogyne* species) in Sri Lanka

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Root-knot nematodes (RKNs) from the genus *Meloidogyne* are major obligate endoparasitic pathogens of a multitude of economically important host plants worldwide. Correct identification of RKN species is becoming increasingly important for the design of effective nematode management practices. To our knowledge there were no literature records about molecular identification of RKNs in Sri Lanka. The main objective of this study was to develop a fast, accurate and sensitive Polymerase Chain Reaction (PCR) based molecular assay to accurately identify RKNs parasitizing important vegetable and fruit crops in Sri Lanka. Root knot nematode infected root samples were collected from 4 different localities in Sri Lanka during the years 2013-2014 and labeled as 1- Horana/Tomato, 2- Horana/Spinach, 3-Anuradhapura/Guava, 4-Kalpitiya/Tomato, 5-Colombo/Cherry Tomato, 6- Kalptiya/ Guava. DNA extracted from juvenile stages of *Meloidogyne* was used in PCR. Amplification of ribosomal DNA with MF/MR universal primers yielded a 500 bp fragment specific for genus *Meloidogyne* for samples belonging to all localities. The sequence of 500 bp PCR product was found to be 100 % identical to the most common *Meloidogyne* species available in Genbank. C2F3/1108 primers that result in species-specific PCR products based on size were used to identify and differentiate infected *Meloidogyne* species in the collected samples. Amplification of mitochondrial DNA with C₂F₃/1108 primers yielded an 1100 bp product specific for *M. arenaria* for only sample 1, a 705 bp size products specific for *M. enterolobii* for sample 1, 3 and 6, a 520 bp products specific for *M. chitwoodi* or *M. hapla* for sample 2, 4, 5 and 6. Sample 2, 4, 5 and 6 were further analyzed with 194/195 primers and the exact RKN infected was identified as *M. hapla* by the amplification of specific ~ 700 bp size PCR product. This study demonstrated the occurrence of *Meloidogyne* species in Sri Lanka either alone or in mixed populations. Even though the species *M. arenaria*, *M. incognita*, *M. javanica*, and *M. hapla* are generally considered the most widespread, *M. enterolobii* and *M. hapla* were found to be more widely distributed in the studied areas of Sri Lanka. The protocols optimized in this study would be useful in the future to analyze RKN infected samples collected across Sri Lanka to evaluate the prevalence, incidence and diversity of RKNs more comprehensively.



412/D

Analysis of helices of the ITS2 secondary structures of *Anopheles culicifacies* sibling species complex

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Anopheles culicifacies Giles s.l., the primary vector of malaria in Sri Lanka comprises a complex of five sibling species as A,B,C,D and E. Among them only sibling species B and E are found in Sri Lanka. Sibling species of the complex are morphologically identical and varies in vectorial capacity. Molecular characterization of the vector species is important in malaria control programs. Thus, in this study, secondary structures of Internal Transcribed Spacer 2 (ITS2) region of rDNA of the five sibling species were analyzed and further compared with the universal eukaryotic secondary structure. To obtain an in depth understanding of secondary structures different types of loops were examined. Genomic DNA of *An. culicifacies* sibling species B and E collected from six different locations in Sri Lanka were amplified for ITS2 region and sequenced. NCBI GenBank deposited ITS2 sequences of sibling species of *An. culicifacies* were retrieved for comparison. The length of the ITS2 region was 370 bp for A and D sibling species whereas this was 372 bp for B, C and E sibling species. Secondary structure analysis showed that all the sibling species possessed three helices as Helix I, Helix II and Helix III. Pyrimidine-pyrimidine mismatch in Helix II and a UUUGG motif at 5' of Helix III were displayed by sibling species B, C and E while these characters were absent in sibling species A and D. However, all five sibling species displayed a CGGC motif at 5' of Helix III. Five different types of loops were observed in all five sibling species. Out of five types of loops, interior and exterior loops were found to be more conserved than multibranching, hairpin and bulge loops. Bulge loops were highest in number. This study concluded that the secondary structures of ITS2 regions are highly conserved in the complex despite the vectorial capacity or geographical locations.

Keywords: *Anopheles culicifacies*, ITS2, sibling species, secondary structures

Acknowledgement: National Research Council grant (09-21)



413/D

A preliminary study on application of phage-indicator model in evaluation of antiviral drugs.

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Due to newly emerging viral diseases and the building of rapid resistance among targeted viruses, the continuous search for useful and novel antiviral compounds has become important. Hence, a study was carried to develop a method for the preliminary screening of antiviral drugs and identification of their targeted stage of the viral replication cycle.

A model system of bacteriophage and susceptible *Escherichia coli*, isolated together from a sewage effluent was used for the screening process. Two plant extracts, each from *Carica papaya* leaves and *Psidium guajava* leaves and two plant based products each "Sudarshana Churnaya", an aurvedic drug and black tea produced from *Camellia sinensis* leaves were screened using two approaches developed based on plaque reduction assay to detect their effect on different stages of the phage replication cycle. In the first approach, the purified virus suspensions pre-incubated with filter sterilized herbal extracts were used to detect the antiviral effects of herbal extracts on adsorption and penetration steps. For the second approach, the host bacterium pre-incubated in filter sterilized herbal extracts were used as the indicator host to detect the effects of herbal extracts on intracellular replication steps of the virus replication cycle.

Screening revealed that black tea has the ability to inhibit viral propagation by preventing phage attachment to their host and *Carica papaya* leaf extract showed an ability to inhibit intracellular stage(s) of the bacteriophage's replicative cycle. The study provides evidence for the availability of antiviral compounds in plant extracts and plant based products which are used in routine life and traditional healing methods. The results also indicate that different herbal extracts apply different modes of action to prevent the propagation of the targeted virus.

Keywords: Antiviral drugs, bacteriophages, phage replication, plaque reduction assay



414/D

Antibacterial activity of endophytic fungi isolated from two *Cyperus* species, *C. bulbosus* and *C. alternifolius*

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Endophytic fungi isolated from Cyperaceae family plants are known to assist the host against biotic stresses including microbial attacks. Accordingly, endophytic fungi of *Cyperus* species are a judicious target for investigating their ability to produce antimicrobial agents. The current study was designed to isolate the endophytic fungi of two *Cyperus* species and evaluate their antibacterial producing potential. For the isolation of endophytic fungi, the leaves and roots of two healthy plants, *C. bulbosus* and *C. alternifolius*, were surface sterilized using standard procedure and the plant materials were next cut into small segments and were placed on five types of media, potato dextrose agar (PDA), malt agar extract (ME), malt peptone dextrose agar extract (MEA), starch yeast peptone agar extract (SYP) and yeast peptone dextrose agar extract (YPD). Fungi emerging from the host tissues were transferred onto new PDA dishes and sub culturing was done until pure cultures were obtained. After incubating for 2-3 weeks each fungal culture was extracted with ethyl acetate and the extracts were tested against *Staphylococcus aureus*, *Bacillus cereus*, *Pseudomonas aeruginosa*, *Escherichia coli* and *Salmonella enterica* at 400, 200, 100 µg/disc using agar disc diffusion assay.

Eleven and ten endophytic fungi were isolated from *C. bulbosus* and *C. alternifolius* respectively. Nine endophytes were isolated using YPD medium while five, four, three and two endophytic fungi were isolated from PDA, SYP, MEA and ME media respectively. At 400 µg/disc concentration, of the isolated endophytic fungi, nine from *C. bulbosus* and eight from *C. alternifolius* inhibited at least one bacterium tested. At this concentration, three extracts (02 from *C. alternifolius* and 01 from *C. bulbosus*) were active to both Gram positive and Gram negative bacteria. Furthermore, 11 and 10 endophytic fungal extracts showed activity against Gram positive *S. aureus* and *B. cereus* while 09, 05 and 06 showed activity against *P. aeruginosa*, *E. coli* and *S. enterica* respectively. At 200 and 100 µg/disc concentrations, eight endophytic fungal extracts were active for the tested pathogens. This screening revealed that *Cyperus* spp. are hosts to a number of endophytic fungi producing antimicrobial agents and that further research may result in potential antimicrobial drug leads.

Keywords: Endophytic fungi, *Cyperus*, antibacterial



415/D

Preliminary survey of nesting birds in the islands of Kalpitiya lagoon

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With the development activities planned for the Kalpitiya peninsula, the ecology of the islands in the lagoon is being threatened. Presently these islands are covered with several vegetation types including mangroves, grasslands, bushes and some large trees and are inhabited by many species of birds. They provide ideal nesting and roosting grounds for the birds as the predation pressure is minimal.

A preliminary survey was carried out in the islands of Kalpitiya to determine the importance of these islands for breeding birds. Six islands in the lagoon containing different habitat types were selected for the study. Quadrant sampling was carried out using 100 m² quadrates and active nests, nest building and recently abandoned nests were counted. The species utilizing the islands for nesting were mainly *Phalacrocorax*, *Ardea* sp., *Butorides striata*, *Bubulcus* sp., *Egretta* sp., *Corvus* sp., *Pycnonotus* sp., *Pomatostomus* sp., *Turdoides* sp., *Leptocoma* sp., *Cinnyris* sp., *Vanellus indicus*, *Amaurornis phoenicurus*, *Haliastur indus*, *Haliaeetus leucogaster* and grassland birds such as *Cisticola juncidis*. Two islands containing tall trees were utilized by *Psitta culakrameri* and *Megalaima* sp., for nesting. Maximum number of nests observed within a 100 m² quadrat was 26 while the minimum number was 3. Highest nest diversity was observed in islands with habitats diversity, and undisturbed by human activities. Islands visited by fisher folk contained less breeding sites and the maximum number of nests observed within a 100 m² area was 6. Highest number of nests recorded belonged to egrets, crows and cormorants. However it was noted that the islands were visited by many species of birds during the day for feeding and resting, and for roosting during evenings.

The survey concluded that the islands in the Kalpitiya lagoon provided safe and good breeding habitats for birds due to security with low predator pressure and availability of nesting sites as well as space. High food availability close to the breeding sites was also an advantage. Therefore, altering the vegetation structure and ecology of the islands for development activities would affect many bird species, specially cormorants, egrets and herons and may have a severe impact on their populations. Further studies are recommended to assess the anthropogenic impacts on avian diversity in the islands of Kalpitiya peninsula.

Keywords: Avifauna diversity, breeding bird survey, Bar reef sanctuary avifauna, island biodiversity, Kalpitiya biodiversity.

Acknowledgement: The Bar reef area management study under the BOBLEME project



416/D

Impact of one month old sludge as top inoculum layer on biogas flow rate in dry batch type digesters

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The dry batch digesters established at Dickovita biogas plant in Wattala, Sri Lanka, treat pre-sorted Municipal Solid Waste (MSW) anaerobically to recover both energy and material in an environmentally friendly manner. Efficient biogas production has been achieved by the plant by adding three cow dung (inoculum) layers. Since a continuous supply of cow dung is not available, switching to an alternative inoculum source is a priority requirement for the continuation of the process. Hence, a laboratory scale study was planned to determine the impact of replacing the top cow dung layer by previously produced one month old sludge by the plant, on biogas flow rate. Dry batch type digesters designate treatment 1, 2 and control were set up using empty 20 L bottles, each consisting of 3 replicates. The experimental setup was comparable to the field operations conducted at the Dickovita biogas plant. The contents in each digester from bottom to top were bottom inoculum layer, first organic waste layer, middle inoculum layer, second organic waste layer and top inoculum layer respectively and the volume of water in each digester was 50% of the volume of the digester. The top inoculum layer of treatment 1, 2 and control consisted of cow dung, previously produced one month old sludge and organic waste respectively. Daily biogas flow rate, sludge temperature, sludge pH and internal and external air temperatures were recorded. The significant highest and lowest bio gas flow rates were recorded from treatment-2 and control respectively on day 04. One way ANOVA followed by Tukeys pair wise comparison tests confirmed that there were no significant differences ($P \geq 0.05$) between the mean biogas flow rates generated from treatment-1 and treatment-2. The mean internal air temperature and the mean internal sludge temperature of digesters varied between 28.2 °C – 33.9 °C and 27.1 °C – 31.2 °C respectively. Hence, the digesters showed a mesophilic type digestion. The study recommends that the previously produced one month old sludge by the plant could be used as the top inoculum layer to produce biogas without having an adverse impact on biogas flow rate, under mesophilic conditions. Keywords: Biogas, cow dung, dry batch type digesters, inoculum layer, sludge



417/D

Efficacy of different leaf formulations from five medicinal plants against rice weevil, *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae)

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Rice weevil, *Sitophilus oryzae* (L.) is one of the major pests of rice both in the field after harvest and during storage. Previous studies have revealed that plants are a potentially rich source of pesticides. Therefore, the present study was designed to evaluate the repellent activity of selected medicinal plants, *Acalypha indica*, *Murraya koenigii*, *Juticia gendarussa*, *Pongamia sp.* and *Piper longam* against rice weevil, *Sitophilus sp.* Repellent activity of leaf powder (1:10 w/w) and leaf paste (1:4 w/w) from these five plants were tested using a six- armed olfactometer based on the number of insects oriented towards each treatment.

Ten grams of infestation free rice grains were mixed with the leaf powder (1 g) from the selected plants and placed on a filter paper (2 inch diameter) and kept separately within each bottle (250 ml) of the six-armed olfactometer. The sixth bottle contained 1 g of untreated sound rice as the control. One hundred 1-3 day old adult *Sitophilus sp.* from the laboratory culture were introduced into the centre bottle of the six-armed olfactometer. The number of insects in each bottle was counted at 24 hrs and 48 hrs of exposure. This was replicated five times. Similarly 1:4 (w/w) fresh leaf paste from the above said plants were prepared and placed in each bottle of the olfactometer. Data were analyzed by using analysis of variance and LSD. The percentage repellency was compared with the control. Orientation of *Sitophilus sp.* towards leaf powder and leaf paste from all tested plants was significantly less in numbers ($P < 0.05$) than the untreated control after 24 hrs and 48 hrs of exposure. From the LSD analysis, the leaf paste of *P. longam* showed less repellent effect than the other plants tested. However, leaf powder of *M. koenigii*, *J. gendarussa* and *P. longam* showed high repellent activity followed by *A. indica* and *Pongamia sp.* After 48 hrs of exposure percentage repellency ranged from 44 % to 92 % for leaf powder but for leaf paste it ranged from 66 to 89 %. It was concluded that the leaf powder of *M. koenigii*, *J.gendarussa*, *P.longam*, *A. indica* and *Pongamia sp* at 1:10 (w/w) and leaf paste of *M. koenigii*, *J.gendarussa*, *Pongamia sp* and *A. indica* at 1:4 (w/w) has a potential repellent effect against *Sitophilus sp.* and could be considered for integration with other control options in the control of *Sitophilus sp.*.

Keywords: Repellent, *Sitophilus sp.* *Acalypha indica*, *Murraya koenigii*, *Pongamia sp.* *Piper longam*, *Juticia gendarussa*



Section E1

501/E1

A double layered co-sensitization in dye sensitized solar cells (DSSCs) by using natural pigments

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The co-sensitization method is employed in dye sensitized solar cells (DSSCs), with the aim of improving the absorption of light over a border wavelength region and thereby to improve the current output of the devices and the overall efficiency. In this work, natural pigments from the fire fern leaves and begonia black velvet leaves were used for double layered co-sensitization in dye sensitized solar cells (DSSCs). UV-VIS Spectral data revealed that both dyes were anthocyanins. The co-sensitization was done by first adsorbing the dye from begonia black velvet on to a TiO₂ electrode by dipping, and then by removing the adsorbed dye of the top layer of TiO₂ using a de-sorption solution. After that the fire fern dye was allowed to adsorb. The best performance was exhibited by the co-sensitized cell which showed conversion efficiency (η) of 1.2%, with open circuit voltage of 412.9 mV, short circuit current density of 5.08 mAcm⁻² and fill factor of 57.2%. This performance is superior to that of either individual devices made from fire fern ($\eta=0.96\%$) and begonia black velvet ($\eta=0.87$) under the same conditions of fabrication.

Keywords: Co-sensitization, DSSCs



502/E1

Fabrication of $\text{CuInS}_2/\text{Cu}_2\text{O}$ heterojunction using electrodeposition technique to use in photovoltaic applications

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CuInS_2 is a promising PV material due to its direct band gap of 1.5 eV which is very closer to the theoretically optimum energy band gap of 1.4 eV suitable for photovoltaic applications. On the other hand CuInS_2 based solar cells were also reported having a conversion efficiency of 12.5 %. Further enhancement of CuInS_2 based solar cells can be expected by optimizing the growth conditions and choosing proper window material for CuInS_2 in order to fabricate more efficient heterojunction solar cells. Cu_2O is one of the attractive materials for this purpose, due to its optoelectronic properties (high absorption coefficient and direct band gap of 2 eV). Among the CuInS_2 growth techniques, sulphurisation of electrodeposited Cu and In stack layers by annealing in hydrogen sulphide or sulphur environment is an attractive technique. In this method thin films of Cu were first electrodeposited at -700 mV Vs SCE for 20 min in an aqueous solution of 0.1 M sodium acetate and 0.01 M cupric acetate on Ti substrates. The temperature of the bath was maintained at 55 °C. Subsequently, In films on Ti/Cu substrates were electrodeposited at -1.1 V Vs SCE in an aqueous solution of 25 mM InCl_3 . All the Ti/Cu/In films were annealed at 130 °C for 4 hours in air for the formation of Cu-In alloy. Cu/In atomic ratio of alloy films were adjusted to 0.6, 0.7, 0.8, 0.9, 1 and 1.5 by changing the In deposition period. Sulphurisation of Cu-In alloy was carried out at 500 °C for 30 min in 100% H_2S gas with a constant flow rate. After the sulphurisation, bluish grey colored CuInS_2 films were obtained. The film quality of CuInS_2 was very subjective to the Cu-In alloy preparation conditions and methodology being adopted. Dark and light I-V measurements of the films were obtained in PEC containing 0.1 M sodium acetate solution. Results revealed that CuInS_2 films produce n-type photoconductivity in PEC and the best films were grown when the Cu/In ratio was maintained at 0.7. In order to fabricate the $\text{CuInS}_2/\text{Cu}_2\text{O}$ heterojunction, Cu_2O was electrodeposited on the Ti/ CuInS_2 electrode in lactate bath at -450 mV Vs SCE for 40 min. The pH of the bath was set to 12 and temperature was maintained at 55 °C. Formation of the $\text{CuInS}_2/\text{Cu}_2\text{O}$ heterojunction was studied using dark and light I-V characteristics in PEC containing 0.1 M sodium acetate. Results revealed the possibility of fabrication of photoactive $\text{CuInS}_2/\text{Cu}_2\text{O}$ heterojunction. To our knowledge, this is the first report of the possibility of fabrication of photoactive $\text{CuInS}_2/\text{Cu}_2\text{O}$ heterojunction by electrodeposition technique. This study will pave the way to develop a low cost $\text{CuInS}_2/\text{Cu}_2\text{O}$ thin film heterostructure suitable for photovoltaic solar cells.

Acknowledgement: National Research Council research grant NRC 11-13.



503/E1

Synthesis and electrical characterization of $\text{Na}_x\text{Ni}_{1-x}\text{O}_2$ compositions

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Sodium layered oxide compounds ($\text{Na}_x\text{M}_{1-x}\text{O}_2$) have drawn significant attention as cathode materials for Na-ion batteries (NIB). Their Li analogues have already been comprehensively understood. In this study, powder compositions of $(\text{Na}_x\text{Ni}_{1-x})\text{O}_2$, ($x = 0.1, 0.25, 0.5, 0.75$) were prepared by the Pechini method. For that, metal nitrates of NaNO_3 and $\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$ were mixed according to stoichiometric formula of the nominal compositions. The powder synthesis process was completed by calcining the ash product at $800\text{ }^\circ\text{C}$ for two hours in air. The synthesized powders were uni-axially pressed at 150 MPa and the green pellets were subsequently sintered at $800\text{ }^\circ\text{C}$ for two hours in static air. The electrical conductivity of these materials were determined by performing d.c. electrical conductivity measurements on sintered pellets by the four-probe method. The conductivity measurements were performed in a cyclic manner on heating and cooling in air, in the temperature range $25 - 200\text{ }^\circ\text{C}$.

This study revealed the possibility of synthesizing $\text{Na}_x\text{Ni}_{1-x}\text{O}_2$, $x = 0 - 0.75$ compositions by the Pechini wet chemical synthesis technique. All these prepared materials showed an increase in conductivity in an exponential manner with increasing ambient temperature. This is a good indication of the semiconducting nature, which is the main requirement for an electrode material. In this $\text{Na}_x\text{Ni}_{1-x}\text{O}_2$ system, the $x = 0.1$ composition showed a sufficiently high electrical conductivity of $3.5 \times 10^{-3}\text{ S/cm}$ at room temperature. These achievements in electrical conductivity indicate the potential of $\text{Na}_x\text{Ni}_{1-x}\text{O}_2$ compositions for NIB cathode application.

Keywords: Electrical conductivity, electrode materials, Na-ion batteries, Pechini method, sodium layered oxide compounds



504/E1

**Background radiation levels along Hambantota to Dondra coastline,
Sri Lanka**

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Absorbed dose rates at 38 locations along the coastline from Hambantota to Dondra, at 1 m above ground were measured using a portable digital survey meter. The values ranged from <0.01 to 3.66 $\mu\text{Sv h}^{-1}$.

The measured values were compared with the dose rates calculated using the activity concentrations of ^{232}Th , ^{226}Ra and ^{40}K in sand collected from each location and measured in the laboratory using a HPGe detector. Calculated values ranged from 0.005 to 5.527 $\mu\text{Sv h}^{-1}$. A good correlation was obtained between the calculated and the measured values. However the calculated values were somewhat higher than the measured values. The calculated annual effective dose ranged from 0.01 to 9.68 mSv with an average of 0.43 mSv. In 3% of the locations, the annual effective dose was greater than the worldwide average annual effective dose of 2.4 mSv. The highest background radiation level was recorded in 'Nilwella' (5°57'54.8"N 80°43'03.3"E) beach which is a newly identified location with high radiation background.

This research is a part of an ongoing study to measure radiation levels along the entire coastline of Sri Lanka.

Keywords: Beach sand, HPGe detector, high background radiation area, annual effective dose, Sri Lanka



505/E1

Competence and reliability to analyze gamma emitting anthropogenic radionuclides in water samples at the Department of Nuclear Science, University of Colombo

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Contamination of water bodies with anthropogenic radionuclides has been of concern with nuclear weapon testing and nuclear power plant disasters. As water plays an important role to sustain life, it may affect life when contaminated even in tracer levels. The Department of Nuclear Science (DNS) has been involved in water analysis for radioisotopes for more than three decades. The need for technical competence by a certified validation method became important for the credibility of testing and results generated. With the International Atomic Energy Agency Analytical Quality Control Service (IAEA-AQCS) providing member states the opportunity to participate in inter laboratory comparisons, the Department became a participant in proficiency tests (PTs) for anthropogenic gamma (γ) emitting radionuclides (^{51}Cr , ^{54}Mn , ^{57}Co , ^{60}Co , ^{65}Zn , ^{85}Sn , ^{133}Ba , ^{134}Cs , ^{137}Cs , ^{152}Eu and ^{241}Am) in water. Gamma spectra of the prepared sample bottles (diameter, 8.5 cm; height, 9.0 cm) were measured using a shielded High Purity Germanium Detector (HPGe, Gem 13200; Ortec). This study reports data for thirteen participated PTs of water during the period 2006 - 2014. PT samples provide results in terms of satisfactory relative bias, precision and z scores at 95% confidence limit. IAEA evaluate reported results against the acceptance criteria for accuracy and precision and assign the status "acceptable" when it passes both criteria. In analyzing similar radionuclides over the years, acceptance of reported results have increased, with less relative bias and higher precision due to the availability of primary and secondary standards and improvement of analytical skill. At present, DNS has gained the competence to determine ^{51}Cr , ^{54}Mn , ^{60}Co , ^{65}Zn , ^{85}Sn , ^{134}Cs , ^{137}Cs and ^{152}Eu in water. Minimum detection limits (MDL) of the above radionuclides were 5.0, 0.8, 0.8, 1.3, 0.7, 0.8, 0.8 and 3.0 Bq kg⁻¹ respectively. Accurate and precise determination of ^{57}Co (MDL = 0.7 Bq kg⁻¹) and ^{133}Ba (MDL = 1.3 Bq kg⁻¹) are critical in the presence of ^{152}Eu and ^{214}Pb due to their less resolved energy peaks. DNS has still been unable to get good agreement with precision for gamma analysis of ^{241}Am .

Keywords: Gamma emitting radionuclides, proficiency test, anthropogenic



506/E1

Earthquake activity of offshore Sri Lanka after recent major Sumatra earthquakes

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The study of earthquakes has provided a better understanding of the plate tectonics and the internal structure of the Earth. Subduction zones are generally characterized by well defined inclined seismic zones extending, in some cases, down to about 500-670 km deep beneath the Earth. The Sumatra subduction zone is characterized by the Indo-Australia Plate subducting beneath the Sunda plate and Andaman micro plate about 55 mm/yr, causing seismic activity along the plate boundary. Therefore, a large number of earthquakes take place in the region. There had been five major earthquakes of magnitude greater than 8.0 in this region from 2004 to 2014. Three of them are dip-slip and the other two are strike-slip type events. Regional earthquake activity after the occurrence of these five events was analyzed.

Hypocentral data of magnitude 3.0 obtained from the Data Management Center at the Incorporated Research Institutions for Seismology for the period from January 2000 to December 2014 were used in the analysis. Spatial distribution of focal mechanisms was analyzed for major events to investigate the geometry of faulting during earthquake fault slip using the data available from the Global Centroid Moment Tensor solution database for the above period. A statistical analysis was carried out to determine if earthquake activity had increased after the five major events. For this purpose, the analysis was carried out both qualitatively and quantitatively.

The results of the analysis show that the number of earthquakes in the region has increased considerably after the occurrence of the April 2012, magnitude 8.6 and 8.2 strike-slip events. Further, the results show that there was no change in regional earthquake activity after the occurrence of the other three major dip-slip type events. The strike-slip type focal mechanism of the 2012 two major events may be the reason for the increase in regional activity. The results of the present study reasonably agree with the results obtained by the other studies carried out in the same region using different methods.

Keywords: Seismology, geophysics, Sumatra subduction zone, regional seismicity, Sri Lanka



507/E1

An automated system to detect feature variations of planet Jupiter

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The giant planet Jupiter is the telescope-user's delight with interesting cloud belts, cyclones, anti-cyclones and other fascinating features. This paper describes an inexpensive and accurate automatic technique developed using image processing methods to detect the variation of features on the planet Jupiter. The study was focused on the two main features namely the Great Red Spot (GRS) and shadows cast by Jupiter moons on the planetary disk. GRS is a very fast storm in Jupiter's atmosphere rotating anti-clockwise and completing a full rotation in six days. Observing the GRS is one of special treats in astronomy. A method of detecting the GRS was developed using both image processing and clustering techniques. With the help of this developed system, one can detect the GRS well and measure the size of its long axis within an error range of 0.1%. Using this new technique 35 Jupiter images captured during the period 2010 – 2014 were analysed. In 2004 the size of the GRS was found to be 16570 km across. It is found that the GRS has begun to shrink and from 2010 to 2014 the red spot had shrunk at a rate of 375 km per year and its shape is gradually changing from an oval to a circle. These values are in agreement within an accuracy of 97% with those of other researchers obtained through manual methods.

Another method was developed to automatically identify Jupiter's Galilean moons by using the shadows of moons on the planet. This is important because sometimes even an experienced astronomer may not be able to identify the exact moon which transits by looking at the shadow. With the help of this developed automatic method, anyone can identify which moon belongs the respective shadow cast on the Jupiter disk. Both image processing and Artificial Neural Network methods were used to develop this method. The Artificial Neural Network was trained using supervised learning to classify the largest four moons of the planet Jupiter, Europa, Io, Ganymede and Callisto. The trained network was capable of identifying the moons at a success rate of 95.5%.

This technique can be further extended to detect other features of Jupiter as well with the combination of both image processing and Artificial Neural Networks.

Keywords: Great Red Spot, image processing of Jupiter features, Jupiter moons.



Section E2

601/E2

**Hypolipidemic activity and hypoglycemic effects of banana blossom
(*Musa acuminata* Colla) incorporated experimental diets in Wistar rats**

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Banana blossom is a popular Sri Lankan dish consumed as a curry as well as a boiled or deep fried salad, which is rich in nutrients and antioxidants. The present work was designed to study the hypolipidemic and hypoglycemic effects of banana blossom in high-cholesterol diet fed rats. Whole blossom of Ambul banana were washed and cut into small pieces followed by air and oven drying and ground into powder. Seven months old eighteen Wistar rats were purchased from the Medical Research Institute, Sri Lanka and divided into three experimental groups. All three groups were fed for 4 weeks, with casein as the basal diet (CN), in comparison with two diets containing 0.5% cholesterol (CD) and 0.5% cholesterol + 21% banana blossom powder (CDB). Serum total cholesterol (1.32 ± 0.09 mmol/L), non-HDL cholesterol (0.83 ± 0.10 mmol/L) and serum glucose concentration (2.94 ± 0.31 mmol/L) were significantly lower ($P < 0.05$) in CDB-fed group compared with the CD-fed group. In the CDB-fed group, significantly higher fecal weight (3.72 ± 0.25 g), cecal weight (0.61 ± 0.05 g), cecal Lactobacilli (7.91 ± 0.05 log₁₀cfu/g) and Bifidobacteria (8.32 ± 0.25 log₁₀cfu/g) populations were observed compared to CD and CN diet fed groups. Significantly lower serum AST level (0.74 ± 0.42 Δ A /min) ($P < 0.05$) in banana blossom fed rats was an indication of the reduction in oxidative stress induced by high cholesterol diet. Based on these data, it could be speculated that banana blossom incorporated experimental diets may modulate the hypocholesterolemic and hypoglycemic responses in Wistar rats.

Keywords: Antioxidant, banana blossom, hypoglycemic, hypolipidemic, Wistar rats



602/E2

Evaluation of total phenolic content and antioxidant activities of ten plants used in Ayurvedic medicine in Sri Lanka

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Physiological and biochemical processes in the human body may result in overproduction of free radicals leading to oxidative damage to biomolecules (e.g. lipids, proteins, DNA). Usage of medicinal plant products has increased recently due to their beneficial properties such as antioxidant, anticancer, hypoglycaemic and hypolipidaemic activities. The present study was designed to assess the *in vitro* antioxidant activity and free radical scavenging capacity of ten medicinal plants; Belimal (*Aegle marmelos*), Iramusu (*Hamidesmus indicus*), Ranawara (*Cassia auriculata*), Walkottamalli (*Scoparia dulcis*), Nelli (*Phyllanthus emblica*), Rasakinda (*Tinospora cordifolia*), Polpala (*Aerva lanata*), Babila (*Sida rhombifolia*), Beligeta (*Aegle marmelos*) and Venivel (*Coscinium fenestratum*), which are extensively used in the *Ayurvedic* system in Sri Lanka. Water extracts were used to evaluate the antioxidant and free radical scavenging activity by different methods; DPPH, ABTS and FRAP. The total Phenolic (TPC) and Total Flavonoid Content (TFC) were also assessed. There was a significant difference ($P < 0.05$) between the antioxidant activities of the tested extracts. The TPC and TFC values of the extracts varied from $5.22 \pm 0.08 - 295.94 \pm 3.65$ mg Gallic Acid Equivalent (GAE)/g dry weight and $0.97 \pm 0.002 - 115.01 \pm 1.69$ mg Catechin Equivalent (CE)/g dry weight respectively. The DPPH and ABTS radical scavenging activity was higher for the Nelli extract while the least activity was observed in the Venivel extract. As per the DPPH and ABTS radical scavenging activities, the Nelli extract exhibited the highest FRAP activity while the polpala extract showed the least activity. A positive, significant linear relationship between antioxidant activity and TPC and TFC content showed that phenolic compounds and flavonoids were the dominant antioxidant components in the tested medicinal plants.

Keywords: Antioxidant activity, medicinal plants, phenolic compounds, radical scavenging



603/E2

Effect of processed mung bean (*Vignaradiata* L.) on modulating serum lipid and glucose concentrations in Wistar rats (*Rattus norvegicus*)

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A high serum cholesterol level is a major risk factor for cardio vascular disease (CVD). The study assessed the *in vivo* hypocholesterolemic and hypoglycaemic effect of raw and processed mung bean powder (Variety MI 6) incorporated high cholesterol diet in comparison to the control diet in rats. Seven week old 20 male Wistar rats were randomly allocated into four groups (n=5) and fed with experimental diets *ad-libitum* for 5 weeks. Experimental diets were prepared according to the ANI-93G semi purified rodents diet and 0.5% cholesterol was added to obtain a high cholesterol diet. 0.5% cholesterol + 30% raw mung bean (RMD), 0.5% cholesterol + 30% boiled mung bean (BMD), 0.5% cholesterol + 30% sprouted mung bean (SMD) were given as treatments and 0.5% cholesterol + 10.15% casein powder (CD) as the control. No significant change ($P < 0.05$) was observed in total cholesterol levels in all treatment groups compared with the control group. Serum HDL cholesterol concentration in rats fed with SMD and BMD diets were significantly ($P < 0.05$) higher than that in the control and serum non-HDL cholesterol concentration in rats fed with SMD and BMD diets were significantly ($P < 0.05$) lower than that in the CD fed group. At the same time triglyceride levels of BMD and SMD fed groups were significantly lower ($P < 0.05$) than the RMD fed group. Triglyceride levels and serum glucose concentration levels in all treatment groups were significantly lower than in the CD fed group. Serum insulin concentrations in rats fed RMD, BMD were significantly ($P < 0.05$) lower than with CD diet. These results indicate that processed mung bean incorporated diets positively modulate both serum lipids and glucose levels higher than the control group. Within that, BMD and BSD positively modulate serum lipids more than RMD though there was no significant change in modulating serum glucose levels within mung bean fed groups.

Keywords: Cholesterol, hypocholesterolemic effect, hypoglycaemic effect, mung bean, Wistar rat



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In vitro* anti-arachidonate 5-lipoxygenase, anti-hyaluronidase and antioxidant activities of ethanolic leaf extract of *Argyria populifolia

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The inhibitors of Arachidonate 5-Lipoxygenase (A5-LOX) and hyaluronidase enzymes have gained a high therapeutic value in the treatment of inflammatory diseases. Medicinal plants remain as potent sources of new enzyme inhibitors and antioxidants. *Argyriapopulifolia* (Convolvulaceae) is a common medicinal plant, endemic to Sri Lanka, used for the treatment of various diseases including inflammatory diseases in the Sri Lankan folklore. The objective of the present study is to investigate *in vitro* anti-A5-LOX, anti-hyaluronidase and anti-oxidant properties of ethanol leaf extract of *A. populifolia*. The air-dried, powdered leaf of *A. populifolia* was extracted with ethanol using cold extraction technique. *In vitro* anti-inflammatory activity was determined by A5-LOX and hyaluronidase enzyme inhibitory assays. Anti-oxidant activity was determined by DPPH free radical scavenging, Ferric Reducing Anti-oxidant Power (FRAP), Ferrous Iron Chelating (FIC) and Oxygen Radical Absorbance Capacity (ORAC) assays. The Total Phenolic Content (TPC) and Total Flavonoid Content (TFC) were also determined. The ethanol leaf extract of *A. populifolia* showed a moderate anti-A5-LOX activity, having the IC₅₀ value of 150.8 ± 1.5 µg/mL in comparison to Baicalein (1.55 ± 0.24 µg/mL) and exhibited hyaluronidase enzyme inhibition of 16.3 ± 0.7% at 500 µg/mL in comparison to Tannic acid (90.3 ± 0.8% of inhibition at 500 µg/mL). The extract exhibited moderate DPPH free radical scavenging activity (IC₅₀=291.6 ± 5.4 µg/mL, Trolox: 5.29 ± 0.09 µg/mL) and ORAC (476.2 ± 31.8 mg TE/g), in comparison to that of green tea extract (1662.82 ± 0.22 mg TE/g). The extract showed low FRAP (265.1 ± 2.2 mg TE/g) with no FIC activity. The TPC and TFC were found to be 10.59 ± 1.16 mg Gallic Acid Equivalents (GAE)/g and 21.79 ± 0.39 mg Quercetin Equivalents (QE)/g respectively. The anti-A5-LOX, anti-hyaluronidase and anti-oxidant activities of leaf extract of *A. populifolia* were significantly different from the respective reference standards (P<0.05). This is the first report of A5-LOX and hyaluronidase related anti-inflammatory activities and anti-oxidant activities of ethanol leaf extract of *A. populifolia in vitro*. The present study may provide impetus to search for novel anti-inflammatory compounds from this plant and supports the traditional claims.

Keywords: *Agyria populifolia*, anti-arachidonate 5-lipoxygenase, anti-hyaluronidase, antioxidant

Acknowledgement: National Research Council, Grant No:12-100



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Electron spin resonance, ABTS⁺ on-line HPLC and *in vitro* antioxidant activities of Sri Lankan brown alga: *Padina commersonii*

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Marine seaweeds are rich sources of biologically active secondary metabolites and have potential as lead compounds in drug discovery. However, antioxidant activities of the Sri Lankan seaweeds have not been studied extensively. Therefore, in this study, the main objective was to evaluate the antioxidant activities of the marine brown alga, *Padina commersonii* (Pc) by electron spin resonance (ESR) spectroscopy, ABTS⁺ on-line High Performance Liquid Chromatography (HPLC) and *in vitro* assay. The crude methanolic extract was partitioned into hexane, CHCl₃, EtOAc and H₂O and used for bioassays. Free radical scavenging activity was determined by ESR spectroscopy and ABTS⁺ On-line (HPLC) technique. *In vitro* antioxidant activity was determined on VERO cells by 2,7-dichlorofluorescein diacetate (DCFDA) assay and cell viability (MTT) assay. Ethyl acetate fraction (PCE) showed the highest total phenolic content (7.44 mg GAE g⁻¹) compared to the other fractions. The strongest radical scavenging activities were observed by PCE and water (PCW) fractions against alkyl radicals; IC₅₀ values were 0.017 ± 0.001 and 0.02 ± 0.003 mg mL⁻¹, respectively. The highest DPPH radical scavenging activity was identified from the PCE fraction (IC₅₀ value of 0.71 ± 0.03 mg mL⁻¹). Four different fractions were obtained from the reverse phase (RP) - ODS open column of PCE. Among them, PCEF2 fraction showed the best scavenging activity for DPPH (0.014 ± 0.001 mg mL⁻¹), alkyl (0.01 ± 0.001 mg mL⁻¹) and hydroxyl (0.100 ± 0.003 mg mL⁻¹) radicals. In addition, ABTS⁺ On-line HPLC profile showed eight very strong negative signals in the ABTS⁺ chromatogram due to trace antioxidant compounds available in PCEF2. Subsequently, three compounds were isolated from the PCEF2 fraction by High Performance Centrifugal Partition Chromatography (HPCPC). Among the isolated compounds, PCEF2-1 showed the strongest intracellular ROS scavenging activity on Vero cells under H₂O₂ oxidative stress. The results indicate that *P. commersonii* contains natural products with promising antioxidant effects.

Keywords: Antioxidant, brown algae, electron spin resonance, *Padina commersonii*



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Synthesis of peppermint oil microcapsules to be used as a digestive supplement

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Peppermint oil (PO) has valuable medicinal properties such as high antioxidant activity and is used to treat numerous diseases including irritable bowel syndrome and indigestion. However, it is sensitive to light and heat. Furthermore, it could cause heartburns during its passage through the stomach. Therefore, the objectives of this research were to make microcapsules of PO, which can help to overcome the fore stated complications. PO microcapsules that are stable under acidic pH of the stomach can be taken as a dietary supplement. PO microcapsules were synthesized by complex coacervation method using gelatin and gum acacia wall materials. Formaldehyde was used to make cross links between gum acacia and gelatin to increase the stability of the wall. Gelatin enteric coating was used to further increase the strength of the microcapsule wall. Morphology of the synthesized microcapsules was studied using the optical microscope and was found to be spherical. Encapsulation of PO was confirmed by the UV-Visible spectra of mechanically crushed microcapsules. Antioxidant capacities (AOC) of the encapsulated PO were assessed using the Folin-Ciocalteu reagent and were found to be 33.3 (± 7) mg pyrogallol equivalents (PGE)/g and 38.7 (± 1) mg PGE/g for gelatin coated and non-coated microcapsules respectively. In order to assess the stability of the microcapsules, they were subjected to acidic conditions similar to the stomach and the resulting microcapsules and the acidic solutions were analyzed for their AOC. It was found that only 4-9% of active PO was lost from the microcapsule during the acidic treatment, hence indicating the capacity of PO microcapsules to significantly retain the encapsulated PO. After subjecting to acidic conditions similar to the stomach, the gelatin coated and non coated microcapsules retained 91% and 96% of active PO respectively. Pure PO directly added to the acidic solution displayed a loss of 44% of AOC, hence signifying the extra stability of microencapsulated PO. The acid treated PO microcapsules were then subjected to conditions similar to the intestine by treating with neutral solution in the presence and absence of a protease enzyme (Bromelain). In the absence of the enzyme, both gelatin-coated and non-coated microcapsules indicated 3-5% release of active PO to the solution. In the presence of the protease, both types of microcapsules indicated 8-18% release of active PO. This ensures the enhanced release of encapsulated PO inside the intestine in the presence of digestive proteases that can digest the microcapsule wall, similar to bromelain.

Keywords: Antioxidant, Folin-Ciocalteu, microencapsulation, peppermint oil



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Binding affinity of steroid molecules from Sri Lankan flora to corticosteroid-binding globulin receptor using QSAR Analysis

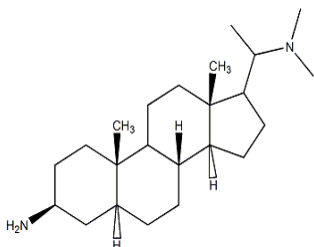
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The "Sri Lankan Flora" web based information system, which contains nearly 200 chemical compounds isolated and identified from flora of Sri Lanka was created and hosted under the www.science.cmb.ac.lk/tools/slflora web address. This information system comprised basic computational parameters for each compound and several structural parameters that can be used in Quantitative Structure Activity Relationship (QSAR) analysis. Experimentally found binding affinities of 30 different steroids to corticosteroid-binding globulin (CBG) receptor together with calculated seven different structural parameters (log P, polar surface area, solvent accessible surface area, π energy, molecular volume, molecular polarizability and molar refractivity) were incorporated to construct QSAR model using multiple linear regression (MLR) technique. The constructed model has the functional form of;

$$\text{Binding Affinity} = a_0 + (a_1 \times \log P) + (a_2 \times \text{PSA}) + (a_3 \times \text{SASA}) + (a_4 \times \text{PiE}) \\ + (a_5 \times V) + (a_6 \times \text{MP}) + (a_7 \times \text{MR})$$

where a_i 's are numerical coefficients obtained from MLR calculation and the other symbols represent calculated structural parameters. Finally, the constructed QSAR model was used to predict binding affinity of seven steroids found from Sri Lankan Flora database. One steroid namely, chonemorphone shows a good binding affinity with CBG receptor while the other six steroids predict binding affinities out of range of the constructed QSAR model. It is interesting to note that the steroid, chonemorphone reportedly having anti-amoebic activity and this molecule was isolated from the plant: *Chonemorpha fragrans* (native name: bulu wal anguna). Further studies stability of receptor-steroid complex in aqueous medium using molecular docking and molecular simulation techniques are already underway.



chonemorphone

Keywords: Chemistry of plant extracts, corticosteroid-binding globulin, QSAR, Sri Lankan Flora database

Acknowledgement: University of Colombo Research grant AP/3/2/2014/RG/01

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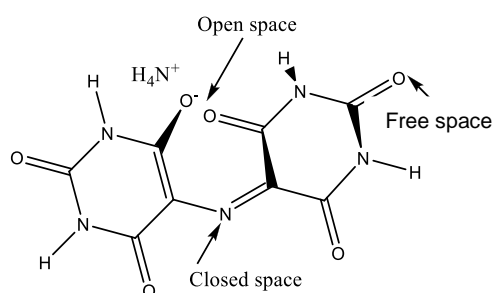
Stability of murexide-metal ion complexes in aqueous medium: A preliminary study using classical and quantum mechanics

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Murexide is an ammonium salt of purpuric acid, which is a reddish violet compound and serves as a metallochromic indicator. Although murexide is used as a suitable complexing agent for a large number of metal ions experimentally, there were not much expounded data available for its complexes. Hence, this is an attempt to explicate the stability of the structures of murexide-metal ion complexes in water, especially at three different binding sites (as given in Figure 1) using molecular mechanics (MM) and quantum mechanics (QM) techniques. Aluminium, iron, copper and zinc (Al^{3+} , Fe^{3+} , Cu^{2+} , Zn^{2+}) murexide complexes have been analyzed.



Optimized structure of murexide was generated using Gaussian 09 software on LINUX operating system with 6-31g (d) basis set and Hartree-Fock method in aqueous medium. Metal oriented structure in a befitting site was used for QM and MM simulations. Software packages were used for QM and MM simulations are Gaussian 09, GROMACS respectively in the LINUX operating system.

Figure 1. Structure of murexide indicating possible metal binding sites

Appraisal of the stability of metal complexes was carried out regarding intermolecular interaction energies in MM and Gibb's free energy change in QM. The outcome of MM and QM techniques upholds that metal ion-murexide complexation does occur as the resultant intermolecular interaction energies and change in Gibb's free energies were negative except at the closed site of Murexide- Zn^{2+} interaction in QM. The resultant trends in the stability of the metal-murexide complexes were as follows:

QM: $\text{Al}^{3+} > \text{Zn}^{2+} > \text{Cu}^{2+} > \text{Fe}^{3+}$ MM: $\text{Al}^{3+} > \text{Cu}^{2+} > \text{Zn}^{2+} > \text{Fe}^{3+}$

Despite the small variations in the trends in the stability of metal-murexide complexes, it confirms the surmise that a molecular mechanics method is sufficient for these studies and yields structural, dynamical, thermodynamic properties without much computational cost.

Keywords: Free energy, molecular dynamics, murexide-metal ion complexes

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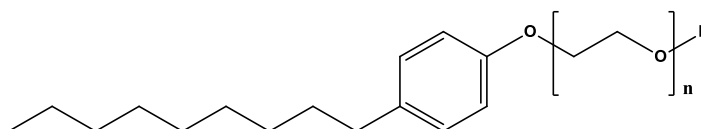
Density Functional Theory Simulation of structural, electronic and thermodynamic properties of nonylphenol ethoxylate surfactants

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'Surfactants' or 'surface active agents' are chemical agents capable of reducing the surface tension of a liquid in which it is dissolved. Nonylphenol ethoxylates (NPEs) are a group of non-ionic surfactants commonly known as Tergitol NP surfactants. Nonylphenol ethoxylates are classified according to the number of ethoxylate units in the hydrophilic chain. The properties of the nonylphenol ethoxylates differ with the number of ethoxylate units in the molecule. The hydrophilic-lipophilic-balance (HLB value) is the key parameter that surfactant formulators are focused on when studying the properties of non-ionic surfactants. Even though the HLB values of two surfactants are equal or close to each other, the expected properties cannot be obtained by replacing one surfactant with another. This issue leads to the necessity to carry out many trial and error tests to identify the equivalent surfactants in industrial applications.

Common structure of
Nonylphenoethoxylates



To address this issue, a comprehensive investigation of the nonylphenol ethoxylate molecules was carried out computationally at B3LYP level of theory using 6-311G basis set in Linux version of Gaussian 09 computer software package. The aqueous phase investigation focused on deducing the interactions between nonylphenol ethoxylates and water with extending chain length of the ethoxylate part, branching of the nonyl hydrocarbon chain and varying the substituent position (ortho-, meta- and para-) of nonylphenol ethoxylate molecules. To interpret the interactions of nonylphenol ethoxylate molecules with water, molecular properties such as Gibbs free energy changes of solvation (ΔG_{solv}) in aqueous medium, molecular dipole moments and hydrogen bond lengths between surfactant molecules and water molecules were investigated. The more negative values (-46.62 to -116.88 kJ/mol) of the Solvation Gibbs free energy (ΔG_{solv}) indicate that the stability of the NPEs in aqueous medium increases with the extension of the length of ethoxylate chain (4 to 16 ethoxylate units). The substituent position and the branching of nonyl-hydrocarbon chain have not caused the Gibbs free energy of solvation to change significantly. Although electrical dipole moment of NPEs in aqueous medium varied with the position of the substituents, it was not affected by branching patterns of the nonyl hydrocarbon group. Computationally simulated UV-Visible spectra of NPEs revealed that the absorption maximum of NPEs (λ_{max}) was independent of ethoxylate chain length. UV-Visible spectra generated from selected molecules of NPEs confirmed that absorption maximum (λ_{max}) of the surfactant species was significantly affected by the change in position of substituents.



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Investigation of a method to reduce the levels of extractable latex proteins in dipped rubber products

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Natural Rubber Latex (NRL) allergy is an allergic condition caused by the extractable latex proteins in dipped rubber products. This allergic condition is a major concern for consumers, mainly for those who are sensitive to the allergenic extractable proteins in products such as NRL gloves. The objective of this research is to investigate the extractable protein levels in a range of dipped rubber goods and to develop an economical method to reduce the extractable protein quantities in dipped natural latex products. In our investigation of products, it was found that the NRL glove samples available in the Sri Lankan market belonging to different brands and batches contain about 500-4000 $\mu\text{g g}^{-1}$ of extractable proteins. For quantification of extractable latex proteins, modified Lowry assay (ASTM D5712-10) was used, as it was confirmed to be the most suitable through a literature survey and experimental data. Gloves were selected for further analysis on how this reduction of extractable latex proteins could be performed. In order to reduce extractable protein levels, two different natural proteases were extracted and purified; papain from papaya and bromelain from pineapple. Partial purification of bromelain and papain were carried out with 40% and 45% saturated $(\text{NH}_4)_2\text{SO}_4$ solutions (optimum $(\text{NH}_4)_2\text{SO}_4$ percentage according to literature) respectively from crude plant extracts. Activity of the isolated enzymes was confirmed prior to each trial through an egg white digestion test (2 hours), where the weight reduction of boiled egg white was used as an indicator to prove protease activity. With papain a weight reduction of 25 (± 5)% was recorded for this test and with bromelain it was 13.5 (± 2)%. Different glove samples of the same weight were treated with each enzyme, within an incubation time period of 2 hours at 60 °C temperature. Control experiments were carried out using distilled water in the place of enzyme. Triplicate of experiments carried out with bromelain, showed a reduction of 51 (± 11)% of the extractable proteins whereas with papain it was 58 (± 8)%. These results clearly indicate that the selected natural proteases – papain and bromelain contribute significantly towards the reduction of total aqueous extractable proteins in NRL products. This concept can be further reformed for application on an industrial scale to treat either the product or the natural rubber latex itself to decrease the health complications that occur due to allergic conditions in dipped rubber product consumers.

Keywords: Bradford assay, bromelain, modified Lowry assay, NRL allergy, papain

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611/E2

Subcritical water extraction of phenolic compounds from coconut cake

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Subcritical water (SCW) extraction of phenolic compounds in coconut cake (CC) was performed in a home built apparatus. Phenolic substances from powdered CC (0.5 g) were extracted at different temperatures; room temperature (RT), 100 °C, 150 °C and 200 °C at pressure of 20 bar. Total phenolic content (TPC) of the extracts were determined using the Folin-Ciocalteu method and the antioxidant activity was tested using ferric reducing antioxidant power (FRAP) assay and 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid (ABTS) assay. The antioxidant efficacy was also tested in egg yolk homogenate as a food model. Two conventional extraction methods (vortex and sonication) at RT were also performed. The results are summarized in Table 1.

Table 1: Total phenolic content, antioxidant activity and % inhibition in egg yolk homogenate

Extraction conditions	TPC- g (Gallic acid equivalents)/ kg	FRAP% assay - Reducing Power %	ABTS assay- Trolox Equivalents ($\mu\text{mol} / \text{g}$)	Egg yolk homogenate- Inhibition %
20 bar, RT	1.53 \pm 0.13 ^{ab}	66 \pm 20 ^{ab}	26 \pm 4 ^a	16 \pm 5 ^{ab}
20 bar, 100 °C	1.74 \pm 0.08 ^{ac}	74 \pm 14 ^a	27 \pm 7 ^a	18 \pm 2 ^a
Sub critical, (20 bar, 150 °C)	1.87 \pm 0.21 ^c	119 \pm 30 ^{ac}	47 \pm 6 ^b	20 \pm 2 ^a
Sub critical, (20 bar, 200 °C)	2.36 \pm 0.10 ^d	169 \pm 27 ^c	77 \pm 3 ^c	38 \pm 6 ^c
Vortexed, RT	1.59 \pm 0.12 ^{ab}	78 \pm 8 ^{bd}	60 \pm 6 ^d	11 \pm 3 ^b
Sonicated, RT	1.46 \pm 0.17 ^b	69 \pm 9 ^d	53 \pm 4 ^{bd}	11 \pm 1 ^b

Different superscript letters in same column denote significant difference at 95 % level by Tukey's pair-wise comparison.

TPC obtained using high temperature and high-pressure conditions are significantly ($p < 0.05$) higher than that of the extracts obtained at RT (Table 1). Phenolic extracts obtained using SCW have exhibited significantly ($p < 0.05$) higher % reducing power than other extracts. In ABTS assay and egg yolk homogenate, SCW extract (20 bar, 200 °C) has shown significantly ($p < 0.05$) higher antioxidant activity and % inhibition than other extracts. Hence, subcritical conditions can be used to obtain higher phenolic yields with higher antioxidant activity and thereby to extend the shelf life of foods processed under high temperature.

Keywords: Antioxidant activity, coconut cake, phenolic compounds, subcritical water

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612/E2

Development of transgenic rice plants with lysine rich protein coding gene

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Even though it is the staple food of more than half the world's population, rice is not considered a rich source of protein. One of the essential amino acids, lysine is low in rice seed. Hence, this study was aimed at increasing both the lysine and total protein content in rice seeds by introducing the pollen-specific lysine-rich protein encoding gene (*SBgLR*) from potato (*Solanum tuberosum*) into indica rice (*Oryza sativa* L.) seed under the control of the rice seed-specific globulin promoter. Total Ribonucleic Acid (RNA) from potato pollen grains was extracted and the produced cDNA and *SBgLR* gene was amplified by Polymerase Chain Reaction (PCR) using *SBgLR* gene-specific primers. The isolated rice genomic Deoxy Ribonucleic Acid (DNA) from rice variety Bg 94-1 was subjected to PCR to amplify the promoter sequence of the globulin gene. The amplified promoter region was cloned into pGEM[®]-T Easy vector, and then into pCAMBIA1391Z vector. Recombinants were selected and sequenced. The *SBgLR* gene containing recombinant vector (pCR[®]2.1-TOPO-*SBgLR*), previously cloned in our laboratory was restriction digested with *Bam*H1 and *Eco*R1 enzymes, and cloned into the corresponding sites of pCAMBIA1391Z-*Glb* vector construct. Electro competent cells of *Agrobacterium* strain GV3101 was transformed with the recombinant construct (pCAMBIA1391Z-*Glb-SBgLR*). Bg 94-1 rice seed derived calli, and active rice embryos were used for transformation. The embryo transformation method proved less time consuming and more effective in producing transgenic rice plants. PCR analysis of regenerated transformed plants indicated the presence of the *SBgLR* gene.

Keywords: *Agrobacterium*, lysine, transgenic rice, transformation

Acknowledgement: TG11/53 from the Sri Lanka Treasury



613/E2

Optimization of enzyme production and immobilization of a thermo-stable alpha amylase from *Caldimonas manganoxidans* NMS 1 isolated from a hot water spring in Sri Lanka

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Thermostable alpha amylase is used in the production of glucose syrup, desizing fabric in textile industry, fermentation industries, paper sizing, detergent and brewing industries. An α -amylase from *Caldimonas manganoxidans* NMS 1, isolated from Nelum-wewa hot water springs, situated in Sewanapitiya in the Polonnaruwa District of Sri Lanka, has been purified to homogeneity as determined by polyacrylamide gel electrophoresis. Kinetic studies of this enzyme have been reported previously. In this study we have optimized the α -amylase production from *Caldimonas manganoxidans* NMS 1 and the effect of inhibitors on enzyme activity were studied along with the effect of immobilization on the enzyme. The optimum extracellular α -amylase activity, 56 U/ml at 50 °C over a 20 hour incubation period, was observed in a media comprising of 10 % soya powder in a basal media containing 5 g/l NaCl, 0.5 g/l KCl, 0.5 g/l MgSO₄.7H₂O, 0.04 g/l MnSO₄, 0.3 g/l FeSO₄, 0.87 g/l K₂HPO₄, 0.022 g/l CaCl₂ and 1 % soluble starch solution while ammonium sulphate (10 % and 20 %), soya powder (20 %) and urea (10 % and 20 %) showed enzyme activities of 1 U/ml, 15 U/ml, 37 U/ml, 1 U/ml and 1 U/ml respectively. Salts of calcium ions (1 mM), manganese ions (1 mM), copper ions (1 mM), and ferrous ions (1 mM) showed 31 %, 31 %, 18 % and 10 % enhancement of α -amylase activity respectively. Sodium ions (1 mM), magnesium ions (1 mM), and zinc ions (1 mM) showed a 33 %, 37 % and 37 % inhibition of α -amylase activity respectively. The surfactant sodium dodecyl sulphate (1 mM) and urea (1 mM) inhibited enzyme activity by 35 % and 10 % respectively. The heavy metal mercuric ions (1 mM) and the chelating agent ethylene diamine tetraacetic acid (1 mM) strongly inhibited α -amylase activity by 49 % and 57 % respectively. Immobilization of enzyme using low melting agarose and agarose showed a retained activity of 43 % and 48 % respectively with respect to purified, un-immobilized α -amylase at 50 °C. Immobilization using K-Carrageenan at 37 °C showed 48 % retained activity. The α -amylase isolated from *Caldimonas manganoxidans* NMS 1 thus has potential applications in industry.

Keywords: *Caldimonas manganoxidans* NMS 1, extracellular α -amylase, enhancement, inhibition, immobilization



614/E2

In-vitro uptake and localization of Cy3-labeled by *Setaria digitata*

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Setaria digitata resides in the abdominal cavity of ungulates and are generally nonpathogenic in their natural host, cattle. However, transmission of infective larvae into non-permissive hosts such as sheep, goats or horses can result in cerebrospinal nematodiasis (CNS). CNS is a neuropathological disorder that results in major dysfunctions of the central nervous system, producing symptoms of motor weakness, ataxia, lumbar paralysis and ultimate death of infected animals. Therefore, this disease poses a serious threat to livestock farming in tropical countries. Further, *Setaria digitata* can also infect humans and cause abscesses, allergic reactions, enlarged lymph nodes, eye lesions and lung inflammation showing gradual adaptation to humans. siRNA mediated RNA interference (RNAi) is considered to be a promising reverse-genetic tool to study gene functions. In this study, we used siRNA technique to specifically silence the expression of *S. digitata* novel parasitic nematode-specific gene (SDNG). SDNG has been proven to be specific for animal parasitic nematodes. It was found to be abundantly expressed in longitudinal muscles, reproductive systems and during embryogenesis, in all stages of the life cycle of *S. digitata*. siRNA was generated using the DNA fragments resulting from PCR amplification of plasmid vector containing SDNG. This was carried out using forward and reverse primer combinations (four primer pairs; SD1F/1R, SD2F/2R, SD3F/3R, SD4F/4R) containing T7 promoter sequences. dsRNA was synthesized using T7 RNA polymerase. They were cleaved to 21-23mer siRNA fragments using shortcut RNase III, and labeled with Cy3 labeling reagents. siRNA so generated was used to treat adult worms (40µg/ml siRNA, 4hrs per day for 4 days) and microfilariae (10µg/ml siRNA, 3hrs per day for one day) in RPMI culture medium containing 10% FBS, 30 µg/ml Streptomycin, 2.5 µg/ml Amphotericin B without FCS in a CO₂ incubator in the presence of 5% CO₂ and at 37 °C. The visualization of siRNA treated adult worms and microfilariae under the fluorescent microscope revealed uptake and localization of Cy3-labeled siRNA by *S. digitata* indicating that dsRNA is taken up by *S. digitata* which can be used for siRNA mediated RNA interference to study the functional role of *S. digitata* genes. This is the first demonstration of siRNA uptake by *S. digitata*.

Keywords: *Setaria digitata*, SDNG, siRNA



Section F

801/F

Comparison of economic benefits of organic and conventional modes of paddy cultivation: A study in the Kalutara District

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There is a recent trend among farmers in Sri Lanka to practice organic paddy cultivation. This is due to higher market prices and demand for traditional rice varieties. However, studies to compare economic benefits of two systems are lacking. Therefore, the objectives of this study were a) to understand social and economic aspects which are pertinent for the adoption of organic rice production, and b) to compare economic profits between two paddy cultivation systems. Kalutara District was selected as the study area as farmers in the District practice both systems successfully. The survey was conducted in three divisional secretariat areas, Horana, Ingiriya and Madurawala that were randomly selected. One hundred and ten (110) and forty six (46) farmers practicing conventional and organic methods respectively were selected for the study. Data on quantities and prices of inputs and outputs during Yala season 2014, other farming practices, and socioeconomic information of farmers were collected using a structured survey schedule. Data were analyzed descriptively, all economic benefits and costs were valued and farm budgets were computed.

The results indicate that paddy cultivation in the area is mainly practiced as a secondary income generation activity. Contribution by female labour is 20% higher in organic cultivation. Farm size of conventional farmers is 0.4 ha while that of organic farmers is 0.2 ha. Costs for labor and organic fertilizer are higher in organic mode, whereas costs of machinery and agro-chemicals are higher in conventional mode. Total revenues are high for conventional farmers. However, the ratio of total returns to costs is higher in organic mode than in conventional mode with 2.15 and 2.06 as values for organic paddy and conventional paddy respectively. Higher environment benefits occur in organic cultivation. Based on the findings it can be concluded that the organic system of cultivation is economically and environmentally more profitable than the conventional system of cultivation. Implications for policy include the need to provide adequate incentives for practicing organic farming.

Keywords: Economic analysis, environmental benefits, cultivation practices, input use, traditional rice varieties



802/F

Adoption of parachute method in rice crop establishment: Evidence from the Kurunegala District of Sri Lanka

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Rice is the main coping strategy for rural livelihood in Sri Lanka. However, rice cultivation is confronted by diverse biotic and abiotic stress conditions limiting its production and productivity. Moreover, continuation of production has become a challenge due to escalating input prices, particularly of labour and increasing competition for inputs. Parachute method is a novel crop establishment method for rice that demands less labour when compared to direct seeding, the most widely practiced method of crop establishment. The objectives of this study were a) to estimate the rate of adoption of parachute method, b) to determine factors influencing adoption and c) to compute welfare gains to producers due to different methods of crop establishment. A survey was conducted in Ibbagamuwa and Nikaweratiya DS areas of Kurunegala District. Eighty-eight farmers selected through multi-stage random sampling representing major irrigation schemes participated in the study. Data on awareness; adoption history; costs, and benefits of cultivation for 2013/14 *Maha* and 2014 *Yala* seasons were collected using a structured survey schedule. Binary logit regression model was used to determine the factors influencing the adoption decision. Unit rice budgets were developed to compare benefits of different modes of crop establishment. According to the results, adoption rate of parachute method in the study area is 30%. Number of extension contacts; level of farmer education; age and farmer's level of involvement in organizations positively influence the decision to adopt the new method. Farmers' perceived benefits of the method are consistent with the intended benefits by extension services. The results further revealed that, average yields were higher (4.86 t/ha and 4.98 t/ha for *Yala* and *Maha* seasons respectively) in farms that used the parachute method when compared to farms that used direct seeding and transplanting. Net revenue for adopters was 13% and 30% higher than non-adopters for *Yala* and *Maha* seasons respectively. Although the method is proven as a labour augmenting technology, rate of adoption remains low indicating the potential for awareness creation through proactive extension services and field trials to increase adoption rate to realize more economic benefits to the society.

Keywords: Agricultural extension services, binary logit regression, farm budgeting, labor augmenting technology, major irrigation



803/F

Eco-costs of different methods of paddy cultivation in the Kalutara District: An application of Life Cycle Assessment

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Paddy cultivation is well established in nine out of 15 agro ecological regions of the wet zone of Sri Lanka. Kalutara District plays a major role in paddy cultivation and farmers predominantly follow conventional methods in paddy cultivation. However, there is an emerging trend to adopt organic farming due to better prices for rice of traditional varieties grown without chemical inputs. The goal of this study was to compare cost of environmental impacts of paddy cultivation practiced under conventional and organic methods. The study used life cycle assessment (LCA) as a tool and eco-costing method. The study was conducted using input output data from 156 farmers for the 2014 Yala season. The functional unit used in the study was 100 kg of paddy at the farm gate. First, all emissions and the consumption of resources connected to different processes were listed in a Life Cycle Inventory (LCI). Six indicators for environment impacts; global warming; eutrophication; human toxicity; terrestrial eco-toxicity; freshwater aquatic toxicity; depletion of abiotic resources and atmospheric acidification were considered. These impacts were then converted to monetary values adopting the eco-costing method to compare the environmental damage cost of the two systems.

The results indicate that the value of global warming potential of inorganic cultivation is 717 Rs/kg CO₂ eq followed by 323 Rs/ kg SO₂ eq of acidification, and 1105 Rs/kg PO₄³⁻ eq of eutrophication. Values for organic paddy cultivation for the above indicators are respectively, 181 Rs/kg CO₂ eq, Rs/kg SO₂ eq, and 260 Rs/kg PO₄³⁻. The total damage cost of human, freshwater, and eco toxicity from conventional cultivation is 3,334,093 Rs/kg DBeq. The total damage cost of organic cultivation is only Rs.770 which is only a minute fraction when compared to the total damage cost of Rs.30,146,801 in conventional cultivation. The study demonstrates that the eco-cost method is an appropriate tool in determining the environmental cost between comparable production systems by incorporating the LCA tool. It further reveals that the adoption of an organic system is environmentally more profitable than the conventional cultivation of rice.

Keywords: Global warming, damage costs, chemically intensive farming, organic farming, environmental impacts



804/F

The use of participatory rural appraisal technique to identify farmers' needs in agricultural development

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Understanding and addressing farmers' needs are important to enhance the effectiveness of the agricultural sector of Sri Lanka where livelihoods of many depend on small scale farming. In that context, participatory rural appraisal techniques (PRA) play a key role by identifying and prioritizing the problems of farmers and guiding implementing strategies to solve them by using local knowledge. PRA is conducted with the help of outdoor facilitators using a set of participatory and visual techniques that can be easily understood by participants from rural backgrounds. This study was conducted in the Ratemulla Grama Niladhari Division in the Pahatha Hewahata Divisional Secretary's Area of Kandy District to understand the usefulness of PRA in agricultural development. Specific objectives of this study were a) to investigate the current situation of the village, b) to identify and prioritize problems that farmers are facing, and c) to suggest solutions for the identified problems. Eighty two villagers participated actively in this exercise.

Four PRA tools; resource mapping; Venn diagrams; pair wise ranking; and matrix ranking were used in the process. Findings indicate that the majority of people in the village are engaged in agriculture, and mainly in paddy cultivation. In addition they cultivate minor fruit crops, and export agriculture crops. It is revealed through Venn diagrams that relationships between government officers, institutions, organizations and the farmers are weak. Matrix ranking depicts that pepper is the most suitable crop for commercial cultivation. According to pair wise ranking, the major constraint faced by the farmers is lack of technical knowledge in farming practices. In order to solve the problems of farmers, the relevant authorized officers should frequently visit the farmers, examine the current practices and identify the prevailing weaknesses. At the same time, the relevant authorities should identify suitable crops and disseminate appropriate technical knowledge among farmers in order to enhance their livelihoods. This study thus shows that participatory rural appraisal techniques can be used to identify farmers' needs in agricultural development.

Keywords: Agricultural development, farmers' needs, participatory rural appraisal



805/F

Patterns and determinants of household vegetable consumption: A case study in the Udapalatha DS area in Kandy District, Sri Lanka

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Vegetables are considered a main component of healthy human diet. Understanding determinants of household demand for vegetables are important in planning production and supply and to effectively target nutrition interventions. The objectives of this study were to a) identify the patterns and b) the effect of social and demographic characteristics on vegetable consumption levels in households in villages from the Central Province of Sri Lanka. Three study villages, Sinhapitiya North, Godagama and Rathmalkaduwa were randomly selected. Thirty households each were selected randomly from each study village. Data on socio-economic and demographic factors, and consumption and expenditure patterns of households based on one-week recall were collected using a structured survey schedule. Data were analyzed using descriptive statistics to understand consumption patterns. Linear regression analysis was used to explain relationships between the per-capita weekly vegetable expenditure and socio-economic and demographic characteristics of households. According to the results, mean weekly household expenditure for vegetables by households in the study area is LKR 640.89. Respondents indicated price, nutrition value and family preference as the most important factors that influenced the buying decisions of vegetables. Mean per capita daily vegetable consumption is 111 g. Average number of daily meals with vegetables is less than three indicating that households do not consume vegetables for all three main meals. Households reported consuming 20 types of local vegetables and 10 types of exotic vegetables. Sixteen percent of all weekly vegetable meals are generated from their own home gardens. Econometric model is statistically significant with F value of 14.42 and R² value of 0.67. Per-capita vegetable consumption expenditure decreases with increasing household size. Education level of the household head, presence of elders in the family, working mothers, and household well-being Index, a constructed index using availability of household assets, have a positive significant influence on per capita expenditure. Increasing expenditure on vegetable substitutes reduces expenditure on vegetables. Results of this study would be useful for food producers, marketers and policy makers to identify and plan target interventions on vegetable production and consumption.

Keywords: Dietary diversity, exotic and traditional vegetable, home garden produce, market purchases, multiple regression analysis



806/F

A study on production practices and profitability of leafy vegetable farming in peri-Urban Colombo, Sri Lanka

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The demand for leafy vegetables has recently increased due to increasing consumer incomes and the widening of dietary diversity. The highly perishable nature of this vegetable group has led to the development of peri-urban areas as major production areas. This has implications on agricultural land use patterns and sources of income for farmers. Despite the abundance of research on production and marketing of other vegetables in Sri Lanka, there is a paucity of studies on the economics of leafy vegetable production and marketing. The objectives of this research were to a) document production practices, and b) to calculate farm profitability of leafy vegetable farming in a peri-urban production area of Sri Lanka.

A farm level study was conducted in two villages selected from the Bolgoda Lake periphery in the Kalutara District. Located in the South of Colombo, the major urban market in the country, this area is a major supply area of leafy vegetables to the city. A sample of 32 farmers was selected randomly from the two villages for the study. Data on farming practices; quantities of inputs and outputs, and costs and revenues were collected using a structured survey schedule. Crop enterprise budgets were computed to compare profitability among different leafy vegetable crops. According to the results, about two thirds of farmers practice multiple cropping and concurrently grow two to six crops leading to ten crop combinations. Average farm size is 0.5 ha. Kan-kun (*Ipomea aquatica*); mukunuwenna (*Alternanthera sessilis*) and gotukola (*Centella asiatica*) account for 85% of the area under leafy vegetables. Kan-kun is the most popular mono-cropped leafy vegetable as it is grown by 22% of farmers. It is also the crop with the highest plot size with mean plot size of 0.14 ha. Results of crop enterprise budget analysis indicate that kan-kun is the crop with the highest unit profits around LKR 1.5 million/ha/cropping round. Unit profits for gotukola and mukunuwenna are LKR "000" 942 and 287 per ha per cropping round respectively. This analysis concludes that cultivation of leafy vegetables is profitable and generates substantial incomes to small famers in per-urban areas.

Keywords: Farm budgeting, multiple cropping, irrigated farming, ratoon crops, farm income, Kalutara District



807/F

An analysis of patterns of tea exports from Sri Lanka with reference to product forms and destinations (2007-2014)

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Sri Lanka exported tea to more than 40 countries in 2012 that are categorized into five major destination regions. Tea exports are also identified in three different forms. The industry and national policy indulges in a long-term vision to diversify destinations and forms of tea exports. Thus understanding the trends and resultant economic gains due to changing pattern of exports would generate important insights to the industry. Objectives of this study were a) to identify changes in the shares of destination regions of tea exports, b) to identify the patterns of change in the shares of different forms of tea exports, and c) to understand changes in unit values of different forms and destination regions. Data on export volumes and values were obtained from Central Bank Annual Reports. Shares of destinations, export forms and values in constant 2013 terms were computed for selected periods using averages centering on the representative years.

Value of total tea exports in constant 2013 values grew by 17.5% during 2007 - 2014. Export volumes to European Union and other industrialized countries reported a drop of 17.5% during the same period. Unit export values of all forms of tea except for that of bulk green tea increased. In 2008, bulk tea accounted for about two-thirds of all black tea exports. This share dropped to 40% in 2013. The price premium for packeted black tea over bulk tea in 2008 is LKR 19.48 per kg in constant 2013 values accounting for a margin of 4.8%. The premium earned by packeted black tea in 2013 is LKR 12.89 per kg accounting only for 2.3%. The unit value analysis indicates a decrease in value of one kg of tea exported to other countries indicating an estimated potential gain of approximately LKR 1.1 billion in 2013, if the country continued to maintain the exports to high value markets. Although share shifts of forms within three types of tea products are in the expected directions of industry developments, gains from value addition to bulk black tea to black tea packets has declined.

Keywords: Market segmentation, export destinations, package types, unit values, industry strategies



808/F

Comparison between market share of Sri Lanka and key competitors in the total cinnamon market (2000 – 2013)

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The world market for cinnamon comprises true cinnamon and cassia. Produce originating from *Cinnamomum verum* / *Cinnamomum zeylanicum* is considered as true cinnamon while cassia is a collective name for *Cinnamomum cassia*, *Cinnamomum burmannii* and *Cinnamomum loureirii*, Cinnamon is the most important tree spice produce from Sri Lanka. The cinnamon produced in Sri Lanka, has been in the market for centuries and is considered as the world finest.

Sri Lanka is the largest producer and the exporter of true cinnamon while China, Indonesia and Vietnam, are the major producers and exporters when considering the total cinnamon market. Cassia is the closest substitute for true cinnamon, and therefore Southeast Asian countries are competitors to Sri Lanka in the world market.

In this context this study aimed to identify and compare fluctuation of Sri Lanka's share in the world cinnamon market with the shares of other major exporters. The ITC (International Trade Centre) Trade Map and the United Nations Comtrade Database were used as the secondary data sources. Percentage shares of volumes and values for Sri Lanka, China, Indonesia and Vietnam for the period 2000-2013 were calculated and trends were compared. According to the results, Sri Lanka has lost about 10% of its share in the value of the world cinnamon market and about 5% of its share in the trading volume during the study period showing a declining trend, while the other three main competitors have shown a rising trend.

Keywords: Cassia, Ceylon cinnamon, true cinnamon, trend analysis, World Market Share



809/F

Household willingness to pay for improved plastic recycling: A study in the Western Province of Sri Lanka

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Plastic recycling is the use of post-consumer plastic material in the production of new or similar products. Recycling has significant economic and environmental benefits, as it reduces the demand for virgin materials. This study intends to estimate the benefits to households due to improved plastic recycling and was conducted in the Western Province of Sri Lanka. A sample of 300 households were selected from eight GN divisions in the Colombo, Gampaha and Kalutara districts representing two municipal councils, three urban councils and three Pradeshiya Sabhas. The survey was designed to collect information related to households including socio economic data, plastic waste generation rates, and household's willingness to pay for improved methods of disposal of plastic waste. A hypothetical market was presented to respondents to estimate households' willingness to pay (WTP) using the contingent valuation method.

Multinomial logistic regression analysis was conducted to find out the effect of predictor variables on the response variable (WTP). Predictor variables included in the analysis were; age and level of formal education of the decision maker; monthly household income; local authority type of the household's location; household size, and quantity of plastic waste generated per month. WTP was included in five categories as; LKR 150; 200; 250; 300 and 350. The reference level considered for the logistic regression analysis was level 5 (Rs.350, WTP value). Based on the results of the likelihood ratio test, variables; income; education level of the decision maker and amount of plastic waste generated are significant at 0.05. The R^2 value for the regression model was 0.57. Logistic coefficient (B) for each predictor variable was used to interpret the results for each WTP level. The results could be used in designing appropriate incentives for the sector. Plastic recycling sector improvements through proper policies and support for research are needed by the Sri Lankan Government in reaching sustainable development goals.

Keywords: Post-consumer resource recovery, contingent valuation, multinomial logit, environmental benefits, conservation



810/F

Financial benefit-cost analysis of plastic recycling centers in the Western Province

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Recycling of plastic waste provides both financial and economic benefits. Plastic recycling is one of the best strategies that have been initiated in Sri Lanka in the area of waste management. Mainly the National Post Consumer Plastic Waste Management Project managed by the Central Environmental Authority (CEA) engages in facilitation and promotion of plastic recycling activities in Sri Lanka. This study aimed to find out the financial performance and viability of mechanical plastic recycling activities in the Western Province.

All mechanical plastic recycling centres in the Western Province were divided into three categories as; large, medium and small, based on the average amount of plastic waste recovered per month. Two medium scale centers and one small scale centre were included in the study. Management of these centers agreed to cooperate with the study team by providing information on costs and benefits of operations. Financial cost benefit analysis was conducted for three recycling centres. Information on prices and quantities of activities, and other relevant data were gathered through in-person interviews and telephone conversations. A pre-tested structured questionnaire was used in collecting data. Financial benefit cost analysis was conducted separately for the study entities. A time horizon of 20 years for projects and the discount rate of 10% was used in the analysis. Net present value and benefit cost ratio criteria were used as measures of project worth.

According to the results, net present value (NPV) of all three projects is positive. All three entities show benefit cost ratio (BCR) values greater than one. It can be concluded that, the plastic recycling business in small and medium scale categories irrespective of their scale of waste recovery amount, are viable for 20 years from the financial point of view.

Keywords: Mechanical recycling, scale of operation, National Post Consumer Plastic Waste Management Project, mixed-mode surveys, financial analysis



811/F

The contribution of religious rituals to link Sinhala and Tamil communities: The case of Panama in the Eastern Province of Sri Lanka

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According to Victor Turner, the liminal condition created by rituals derived from their anxieties concerning security, safety and well-being create a space for collaboration among diverse ethno-religious groups. Little attention is paid to how conflicting ethno-religious groups in Sri Lanka actually unite in everyday interactions. This paper based on an ethnographic research conducted in Pānama discusses how this is possible in a background where stigmatized ethno-religious identities continue despite anxiety between communities. Further, how religious rituals construct a space for conflicting groups to develop relationships with special reference to Victor Turner's idea of *communitas*, i.e. unstructured groups of equal standing, will be discussed. Reference will be made to two annual religious performances, namely, PādaYātra, the pilgrimage to the shrine of the Hindu god Murugan (or Kataragama), and Ankeliya, a ritual to worship the Hindu goddess Pattini and god Kōvalan. The religious festival season in this part of the country in general and Pānama in particular begins in the month of July with PādaYātra, The Ankeliya ('horn pulling') ritual to respect Goddess Pattini and God Kovalan is usually performed in the following month. Both Sinhala and Tamil devotees of Pānama join the PādaYātra with the other pilgrims (Sāmis) at Pānama. They engage in a three-to-six-day walk of around 105 km to the Murugan Shrine in Kataragama through the harsh conditions of the Yāla National Park. During the Ankeliya ritual the entire village is divided into two groups; *udupila* ('upper side') and *yatipila* ('lower side') generationally. Irrespective of caste, class, gender, age, ethnic or other divisions of everyday life the villagers are united to pay their respect to Goddess Pattini and God Kovalan in line with the traditional beliefs. The findings suggest that *communitas* in the local context are formed through their rituals that mix Hindu and popular Buddhist religious traditions. These festivals bring security, prosperity and well-being in general to conflicting communities, Sinhalese and Tamils. This indicates that members of rival ethno-religious groups are inclined to disregard their differences in the context of rituals.

Keywords: *Communitas*, ethnic conflict, ethnic border crossing, pilgrimages, Pattini worship



812/F

Construction of a health well-being index and its application in a selected fisher community

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The World Health Organization defines health as a state of complete physical, mental and social wellbeing and not merely absence of disease or infirmity. The contemporary thinking is the recognition of dualism between objective and subjective measurements in measuring of health well-being. However, many currently used indexes depend only on either subjective or objective parameters. This study attempted a) to identify parameters to describe health well-being using both subjective and objective perspectives, b) to use identified parameters to construct an index, and c) to apply the constructed index to explore health well-being in a selected community in Sri Lanka. Twenty-three parameters related to health well-being were identified through a review of literature. Identified parameters were grouped into five sub themes as, i) physical fitness, ii) mental fitness, iii) healthy environment, iv) access to healthy food and clean water, and healthy behavior and v) and accessibility of medical services. The Rekawa fishing community in Southern Sri Lanka was selected to apply the prepared indicators. Four modes of fishing, a) beach seiners, b) one day fishing, c) multiday fishing, and d) lagoon fishing, were practiced by the community. Forty fisher households were selected from each of the four identified categories based on predominant engagement in selected mode of fishing. Twelve qualitative interviews were conducted to validate the quantitative findings.

The incidences of daily betel use, smoking, and liquor consumption are 72%, 69% and 43% respectively. Mental fitness and healthy living environment is highest for lagoon fishers. One day fishers report highest physical fitness. Best sanitation and health habits are reported by beach seiners. Access to health services and availability of healthy food and water are highest in multiday fishers. The community records an overall value of 0.7 in health well-being index. There are no significant differences among health well-being of households by fishing mode. In conclusion, the constructed index can be used to compare health well-being of different sub groups of a community and among communities.

Keywords: Modes of fishing, sanitation, nutrition status, consumption of betel, Rekawa



813/F

Effect of environment-based activities in learning chemistry: An experiment based on selected topics in G.C.E (Advanced Level) chemistry curriculum in Sri Lanka

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Principles of modern education guide teachers to provide opportunities for students to construct and apply their knowledge to engage in higher order thinking abilities while keeping the student at the centre of the process. This study was conducted with three objectives, a) to identify topics in the current General Certificate of Education (Advanced Level) chemistry curriculum that can be incorporated in to environment-based teaching, b) to introduce the environment-based activities to identified subject areas, and c) evaluate the effect of the above application on students' learning outcomes.

Four topics of advanced level chemistry syllabus; i) hydrology investigations, ii) paper chromatography, iii) pH, and iv) indicators of functional groups were identified. Two learning sessions on each selected topic were planned based on either, a) integrated method, or b) the conventional method. Environment-based activities; field studies, *in-situ* observations, *in-situ* investigations, and *in-situ* recordings were included under the Integrated method. Teacher demonstrations, classroom discussions, laboratory experiments and students' presentations were included in the conventional classroom method. A randomly selected sample of 320 students from schools in the Western Province of Sri Lanka was allocated to eight study groups of forty students each. The learning of all groups was facilitated by the same teacher. Pre-tests and post- tests were conducted and the results were analyzed to compare achievements under two learning methods. There was no significant difference in pre-tests marks between conventional and environment-based groups. The post-test marks of all four groups with environment-based activities were significantly higher than that of the corresponding conventional groups. These results indicate that environment-based learning is more effective than traditional methods in learning concepts in the current G.C.E (A/L) chemistry curriculum.

Keywords: Educational achievement, pre and post tests, teaching and learning, student-centered learning, Western Province of Sri Lanka



814/F

The use of students' feedback indicators in programme quality assessment in Sri Lankan universities

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The need for assurance of quality in higher education programs has continued to draw the attention of stakeholders globally and in Sri Lanka. The key purpose of reviews of educational programmes is to evaluate the overall quality of education provided by a specific degree programme. This activity is based on the perception of students on their learning experience and achievements. However, there is no established formal mechanism to assess and evaluate the students' educational and learning experience in the Sri Lankan context. The objectives of this study were a) develop a set of applicable indicators to evaluate programs in the Sri Lankan context, and b) to apply developed students' learning experience indicators to evaluate selected degree programme performance.

Indicators were selected based on a review of literature on current international practices of evaluation of study programs. Fourteen indicators were identified and included in to seven categories as; i) curriculum design; ii) teaching and learning; iii) assessment methods; iv) generic skills; v) academic guidance and counseling; vi) support and resources, and vii) learning community. Applicability of selected indicators was validated using responses to a structured questionnaire by 748 undergraduate students from seven universities that offered undergraduate programs on management. Validated indicators were subsequently used to evaluate selected six undergraduate study programmes through a survey of a total of 249 undergraduates selected from two universities. The findings support the use of students' educational and learning experience based indicators in evaluating and comparing the performance of degree programmes. The indicators identified and the procedures can be used in identifying areas for improvement at programme level and faculty level, or comparing performance within programmes to identify the weaknesses and good practices.

Keywords: Learning experiences, perception based Indicators, performance evaluation, teaching and learning, undergraduate programs



815/F

**Effects of the use of inward remittances on primary education by rural households:
A case study in the Galewela DS Area**

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Large scale migration for foreign employment from Sri Lanka started after the economic liberalization policies implemented after 1977. Around two million Sri Lankans are currently employed in foreign countries generating a remarkable amount of inward remittances. This accounts for nearly 8.3% to the Gross National Product of Sri Lanka and is second only to total export earnings from the apparel sector. This indicates that remittances play an important role in the economy. However, literature in this area is confined to the benefits of migration and do not focus on the effect of remittances on reduction of poverty. The impact of remittance on education levels of households especially are not adequately studied or documented. Therefore, the present study was conducted with the objective of measuring the usage of remittance in primary education and its effects. This study was conducted in Galewela, a predominantly rural area within the Central Province of Sri Lanka. Forty-five households were randomly selected from beneficiaries of foreign remittances *via* Sampath Bank PLC and another 45 households that did not receive remittances but resided in the same area were selected for comparison with the beneficiary households. Data were collected through interviews using a pre-structured questionnaire. Findings of the study reveal that households that receive inward remittances spend a higher share of their income on primary education of their children than other households. Children in households that receive inward remittances; show better academic records; participate more in extra-curricular activities; depict signs of better personal development; are more aspired to gain further educational achievements; and have higher rates of participation in tuition classes when compared with children in other households. Results of Wilcoxon signed-rank test based on five criteria reveal that the indicators of involvement of rural primary education has increased after the remittances are invested according to perceptions of parents of families receiving remittances. Therefore, it is concluded that remittance has been effectively used for the primary education of children of rural households.

Keywords: Foreign employment, primary education, personal development, Wilcoxon signed-rank test, school activities



Poster Presentations



901/A/Poster

Body composition of exclusively breast-fed, 4-6 months old infants by ¹⁸O isotope dilution

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Body composition refers to the percentages of water, fat, bone and muscle in the human body. Body composition in early life impacts a wide array of health outcomes later in life. Knowing the body composition in infants is considered valuable in pediatric care. This study was designed to measure the body composition of 4-6 month old, exclusively breast-fed Sri Lankan infants.

Twenty five healthy, exclusively breast-fed infants (aged 4-6 months) were randomly recruited for the cross-sectional study at well-baby clinics. Body composition was measured by isotope dilution of ¹⁸O. Infants' weights and lengths were measured using a standard scale and an infantometer respectively. A pre-dose urine sample (2 mL) was collected from each infant. A dose of ¹⁸O water (10% ¹⁸O enrichment) at 10 mg/kg body weight was administered orally to each infant. Post dose urine samples were collected after 5 hours and on day 3. Urine samples were analyzed by isotope ratio mass spectrometry. Isotope dilution space was calculated using the back extrapolation method. Body composition was calculated using standard equations. Data analysis was done by SPSS and p<0.05 was considered significant.

Mean (\pm SD) age of the infants was 4.5 months (0.8). Mean body weight and length of the infants were 6.5 kg (0.9) and 64.7 cm (2.8), respectively. Mean total body water (TBW), fat free mass (FFM), fat mass, and % fat mass were 3.86 kg (0.65), 4.6 kg (0.8), 1.9 kg (0.5) and 29.5% (6.1) respectively. % TBW and FFM were higher in boys when compared to girls [TBW: 61.3 % (5.9) vs. 56.7 % (2.9), p=0.02; FFM: 5.0 kg (0.8) vs. 4.3 kg (0.6), p=0.01, respectively].

Reference data on infants' body composition in developing countries are limited. Body composition of Sri Lankan infants was found to be comparable to the normative data available from industrialized countries. However, the requirement for longitudinal body composition data on infants in developing countries is emphasized.

Keywords: Fat mass, fat free mass, isotope ratio mass spectrometry, ¹⁸O dilution, total body water

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902/A/Poster

Availability of key information in package inserts of drugs used in Sri Lanka

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Package inserts (PIs) aim to provide information about drugs to health professionals. Incomplete or missing information in PIs may lead to medication errors and affect patient safety. We aimed to assess the availability of key information in PIs of drugs used in Sri Lanka.

A sample of 100 PIs were randomly selected from drugs dispensed at a government hospital and a private pharmacy. This sample included at least one PI related to a drug in each Anatomical Therapeutic Chemical class (level 1). A list of essential information to be included in a PI was developed by a Senior Pharmacologist and Senior Pharmacist taking into consideration the regulations of the Cosmetics, Devices and Drugs Act (CDDA) No. 27 of 1980 (CDDA). Some essential criteria not mentioned in the CDDA regulations, but deemed important to be included in PIs, were adopted from the 'Guidance for Useful Consumer Medication Information' of the Food and Drug Administration (FDA), USA, 'DISCERN' developed by the British National Library and the University of Oxford in 1997, and guidelines introduced by the Picker Institute of Europe in 2006.

The 100 PIs included, 60%, 29%, 4%, 2% and 5% of inserts related to oral, injection, local application, inhalation and other drug dosage forms respectively. 82% of PIs had at least one deviation from the CDDA regulations. The most frequent deviations were related to pharmacokinetic data, duration of treatment, overdose, and dosage information in special situations. In addition, only 30% of PIs indicated the route of administration, 24% specified what should be done for an adverse reaction, 32% specified maximum dose of the drug, and 50% of PIs provided definite information on pregnancy and lactation. Among the 100 PIs, 56% did not specify to whom the information was aimed at, 93% failed to indicate the sources of information, 87% did not specify where to refer for additional information, and 79% did not indicate the date of publication.

We conclude that information provided in PIs are inadequate. Most PIs did not even contain information specified in CDDA regulations, which is unacceptable and a potential threat to patient safety. There is an urgent need to continuously review PIs prepared by drug manufacturers and for regulatory authorities to ensure that adequate information is available to health professionals.

Keywords: Package inserts, medicines information, patient safety, medicines, Sri Lanka



903/A/Poster

Knowledge, attitudes and practices of pregnant mothers on maternal nutrition in the Pannala MOH area

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Maternal nutrition during pregnancy is crucial in reducing maternal and infant mortality, morbidity and adverse birth outcomes. Even though a mother's Knowledge, Attitudes and Practices (KAP) on nutrition is one of the key determinants of nutritional status, no study has been conducted to assess the KAP of pregnant mothers on nutrition in the Pannala MOH division. Hence, this cross-sectional clinics based study was conducted to ascertain pregnant mothers' KAP towards maternal nutrition using a pre-tested interviewer administrated questionnaire. A total of 150 mothers were interviewed. The KAP levels of pregnant mothers were evaluated on scales of 0 to 23, 0 to 14 and 0 to 9, respectively. Scores were given on the basis of the response of subjects to each question. Each positive/correct answer was given 1 mark and negative/incorrect answer was given 0 marks. The mean value of the total score was calculated and according to these mean values, the scores were divided as low and high for knowledge, positive and negative for attitudes and good and poor for practices. Further, simple descriptive analysis (n & %) was used. Age of pregnant mothers ranged from 19 to 40 years with a mean age of 27.3 ± 4.59 years and the entire sample was literate. The results showed that 71% of mothers had a higher knowledge level on nutrition with the mean score of 19.4 ± 2.18 . Out of the total, 12%, 42% and 47% of pregnant mothers knew about energy rich food, major nutrients present in animal foods and yellow colour foods respectively. They had a good knowledge about the importance of having calcium (98%), folate (86%) and small frequent meals (92%) during pregnancy. In this study, 88% of mothers had positive attitudes on nutrition during pregnancy with the mean score of 12.18 ± 1.38 . Although most of the mothers had positive attitudes, only 30% of mothers had a positive attitude on the bad effects of high consumption of vitamin A. Further, 36% of mothers avoided some foods during pregnancy due to traditional beliefs. A majority (85%) of mothers had good practices on nutrition with the mean score of 8.19 ± 0.82 . Ninety percent of mothers consumed a variety of food and iodized salt, 96% did not drink tea soon after meals and 95% did not skip any meals during pregnancy. Even though only 54% of mothers consumed "Thiriposha" daily, no one consumed fast foods daily. When selecting food items, 75% considered the nutritive value of foods. The results showed that there was no relationship between socio-demographic characteristics and KAP of mothers regarding nutrition during pregnancy. This study concluded that the mothers had a good knowledge, positive attitudes and followed appropriate practices regarding nutrition during pregnancy.

Keywords: Pregnant mothers, maternal nutrition, knowledge, attitudes, practices



904/A/Poster

Knowledge, attitudes and practices of mothers regarding infant feeding in the Pannala MOH area

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Child nutritional problems remain as one of the public health problems in Sri Lanka. The Knowledge, Attitudes and Practices (KAP) of mothers on infant feeding is very important to provide proper nutrients for infants. The present study was conducted to assess the KAP of mothers towards infant feeding.

This cross-sectional study was conducted among mothers of infants who were attending Maternal and Child Health (MCH) clinics during the study period and willing to participate in the study. Permission for the study was obtained from the MOH at Pannala and informed consent was obtained after briefing the mothers about the study. A total of 100 mothers were interviewed using a pre- tested interviewer administrated questionnaire. The knowledge, attitude and practice levels were evaluated by scales of 0 to 20, 0 to 15 and 0 to 17 respectively. Scores were given on the basis of the response of subjects to each question. Each positive/correct answer was given 1 mark and negative/incorrect answer was given 0 marks. The mean value of the total score was calculated and according to these mean values, the scores were divided as low and high for knowledge, positive and negative for attitudes and good and poor for practices. Data was analyzed descriptively and presented as percentages.

The age of the study sample ranged from 20 to 42 years with a mean age of 28.62 ± 4.57 years. Out of the total, there were no illiterate mothers and 42% were educated up to A/L. The majority (90%) of mothers were unemployed and 56 % of mothers had 2-3 children. The results revealed that all mothers knew about the Exclusive Breast Feeding (EBF) period as being up to 6 months but only 73% of them practiced EBF. A majority (97%) thought that colostrum is good for the baby and 96% fed colostrum. Only 22% of mothers have given other feeds during EBF period. 74% had knowledge about the duration of breast feeding as being up to 24 months. 80% knew and practiced the initiation of complementary foods after 6 months. 67% and 27% of mothers introduced mashed food and semi-solid foods as initial complementary feeding respectively. 90% said that family foods should be introduced after 1 year and 87% said sugar and salt should be introduced after 1 year. However, 76% introduced sugar and salt before one year and 93% of mothers did not keep left over food for the next feeding. 92% have changed the feeding pattern when the mother or the child was ill, and among them 67.4% increased the quantity fed. Most of the mothers had positive attitudes regarding infant feeding such as breast milk is the best food for infant, first milk is good (98%), exclusive breast feeding should be practiced up to the first six months. Similarly 87% of mothers accepted that demand feeding is important, 90% mothers knew that they should take extra food during lactation. 35% of mothers said that they did not avoid any foods due to traditional beliefs during the lactation period. This study concludes that the mothers had good knowledge, positive attitudes and appropriate practices regarding infant feeding.

Keywords: Infant feeding, breastfeeding, knowledge, attitudes, practices

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905/A/Poster

Assessment of oxygen lowering methods as an egg hatching stimuli of primary dengue transmitting vector, *Aedes aegypti*

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The rearing of *Aedes aegypti* mosquitoes is complex and demanding due to several factors. The study on rearing of *Ae. aegypti* mosquito vectors is important for insecticide resistance, repellents and other control measures of vector mosquitoes; factors that affect mosquito fitness are of importance for the quality of fundamental and applied research. *Ae. aegypti* larvae are affected by temperature, density and available nutrition; mating is not necessarily accomplished naturally and females need a blood meal to produce eggs. Previous reports suggested an inverse relationship between dissolved oxygen and hatching of eggs flooded under conditions of static oxygen level; very low levels being required to induce a high degree of hatching. In contrast, even a slight lowering of the oxygen level while eggs were flooded provided powerful hatching stimulus such as by Brewer yeast. In this study, mosquito eggs were subjected to hatching using 200 mL portions of different hatching solutions such as tap water, boiled tap water, boiled tap water with Brewer Yeast Suspension (BYS), distilled water with BYS and distilled water and incubated at room temperature overnight. IAEA recommended larval food was used to feed larvae until they became pupae. For general rearing, mosquitoes were maintained at 26-28 °C, 72-80% relative humidity, under a 14-15 hr light and 9-10 hr dark cycle. A glucose solution (10%) was used to feed adult mosquitoes while chicken blood was used to feed *Ae. aegypti* mosquitoes to lay eggs. Counted hatching rates and survival rates were respectively 65% and 46% (n=63) in boiled tap water with BYS, 56% and 38% (n=52) in distilled water with BYS, 22% and 11% (n=53) in boiled tap water, 11% and 2% (n=56) in distilled water and 0%, 0% (n=28) in tap water. The development time duration from first instar to fourth instar in *Ae. aegypti* was 7-8 days (n=828). Pupae development took 2-3 days (n=494). Life span of the adult mosquito stage was 11-13 days (n= 435). This preliminary study on the hatching of *Ae. aegypti* eggs indicated that the yeast suspension method is more suitable than the boiled water method for the laboratory scale mosquito eggs hatching process.

Keywords: *Aedes aegypti*, brewer yeast, dengue vector, mosquito egg hatching

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906/A/Poster

Serum uric acid concentrations of newly diagnosed breast cancer patients

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Toxicity caused by oxygen radicals is considered to be associated with carcinogenesis. Uric acid (UA) is an antioxidant which could scavenge the oxygen radicals formed in the body and thus may have a protective role against cancer development. It is hypothesized that low serum UA may be associated with cancer risk. Altered serum UA concentrations are also reported in other disease status as well. As no data related to serum UA concentration and breast cancer (BC) is reported in Sri Lanka the objective of the study was to assess serum UA concentrations of BC patients and to compare with age matched apparently healthy females.

Newly diagnosed BC patients (n=150) were selected for the study after consent was obtained. Information on other diseases suffered by the BC patients were collected. Patients with diseases that could affect UA level (renal failure and cardiovascular diseases, etc) were excluded from the study. Apparently healthy age matched females (n=75) were selected as controls. Serum UA concentrations were measured using Kone 20XT biochemical analyzer. Statistical significances were determined when $p < 0.05$ using SPSS version 16. Mean serum UA concentration of BC patients was 200 ± 57 $\mu\text{mol/L}$ and a significant difference in UA according to the menopausal status was not observed. The mean serum UA of age matched healthy women was 256 ± 72 $\mu\text{mol/L}$ and serum UA of breast cancer patients was significantly lower ($p=0.000$) compared to healthy women. However, both groups had serum UA within the normal reference range (142-339 $\mu\text{mol/L}$) while BC women had UA levels closer to the lower reference margin. The UA concentration among BC and normal women studied via ROC curve showed 76% ($p=0.000$, CI 0.68-0.83) of area under the curve with UA cutoff value of 194 $\mu\text{mol/L}$ with 92% sensitivity and 63% specificity. In conclusion, it can be stated that serum UA concentrations of breast cancer patients are significantly low compared to healthy females.

Keywords: breast cancer, uric acid, antioxidants, menopausal state, ROC curve



907/A/Poster

Assessing the impact of known risk factors of breast cancer, on breast cancer specific survival

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Breast cancer continues to be a major cause of death among women in Sri Lanka. There are established risk factors for the development of breast cancer but their effect on the breast cancer specific survival (BCSS) of the disease is not clear. Therefore, this study was designed to explore the impact of established risk factors of breast cancer on the BCSS of breast cancer patients in the Southern Province of Sri Lanka.

This was a retrospective study which included all breast cancer patients who had sought the immunohistochemistry laboratory services of the Department of Pathology, Faculty of Medicine, University of Ruhuna, Galle from May 2006 to December 2012. A pre-tested, interviewer-administered questionnaire was used to gather information on risk factors. The BCSS time was calculated from the date of diagnosis of the disease to the death from breast cancer or death with breast cancer using the Kaplan-Meier model. Univariate Cox-regression analysis was performed with 95% confidence intervals and the impact was examined using hazard ratio (HR).

A total of 944 breast cancer patients were included. The mean age was 52.66 years (SD \pm 11.17). The five-year BCSS of the study population was 78.8%. The median survival time was 120 months. Univariate analysis of risk factors of breast cancer in patients who have developed breast cancer indicated that a family history of any cancer (HR=1.23, CI=0.89-1.69), family history of breast cancer (HR=1.397, CI=0.895-2.182), younger age at menarche (HR=1.38, CI=0.79-2.42), older age at menopause (HR=1.798, CI=0.45-7.191), being non lactated (HR=1.06, CI=0.73-1.54), menopausal state (HR=1.06, CI=0.74-1.53) and age at first full term pregnancy of >30 years (HR=0.923, CI=0.549-1.552) had no significant correlation with the BCSS ($p>0.05$). The overall survival was similar in parous and nulliparous women (HR=1, CI=0.68-1.52). An improved survival was observed for patients who had never used oral contraceptive pills (HR=0.65, CI=0.36-1.13). In conclusion there was no impact of the established risk factors of breast cancer on the BCSS of the cohort of patients studied.

Keywords: Breast cancer, risk factors, breast cancer specific survival



908/B/Poster

Vegetative growth and crop water requirement of *Pogostemon heyneanus* Benth. (Lamiaceae) grown under coconut

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Pogostemon heyneanus Benth. (Lamiaceae) is a large, straggling under shrub which is cultivated for its fragrance and other therapeutic benefits. A field experiment was conducted to investigate the effect of shade on *Pogostemon heyneanus* in terms of vegetative growth (plant height, number of leaves, number of branches, branch length, plant spread, and plant girth) and crop water requirement. The study was conducted with two treatments of open field and under matured coconut palms. Treatments were arranged in randomized complete block design with six replicates. Four mini lysimeters were installed as two lysimeters per each treatment in order to find out daily crop coefficients (Kc).

Plants grown under coconut were significantly taller than those grown under full sunlight as the plants grown in shade were found to be more apical dominant than those grown in full sunlight. This increased apical dominance would be a reason for the significant reduction in total branches in shade grown plants as it reduces the emergence of new shoots. The cooler micro climate under the shade of mature coconut palms resulted in a significantly higher number of leaves in shade grown plants than those grown in full sunlight. A significantly higher growth was observed in shade grown plants in terms of branch length than those grown under full sun light. This would be mainly due to the elongation in internode length of shade grown plants in order to capture more sunlight. The greater significant spread of plants found under shade could be explained by their higher growth in terms of increased plant height, total number of leaves, and length of branches than the plants grown under full sun light. Light intensity had no effect on plant girth since throughout the study, change in plant girth remained non-significant. Further, reduced crop water use was observed in plants grown under the shade as the logarithmic trend in crop coefficient (Kc) values are lower in shade grown plants than in plants grown under full sunlight.

According to the results, *Pogostemon heyneanus* could be successfully cultivated under the shade of mature coconut palms. However, further studies on herbage yield, oil content, oil composition, secondary metabolite content and bioactivity are needed in order to ensure the final yield and make recommendations.



909/B/Poster

Preliminary phytochemical screening and evaluation of anti-inflammatory properties of *Albizia* species

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Sri Lanka is one of the few countries in the world which is rich in exclusive species of medicinal plants and has enormous traditional knowledge in use of using herbal medicine for treatment of various diseases. *Albizia lebbbeck* (L.) Benth (Vern. Suriya mara) and *Albizia odoratissima* (L.F) Benth (Vern. Huri mara) are two species that belong to the family Fabaceae which contain remarkable medicinal value. These species have become rare in distribution due to higher demand for medicine, timber and over exploitation from natural habitat. On the other hand, due to the increasing demand for these species, adulteration has been reported in many instances. Therefore, this study intends to screen phytochemicals and to evaluate the anti-inflammatory properties of these *Albizia* spp. to fulfill its quality control needs and to identify which species contain the highest anti-inflammatory properties. Leaves, barks, seeds and flowers of the above two species were subjected to sequential extractions using hexane, chloroform, ethyl acetate, methanol and water. Phytochemical screening of these extracts revealed the presence of alkaloids, glycosides, flavonoids, steroids, tannins, saponins, and terpenoids in different parts of the two species. Methanol extract showed the highest number of phytochemicals while hexane extract showed the least numbers of phytochemicals. Human red blood cell (HRBC) membrane stabilization method was used to evaluate anti-inflammatory activity. Leaves, barks, seeds and flowers of *A. lebbbeck* and *A. odoratissima* were subjected to sequential extraction with hexane, chloroform, ethyl acetate and methanol. Methanolic extraction of barks and seeds of both species have shown higher anti-inflammatory activity compared to the standard (asprin). The presence of anti-inflammatory activities in the barks and seeds of these two species was a worthy indication for exploring these species as potential sources for developing pharmaceuticals.

Keywords: *Albizia lebbbeck*, *A. odoratissima*, anti-inflammatory, phytochemical screening



910/B/Poster

Development of chemical profiles and preliminary phytochemical screening for shoots of *Rhinacanthus* species (Acanthaceae) of Sri Lanka

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Rhinacanthus nasutus (vern: Gas anitta), *Rhinacanthus polonnaruwensis* (vern: Anitta) and *Rhinacanthus flavovirens* (vern: Heen anitta) are three medicinal plant species of Sri Lanka belonging to family Acanthaceae. *R. nasutus* has been used to treat skin diseases in several countries and detailed phytochemical studies were conducted for the species. Although *R. polonnaruwensis* and *R. flavovirens* have been used in Sri Lankan traditional medicine for skin disorders for many years as has *R. nasutus*, their chemical compositions are not yet reported. The physicians as well as the patients who utilize plants of this genus as medicine are faced with difficulties in identifying the most medicinally effective plant species. Therefore, this study aims to develop chemical profiles to discriminate *Rhinacanthus* spp. of Sri Lanka and fulfill their quality control needs. After authentication of the three *Rhinacanthus* spp. at the national herbarium of Sri Lanka, the chemical profiles were developed for their shoots using Thin Layer Chromatography (TLC) for hexane, ethyl acetate and methanol sequential extracts and detected in natural and UV light (at $\lambda = 254$ nm and 365 nm). Solvent extracts of *Rhinacanthus* spp. shoots showed a better separation of their compounds with a mobile phase of toluene: ethyl acetate (75:25 v/v). The results suggested that TLC profiles have the potential to identify *Rhinacanthus* spp. of Sri Lanka. Standard qualitative phytochemical screening of these extracts revealed the presence of alkaloids, flavonoids, steroids, saponins, and terpenoids in the shoots of all three *Rhinacanthus* species. Methanol extracts showed the highest number of phytochemical groups while hexane extract showed the least number of phytochemicals of the three solvent extracts indicating that more polar phytochemicals are present in shoots of *Rhinacanthus* spp. compared to nonpolar compounds. Further isolation and purification of phytochemicals of *Rhinacanthus* spp. are needed to elucidate the chemical constituents to assess their efficacy.

Keywords: *Rhinacanthus* species, Thin Layer Chromatography, phytochemical screening



911/B/Poster

Moss endophytes and polyaromatic hydrocarbon degradation

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Polyaromatic hydrocarbons (PAHs), coming from many urbanization and industrialization processes are known to be toxic, carcinogenic and mutagenic. Bioremediation using endophytic fungi has been a novel attempt to remove PAH in an environmental friendly manner. In this study, an attempt was made to isolate and identify endophytic fungi from the *Macromitrium* sp. and to investigate their ability to degrade phenanthrene and naphthalene. Samples of healthy *Macromitrium* sp. were collected from the Sapugaskanda area (highly polluted) and Hettimulla area (minimally polluted). Moss samples were surface sterilized and endophytic fungi growing from these were isolated onto malt extract agar. Percentage frequency of occurrence was obtained from isolated colonies after identification up to the genus level. Using plate assay and spectrophotometric assay, ability to utilize PAHs and percentage degradation of PAHs on Bacto Bushnell-Haas media and broth, were measured respectively. The results were then analyzed using ANOVA (one way) and Tukey's pair-wise comparisons. Then genomic profiles of each fungus were obtained. Out of 36 and 21 endophytic fungi, from Sapugaskanda and Hettimulla samples, *Eupenicillium* sp1 (highest frequency of occurrence) and sp2, *Aspergillus* sp1, *Penicillium* sp4, *Rhizopus* and a white sterile sp. were common to both sites. From the Sapugaskanda sample, *Mortierella*, *Nigrospora*, *Aspergillus* sp1 and *Penicillium* sp5 showed high growth in PAHs incorporated media. In the spectrophotometric assay, 12 and 7 endophytic fungal isolates (several *Penicillium* sp, *Aspergillus* sp. and *Nigrospora* sp.) of the Sapugaskanda sample showed naphthalene and phenanthrene degradation of over 90%. In contrast to that, almost all from the Hettimulla sample showed significantly lower colony diameter and PAH degradation percentages indicating that some fungal strains from the Sapugaskanda sample have a significantly higher potential to utilize PAHs due to some differences in genomes. Checking of genomic profiles was unsuccessful due to unfavorable genomic digestion. Considering all, it can be concluded that endophytic fungi in *Macromitrium* moss in the more polluted Sapugaskanda area have significantly higher PAH degradation capability than that of the less polluted Hettimulla area, indicating their potential to be used in further studies for the improvement of novel bioremediation processes.

Keywords: Polyaromatic Hydrocarbons (PAHs), bioremediation, *Macromitrium* sp. endophytic fungi



912/B/Poster

Arabinoxylans contents of Sri Lankan Finger Millet (*Eleusine coracana*) varieties

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Arabinoxylans (AX), the main non starch polysaccharide in cereals, are considered as dietary fibers and act as prebiotics with many health benefits. These have also demonstrated beneficial technological properties in food processing. As the consumer preference for functional foods is on the increase worldwide, prebiotics such as AX are gaining much interest. The present study was conducted to determine total AX, water-extractable AX (WEAX) and water-unextractable AX (WUAX) contents of Sri Lankan finger millet varieties, namely Ravi, Rawana and Oshada.

Finger millet samples were collected from the Field Crop Research and Development Center, Mahalluppallama. Total AX and WEAX contents were determined according to the *Phloroglucinol colorimetric assay*. D(+)-xylose was used to plot the standard curve. All samples were analysed in triplicate and data of each experiment were statistically analysed using the MINITAB 14 statistical software. Statistical significance was set at 95% confidence level. One way analysis of variance (ANOVA) was used to determine the differences among the varieties. Total AX percentages of Ravi, Rawana, and Oshada were 1.86 ± 0.05 , 1.82 ± 0.11 and 1.93 ± 0.29 respectively. WEAX and WUAX percentages of Sri Lankan finger millet varieties ranged from 0.18 ± 0.02 to 0.20 ± 0.02 and 1.66 ± 0.08 to 1.76 ± 0.28 respectively. The variety Oshada had the highest total AX, WEAX and WUAX contents compared to the other two varieties. However, there were no significant differences ($p > 0.05$) among total AX, WEAX and WUAX contents of the three finger millet varieties. The findings of this study provide evidence for the prebiotic potential of Sri Lankan finger millet varieties.

Keywords: Arabinoxylans, finger millet, prebiotics

Acknowledgement: Indian - Sri Lankan Inter-Governmental Science and Technology Cooperation Programme



913/B/Poster

Development of ready-to-serve Aloe vera (*Alloe barbadensis* Mill) beverage

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Food and beverage which have physiological benefits beyond basic nutrition is preferred as they reduce the risk of chronic disease and prevent various ailments ranging from heart disease to cancer. Aloe vera is a spiky cactus like xerophytes, which produces large basal leaves. The leaves contain inner parenchyma cells or gel of the leaf under the rind. The gel comprises both mono and long chain polysaccharides and shows anti-allergic effects, anti-diabetic effects, decreases blood lipids levels, supports digestive system health and treats constipation. A study was carried out to develop a ready to serve Aloe vera natural colour beverage that can be consumed as a health drink. Fresh Aloe vera leaves were washed with portable water, in 150 ppm chlorinated water and again with potable water. The bottom parts of the leaves were cut and lines were marked on the leaves with a sharp knife. Leaves were placed in an upright position inside a bucket overnight to remove bitterness. Leaves were peeled and the gel was removed using a cleaned sharp knife. Gel parts were cut into tiny pieces and mixed with citric acid. Gel pieces were washed with water and blended to obtain juice. The resulting juice was strained and heated while stirring. Sugar was added to the heated juice. Citric acid was added to maintain the pH below 3.5. Sodium metabisulphite 50 mg/kg was added and mixed well. Cleaned glass bottles and caps were rinsed with hot water (~ 80 °C) and drained. The heated juice (~80 °C) was filled into bottles (200 ml) and capped. The sealed bottles were kept in a water bath at 80 °C for 20 minutes and cooled to room temperature. Chemical characteristics of total soluble solids content, pH, energy value, moisture, total sugars, protein, fat, fiber, and ash and calcium contents were determined. The quality of the finished product was maintained according to the requirements of SLS 729:2010. The products were stored under room temperature (30 ± 2 °C), refrigeration (10 °C) and the reference products were frozen. Changes in total soluble solids, pH, and colour of the product tested within a six month period (tested at one month intervals) were found to be in the accepted range. The product was tested for sensory and microbiological parameters initially at one month intervals. The sensory quality attributes of the refrigerated product is significantly superior ($p < 0.05$) to the product stored at room temperature. There was no significant difference ($p > 0.05$) between the sensory quality attributes of the refrigerated product and the above up to a six month shelf life duration. Aerobic plate counts, yeasts and moulds, coli forms and *E coli* counts were in the accepted range during the six month shelf life period. Results showed that the developed natural colour ready-to-serve Aloe vera beverage stored under refrigeration at 10 °C up to six months can be used as a health beverage. Non-thermal techniques of micro filtration, ultrasonic treatments and cryogenic processing are being tested to maintain the therapeutic effect of Aloe vera gel and overall juice quality.

Keywords: Aloe vera, thermal processing, ready-to-serve beverage



914/B/Poster

Lead and Chromium contamination of irrigation water, soil and green leafy vegetables collected from different areas in and around Colombo District, Sri Lanka

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Excessive buildup of heavy metals in agricultural soils may contribute to environmental contamination, as well as increased heavy metal uptake by vegetable crops, which ultimately lead to adverse health consequences in mankind. A study was conducted to evaluate the Lead (Pb) and Chromium (Cr) concentrations in randomly collected samples of irrigation water, soils and green leafy vegetables ["Mukunuwenna" (*Alternanthera sessilis*), "Thampala" (*Amaranthus viridis*), "Nivithi" (*Basella alba*), "Kohila Leaves" (*Lasia spinosa*) and "Kankun" (*Ipomoea aquatica*)] obtained from six different locations [Wellampitiya (11 sites), Kolonnawa (5 sites), Kottawa (5 sites), Piliyandala (9 sites), Bandaragama (5 sites) and Kahathuduwa (5 sites)] in and around Colombo District, Sri Lanka using Graphite Furnace Atomic Absorption Spectrometry. The mean concentrations (mg kg^{-1} , dry weight basis) of Pb and Cr in the soils were reported as 39.7 ± 32.30 and 48.4 ± 42.90 respectively. The maximum level of Pb detected in irrigation water samples was 2.01 mg/L and Cr was not detected in any of the irrigation water samples analyzed. The mean levels (mg kg^{-1} , dry weight basis) of Cr and Pb in green leafy vegetables were reported as 3.36 ± 2.76 , 2.96 ± 2.16 for Mukunuwenna, 3.58 ± 2.80 , 3.14 ± 2.32 for Thampala, 3.28 ± 2.45 , 3.11 ± 2.33 for Nivithi, 5.02 ± 4.09 , 4.32 ± 3.47 for Kohila and 3.47 ± 2.88 , 3.21 ± 2.44 for Kankun respectively. Significant differences were observed in Pb and Cr levels, between both production sites and green leafy vegetables analyzed at $P < 0.05$. Maximum Pb and Cr contaminations were found in the green leafy vegetables collected from Kolonnawa area, owing to the high traffic and population density, close proximity to the Kolonnawa oil refinery and Meethotamulla garbage dumpsite and various industries, warehousing complexes, and automobile workshops operating in the area. The highest accumulations of both metals were found in Kohila leaves among the green leafy vegetables analyzed. This may be attributed to differential uptake capacity of vegetables for different heavy metals through roots and their further translocation within the plant parts. Thus, the study highlights the potential risks involved with the consumption of leafy vegetables cultivated in the contaminated areas which may adversely contribute to food quality and safety.

Keywords: Contamination, green leafy vegetables, lead, chromium

Acknowledgement: UGC Research Grant (VC/DRIC/PG/2013/SUSL/01).



915/B/Poster

Developmental biology of *Micraspis discolor* (Fabricius) (Coleoptera: Coccinellidae), a predator of *Aphis craccivora*

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Micraspis discolor (Fabricius) is predatory coccinellid species prey on aphids and leaf hoppers. This species has been considered as potential candidate for augmentative release in biological control to manage aphids. In order to promote this species as a biocontrol agent it is necessary to have the details on growth and development; hence, present study was conducted to generate the data on developmental biology of *M. discolor* under the laboratory conditions. The experiment was conducted in the Entomology Research Laboratory, Department of Agricultural Biology, Faculty of Agriculture, University of Peradeniya, during September to December 2014 under laboratory conditions of 27°C and 80 % RH. The average incubation period of *M. discolor* was 3.61 ± 0.27 days and the total larval duration was 9.23 ± 0.50 days. The first instar larval period was 2.07 ± 0.10 days. According to the results, reported 2nd instar larval duration was 3.07 ± 0.08 days while 3rd and 4th instar larval durations were 1.92 ± 0.08 and 2.15 ± 0.76 days, respectively. The observed pre-pupal and pupal periods were 1.07 and 3.84 ± 0.10 days, respectively. The mean longevities of the male and female beetles were 36.23 ± 0.47 and 44.69 ± 0.82 days, respectively. The mean pre-oviposition period was 5.07 ± 0.77 days and the oviposition period was 41.30 ± 0.95 days. *M. discolor* has 17.75 ± 0.21 days to complete the development. Adult life span is over one month. *M. discolor* can be suggested as potential predatory species according to its developmental biology.

Keywords: Instar, larval duration, oviposition

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916/B/Poster

A landscape analysis of food control framework in Sri Lanka

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The local food industry is a top seated money maker in the Sri Lankan economy. Hence, food controlling becomes an essential and integral concern both for the consumer and industry. As a country which possesses a high posted food industry in its economy, being equipped with an effective and proactive national food control system is of paramount importance. In this study attempts were taken to explore the prevalent food control system in Sri Lanka identifying the local food control agencies and their legislations on different aspects of food trade. The central food administration unit, Sri Lanka Standards Institution, local food control agencies and the stakeholder group of food regulators were surveyed by way of unstructured interviews to analyse the *status-quo* of local food control systems. Altogether 29 respondents were interviewed covering the pertinent stakeholders of apex food control management, inspection and analytical personnel, food operators along with related academia. At present, the multiple agency food control system in Sri Lanka suffers from fragmented mandate, poor coordination, bureaucracies along the way from farm to table continuum. Moreover, Sri Lanka being a developing country, the food industry's infrastructure is deemed poverty stricken and therefore the regulators have to arrive at a compromise between public health protection and industry development in imposing food regulations. Conclusively, the components of the local food control system require improvements and constructive and conceivable recommendations to uplift the local food control framework highlighting an integrated and participatory approach with relevant stakeholder groups. In this case, the study has made its recommendations to obtain assistance from international agencies, especially WHO and FAO, to prepare guidelines.

Keywords: Food control systems, food legislations, food regulations, food standards, Sri Lanka



917/D/Poster

Phytochemical and physicochemical analysis of *Ocimum sanctum* Linn from North Central and Southern provinces of Sri Lanka

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Ocimum sanctum Linn (known as Maduruthala in Sinhalese, Tulsi in Hindi), is a small herb belonging to family Lamiaceae and has been recommended for the treatment of bronchitis, bronchial asthma, malaria, diarrhea, dysentery, skin diseases, arthritis, painful eye diseases, chronic fever, insect bite etc. Traditionally, *O. sanctum* L. is taken in many forms, as herbal tea, dried powder or fresh leaf. *O. sanctum* is widely cultivated in Asian countries including India and Sri Lanka. The active constituents such as eugenol and methyl eugenol present in *O. sanctum*, have been found to be largely responsible for the therapeutic potentials of the plant. Within the same species of plant, the composition of these compounds can vary with the nutrient composition of the soil, climatic season, development stage of the plant, natural association with other plants, storage of raw materials and the types of processing methods such as drying and extraction procedures. Therefore, the present study was designed to investigate differences or similarities in terms of (a) chemical composition of essential oil by GC analysis (b) physico-chemical parameters according to WHO guidelines [ash values and Thin Layer Chromatography (TLC) fingerprint] using *O. sanctum* grown in two provinces of Sri Lanka. *O. sanctum* was collected from two cultivations in the North Central and Southern provinces of Sri Lanka. Only aerial parts of the plant were used for the investigation.

Essential oil yield of plants collected from the North Central and Southern provinces were 1.9 and 1.5 % v/w respectively. Chemical composition of the oil was analyzed using gas chromatography revealed that plants collected from the North Central and Southern provinces contain 51.2% methyl eugenol, 19.7% β caryophyllene, 5.3 % eugenol and 64.7% methyl eugenol, 21.3% β caryophyllene, 0.6 % eugenol respectively in their essential oils. Further, a high content of methyl eugenol was present in plants collected from the Southern province. Total ash, water soluble ash and acid insoluble ash content of *O. sanctum* grown in the North Central province and Southern province were 12.9 ± 0.08 , 6.7 ± 0.14 , 0.35 ± 0.02 (% w/w) and 8.6 ± 0.03 , 3.6 ± 0.001 , 0.17 ± 0.02 (% w/w) respectively. TLC fingerprint profiles were established for CH_2Cl_2 extract of the plant by using CHCl_3 and MeOH in a ratio of 5:0.1 (v/v). Eleven number of prominent spots were present in the TLC profile after spraying vanillin sulphate. However, there were no significant differences between the TLC profiles. In conclusion, this study revealed the differences (by % of methyl eugenol, β caryophyllene and eugenol) and similarities (by TLC fingerprint profiles) of *O. sanctum* grown in the North Central and Southern provinces of Sri Lanka.

Keywords: *Ocimum sanctum* Linn, Lamiaceae, essential oil, physico-chemical parameters, thin layer chromatography



918/D/Poster

A preliminary study on impact of agrochemical-free rice cultivation on soil characteristics

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Rice is the major staple crop in Sri Lanka. Rice is cultivated mostly using agrochemicals, both fertilizer and pesticides. This study was carried out to have an insight into the impact of agrochemical use on soil properties and hence soil fertility. Three adjacent sites were selected from Rammuthugala in the Gampaha District, to represent paddy fields cultivated with and without agrochemicals (both inorganic fertilizer and pesticides), and an abandoned field. Soil samples were collected from ten sampling sites randomly from each type of field, and from two depths, i.e. from surface down to 15 cm depth and from 15 – 30 cm depth. Five composite soil samples were prepared from each paddy field for each depth. All soil samples were collected one month after harvesting. As soil physical properties, water content, bulk density, porosity, texture, water saturation capacity and soil color were determined. Chemical properties, i.e. pH, saturated paste extract conductivity, Oxidizable matter/ organic carbon content, exchangeable Ca and Mg content (by EDTA titration method), Fe content and NO_3^- (by colorimetric method), total nitrogen content (by Kjeldhal method), available P content (by spectrophotometer method), loss on ignition (using muffle furnace), C: N ratio and exchangeable acidity were also measured. Earth worm density was determined as a surrogate variable for overall fertility of soil. “Sandy Clay Loam” soils were found in all three sites and the soil in the field cultivated without chemicals was dark grey to black in color indicating the presence of high organic matter content. It also contained the highest available water content as 43.53%, soil porosity as 52.62%, water saturation capacity 50.18%, optimum pH level, as well as highest saturation paste extract conductivity 257.40 $\mu\text{S}/\text{cm}$, and organic matter content 10.02%. The highest ex. Ca (3.1 me / 100 g content), exchangeable iron content (13.86 mg / kg) nitrate content (6.94 mg / kg), total nitrogen (N) (0.37%), and average. phosphorous (18.39 mg / kg), content along with organic matter (highest loss on ignition, 16.53%), C/N ratio (44.68), and CEC (6.27 meq / 100 g), lowest soil bulk density (0.47 g cm^{-3}) and exchangeable acidity (22.88 meq/ 100 g) were also observed more in this field than in the field where chemicals were used. Highest earthworm density (255.56 no / m^3) indicated improved overall soil fertility in the field cultivated without agrochemicals. The results indicate that agrochemical-free rice cultivation is healthier for soil than agrochemical based rice cultivation.

Keywords: Agrochemicals, modern farming, organic farming, rice cultivation, soil



919/D/Poster

Antimicrobial activity of methanolic extracts from three selected Sri Lankan herbs against an antibiotic resistant strain of *Staphylococcus aureus*

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Medicinal herbs are valuable natural resources which can be used against various infectious agents such as pathogenic bacteria. However, limited or no studies in Sri Lanka have been undertaken regarding the antibacterial activity of medicinal plants against different resistant pathogenic strains such as *S. aureus*. Therefore, in the present study methanolic leaf extracts of three medicinal plants (*Mikania micrantha*, *Ageratum conyzoides* and *Emilia sonchifolia*) that are traditionally used in indigenous medicine were screened for their antimicrobial activity against an antibiotic resistant strain of *Staphylococcus aureus*. Different concentrations (200 mg mL⁻¹, 100 mg mL⁻¹, 50 mg mL⁻¹, 25 mg mL⁻¹ and 12.5 mg mL⁻¹) of crude extracts of various plant parts including leaves, root, stems and flowers were studied using well diffusion method to determine the plant part with the highest antimicrobial activity. Distilled water was used as positive control. Crude methanolic extracts of all three plant species demonstrated significant antimicrobial activity against *S. aureus*. The crude methanolic extracts of leaves of all three species showed the largest inhibition zones over stem, flower or root extracts. Minimum Inhibition Concentration (MIC) for *M. micrantha* was 200 mg/mL, while MIC of *A. conyzoides* and *E. sonchifolia* was 25 mg/mL. The leaf extracts obtained from *A. conyzoides* and *E. sonchifolia* showed a significant inhibition of growth of *S. aureus*. No inhibition zones were observed in the control samples. This study showed that the chemical compounds responsible for the inhibition of the growth of *S. aureus* are localized more in leaves. Results of this study indicate that, fractionate guided bacterial assay of the extracts of *A. conyzoides* and *E. sonchifolia* may result in identification of lead compounds with therapeutic applications against resistant strains of *S. aureus*.

Keywords: Antimicrobial activity, *Ageratum conyzoides*, *Emilia sonchifolia*, *Mikania micrantha*, *Staphylococcus aureus*



920/D/Poster

Diversity of benthic fauna at upper reaches of the Puttalam Lagoon

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Benthic animals play an important role in the food web as primary consumers and biological indicators for different environmental conditions. Similarly, these animals can be used in the determination of pollution levels and abundance of fish shoals. The objectives of this study were to identify the benthic fauna in the upper reaches of the lagoon and study their distribution in order to obtain an idea of the environmental condition of the lagoon. Benthic samples were obtained from 28 line transects (sampling sites) around the upper part of the lagoon. Sampling was carried out in 3 replicate at 5 locations along each line transect at 10 m intervals. Samples were collected using a hand operated corer, and were sieved *in situ* through 4 mm, 2 mm, 1 mm and 0.5 mm (500 μ m) mesh, fixed with Rose Bengal in 5% formaldehyde solution. Benthic fauna in each sample were identified to the nearest taxonomic category using standard guides. The diversity of benthic fauna in each sampling site was determined using Simpson's Diversity Index. The species richness (Family basis) was determined through Menhinick's index. Altogether 17 gastropod families, 03 bivalve families and 22 polychaete families were identified. Sampling site 7 was represented by 31 members of amphinomidae and 11 members of Pisionidae polychaete families. Sampling site 21 was represented by 23 members of polychaetes belonging to the Oweniidae family. The highest numbers of polychaete as well as gastropod families were recorded in sampling site 7. Highest number of polychaete worms was recorded in sampling site 7 as 58 and the second highest number of polychaete worms was in sampling site 21, as 27. Simpson's Index of Diversity of gastropods in all sampling sites except 1 and 17 are in the range of 0.30 – 0.99. Polychaete diversity was nil in sampling sites 8, 9, 15, 17, 20, 24 but in other sampling sites ranged from 0.43 – 0.98. The highest polychaete diversity was recorded as (0.9877) in sampling site 28. This lagoon is considerably rich in polychaete worms and mollusk but it is not a polluted water body.

Keywords: Polychaete, gastropod, benthic fauna, Puttalam lagoon



921/D/Poster

**Cloning and characterization of high molecular weight glutenin genes from
Triticum astivum cultivar dacke to develop wheat like rice**

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Gluten is a main seed storage protein in wheat, which is absent in rice. It is very important for the bread making process as it gives elasticity and extensibility to dough. The present study was initiated to produce transgenic rice expressing High Molecular Weight (HMW) glutenin genes to produce wheat-like rice. Genomic DNA was isolated from wheat leaves of *Triticum astivum* cultivar dacke. PCR was performed using HMW glutenin specific primers. Purified amplified fragments were cloned into pGEM®-T Easy Vector and sequenced. Five putative clones were identified and sequence analysis of the clones revealed the presence of functional and pseudogenes. The pseudogene had C to T transition in the repetitive central domain. The length of nucleotide sequence of functional gene was 2445bp encoding 815aa residues. The molecular weight of the deduced mature protein was 88KDa. This gene contained four cysteine residues that could provide intermolecular disulfide bonds to form protein polymers. The presence of glutamine residues (34%) has a very high capacity to form both intra- and intermolecular hydrogen bonds that could provide the elasticity for dough through formation of intermolecular hydrogen bonds. Repetitive central domain of the functional gene contains 44 tripeptides (GQQ), 6 hexapeptides (PGQGQQ) and a single nanopeptide (GYPTSLQQ). BLASTn analysis of functional HMW glutenin gene showed a high degree of homology to a previously published *Triticum astivum* HMW glutenin subunit Ax2* gene (M22208.2). Molecular phylogenetic analysis using the maximum parsimony method indicated that the cloned functional HMW glutenin gene (Accession number KJ939340) is closely related to Ax type subunit. Currently, work is underway to transfer the functional HMW glutenin gene to rice to generate transgenic rice plants.

Keywords: HMW glutenin, Dacke



922/D/Poster

In-vivo culturing of *Setaria digitata* life stages (*micro filariae*-L3 larvae) in *Culex quinquefasciatus* mosquitoes

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Setaria species (Filarioidea, Nematoda) are commonly found in the abdominal cavities of ungulates and the disease is mild in its normal host cattle. However, when it infects hosts such as sheep, goats and horses, the infectious larvae of *S. digitata* migrate erratically into the central nervous system causing a serious and often fatal neuropathological disorder commonly known as epizootic cerebrospinal setariosis or lumbar paralysis. This has an impact on livelihood of livestock farmers. In addition, *S. digitata* has been used as a model organism for human filarial parasites due to its ready availability and also its close resemblance to human filarial parasites in many respects including morphology, histology antigenicity and response to drugs. Therefore, it was necessary to develop an *in-vivo* culturing method to study the biology of life stages (L1, L2, and L3) of this socioeconomically important parasite. In this study, attempts were made to establish *in-vivo* culturing of *Setaria digitata* life stages using its intermediate host, the mosquito *Culex quinquefasciatus*.

A *Culex quinquefasciatus* colony was established using wild caught mosquitoes. They were fed with chicken blood and the F1 generation was obtained from eggs they have laid. In this study, instead of microfilaria infested blood feeding, microfilariae isolated from dissected adult worms were microinjected in to 3 day old female mosquitoes using a pulled borosilicate capillary injector under a dissection microscope. PBS (0.5 µl) containing 20 microfilariae were injected in to the thorax of the mosquito following anesthetization by exposing to chloroform for around 45-60 secs. The development of larval stages (L1 to L3) from microfilariae within the mosquito was monitored by dissecting them at predetermined intervals and visualizing under a light microscope. Within 24 hrs, 20% of the microfilariae transformed in to L1. Transformation of microfilariae in to 100% of L1, L2, L3 occurs in 3, 6, 10 days respectively. The outcome of this work demonstrates the vector competence of *Culex quinquefasciatus* for *S. digitata* and also enables us to study the functions of the genes, in the transformation of microfilariae to larval stages of *S. digitata* in mosquitoes using gene knock-down techniques such as siRNA mediated RNA interference.



923/E2/Poster

Qualitative determination of the levels of polycyclic aromatic hydrocarbons in contaminated macromolecular compounds using Gas Chromatography-Mass Spectrometry

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Food contamination can occur due to many different groups of chemical compounds in the environment. Polycyclic Aromatic Hydrocarbons (PAHs) are a group of organic compounds, which have been classified as possible and proven carcinogenic compounds to humans by the United States Environmental Protection Agency (US-EPA). The Agency has listed 16 priority PAH compounds to be analyzed in various contact sources. PAHs contain two or more fused benzene rings and they are formed as a result of incomplete combustion of organic materials such as petroleum, plastics, rubber, oil, garbage, wood, and food residues. Human exposure to PAHs can take place through inhalation, skin contact and consumption of contaminated macromolecules such as bread. In Sri Lanka, bread is one of the major macromolecular components of people's diet and it is one of the food items, which holds the potential risk of contamination by PAHs as the bread making process involves high temperature baking with various fuel sources such as wood, gas and electricity. Therefore, it is important to investigate the influence of fuel type used to bake bread on PAH contamination of bread. In this preliminary study, samples (bread/flour) were collected from three different types of bakeries using either fire wood, gas or electricity, over a period of eight weeks at one week intervals. The presence of PAHs in bread collected from these bakeries was assessed qualitatively. Extraction and cleanup of PAHs were done using Soxhlet apparatus and silica column respectively and samples were analyzed using Gas Chromatography-Mass Spectrometry (GCMS). According to the findings, naphthalene (in 7 samples), anthracene (in 2 samples), phenanthrene (in 1 sample) and fluorene (in 2 samples) were detected in the crust of bread baked using firewood and naphthalene was detected in the crust of two samples of bread baked using a gas oven. These four PAHs present in bread crust are possible carcinogens and therefore there may be a risk of exposing bread consumers to these PAHs in Sri Lanka. No PAHs were found in bread baked in electric ovens. Moreover, no PAHs were detected in bread crumb and flour mixtures in all samples collected from all three types of bakeries. It is evident from these preliminary results that there is a relationship between the method of bread baking and PAH contamination. Work is in progress to determine PAHs in bread quantitatively.

Keywords: Macromolecules, bread, contamination, polycyclic aromatic hydrocarbons



924/E2/Poster

**Analysis of dengue virus capsid protein for phylogeny and antigenicity:
A computer based approach**

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Capsid (C), the smallest structural protein of Dengue virus (DENV) has been proven to elicit antibody responses during natural infections. However, the detailed antigenic structure of C protein is yet to be revealed. This study aims to characterize the C protein for its antigenicity by available *in-silico* tools, considering their high speed, accuracy and low cost. The C protein sequences of 50 strains of each of the four DENV serotypes with temporal differences and geographical variation were used for the study. The level of conservation was analyzed by IEDB analysis tools. Accordingly, the C protein sequence seems to be highly conserved within each serotype (>80%) with a considerably high conservancy across the serotypes (52%). The highest conservancy (94.7%) was observed within DENV3. This was also evident in the phylogenetic diagram, with lower sub grouping inside the cluster of DENV3. The highest sequence similarity was observed between DENV1 and DENV3 resulting in a close relationship between those two serotypes in the phylogenetic analysis. Sequence analysis showed the two terminal regions (amino and carboxyl) of C protein to be highly hydrophilic, accessible and flexible. These observations are further strengthened by structural analysis depicting two termini as potential sites of B- cell epitopes, which could have important properties for diagnosis and therapeutics of DENV. This subjective statement is to be verified through laboratory experiment during the remaining part of this research study.

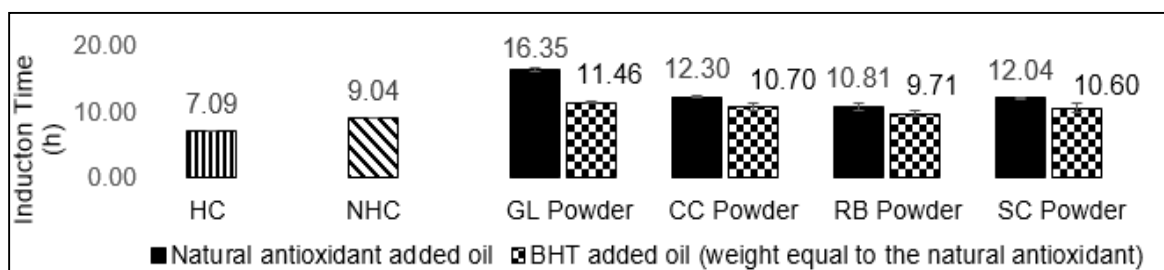
Keywords: Capsid protein, computer applications, dengue

925/E2/Poster

Determination of thermal stabilities of guava leaf, coconut cake, rice bran and sesame cake extracts

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Thermal stability of an antioxidant is important for a food system to function effectively under processing conditions. The objective of the study was to evaluate the antioxidant activities of thermally treated natural antioxidants. In this study, guava leaves (GL), coconut cake (CC), rice bran (RB) and sesame cake (SC) were selected as the natural sources of antioxidants. Phenolic compounds were extracted using ethanol/water (70:30 v/v). Total phenolic contents were determined using Folin-Ciocalteu method. Phenolic concentration of the extracts or butylated hydroxyl toluene (BHT) was adjusted to 40 µg/mL and heated at 100 °C for 1 hour in a special sealed tube. Antioxidant activity of the



heated and non-heated extracts was evaluated using DPPH assay. Effect of the heated phenolic antioxidants on the oxidative stability of stripped sunflower oil was determined using the Rancimat Apparatus. Heated control (HC, stripped sunflower oil heated at 100 °C for 1 h), non-heated control (NHC) and sunflower oil enriched with the antioxidants (heating sunflower oil with 1.0 g of natural source of antioxidants or equivalent amount of BHT at 100 °C for 1 h) were used for the test. According to the results, total phenolic contents as gallic acid equivalents (GAE g/kg) vary in the order, GL extract (21.25 ± 2.09) > RB extract (2.60 ± 0.23) > SC extract (1.31 ± 0.03) > CC extract (0.26 ± 0.04). Thermal stabilities of antioxidants evaluated in terms of antioxidant activities using DPPH assay are $92 \pm 3\%$, $85 \pm 10\%$, $75 \pm 7\%$, $77 \pm 2\%$, and $52 \pm 2\%$ for GL, CC, RB, SC extracts and BHT respectively. According to the results of the Rancimat test (Figure 1), all the natural antioxidant added oils show a higher induction time than its respective BHT added oils.

Figure 1. Induction times of stripped sunflower oil without (control) and with added antioxidants

The tested natural phenolic antioxidants are more thermally stable than BHT. Hence they will be better alternatives for BHT in high temperature cooking.

Keywords: Antioxidants, oxidative stability, rancimat test, stripped oil, thermal stability

Acknowledgement: NRC Grant (12/012)



926/E2/Poster

Investigation of phytochemical content, antioxidant activity and antiproliferative activity of *Nauclea orientalis* L. bark and *Clerodendrum infortunatum* L. root

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Nauclea orientalis L. (Bakmee) and *Clerodendrum infortunatum* L. (Pinna) are medicinal herbs, used in Sri Lanka, in the treatment of cancer. However, the phytochemical content and the cytotoxicity of these plants have not been investigated to understand the reported ethnobotanical significance. The present study therefore, was carried out to evaluate the antioxidant activity and *in vitro* cytotoxicity of *Nauclea orientalis* L. (bark) and *Clerodendrum infortunatum* L. (root) using RD (Human Rhabdomyosarcoma) cancer cells as a model system. The total phenolic and flavonoid contents were determined using Folin-Ciocalteu and aluminium chloride colorimetric methods, respectively. The antioxidant properties of each plant was assessed by 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical assay and nitric oxide radical scavenging assays. Antiproliferative activity was determined using a 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assay. The EC₅₀ values obtained are illustrated in Table 1.

Table 1: Total phenolic content, flavonoids and the EC₅₀ values for DPPH, Nitric oxide and MTT assays, for *N. orientalis* L. bark and *C. infortunatum* L. root (Mean ± SD)

Decoction	Phenolics (w/w% of Gallic acid equivalents)	Flavonoids (w/w% of (-)- Epigallocatec hin gallate equivalents)	EC ₅₀ value (µg/ml); Mean ± SD		
			Antioxidant activity		Cytotoxicity
			DPPH n=9	NO n=9	MTT n=3
<i>N. orientalis</i> L.	11.2 ± 2.1	84.9 ± 27.3	190.7 ± 6.1	119.4 ± 4.7	175.1 ± 7.1
<i>C. infortunatum</i> L.	1.7 ± 0.5	3.1 ± 1.1	345.3 ± 5.6	1171.9 ± 62.3	652.7 ± 19.4

The results obtained show that the phenolic content and flavonoid content are associated with antioxidant capacity of the plant extracts. Furthermore, it is observed that the antiproliferative activity of RD cells associates with antioxidant capacity.

Keywords: Antioxidant activity, *Clerodendrum infortunatum* L., cytotoxicity, EC₅₀, *Nauclea orientalis* L.



927/E2/Poster

Antioxidant activity of bran and endosperm derived protein hydrolysates of selected Sri Lankan traditional rice upon simulated gastric and pancreatic treatments

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Currently there is an unprecedented demand for inexpensive plant derived bioactive peptides with antioxidant activity for human consumption. These peptides derived from hydrolysis of plant proteins by commercial proteases can be digested by gastrointestinal physiological proteases. Rice (*Oryza sativa* L.) is one of the most widely consumed staple food worldwide and contains good quality dietary proteins. Studies on the antioxidant activity of rice peptides and protein hydrolysates are very limited. The present study evaluates the antioxidant activity of protein hydrolysates (PH) of selected Sri Lankan traditional rice upon simulated gastric and pancreatic treatments. Masuran, Goda Heeneti, Sudu Heeneti and Beheth Heeneti varieties were used in this study. Rice bran protein hydrolysates (RBPH) and rice endosperm protein hydrolysates (REPH) were prepared using three digestive treatments: hydrolyzed with Alcalase (A: commercial protease), Alcalase and Pepsin (A+P: simulated gastric treatment) and Alcalase, Pepsin and Pancreatin (A+P+PN: simulated gastric and pancreatic treatment). Antioxidant activity of RBPH and REPH were evaluated using 2-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid) (ABTS) radical scavenging, oxygen radical absorbance capacity (ORAC), ferric reducing antioxidant power (FRAP) and ferrous ion chelating capacity assays (n= 3 each). RBPH and REPH (A, A+P and A+P+PN) of all the selected varieties showed significant antioxidant activity for all the antioxidant assays tested. The order of potency of mean ABTS, ORAC, FRAP and chelating capacity were A > A+P > A+P+PN for both RBPH and REPH. RBPH demonstrated highest antioxidant activity for all the antioxidant assays studied compared to REPH. Mean ABTS, ORAC, FRAP and chelating capacity of RBPH derived from A+P+PN treatment was in the range of 8.93 ± 0.14 - 11.59 ± 0.38 mg Trolox equivalents (TE)/g PH; 21.55 ± 4.35 - 36.02 ± 1.83 mg TE/g PH; 2.29 ± 0.09 - 2.94 ± 0.06 mg TE/g PH and 897.26 ± 15.43 - 1141.81 ± 11.76 mg EDTA equivalents/g PH respectively. It is concluded that RBPH had high antioxidant activity compared to REPH and antioxidant activity of RBPH and REPH decreases upon simulated gastric and pancreatic treatments. Further, even after simulated gastric and pancreatic treatments RBPH of selected Sri Lankan traditional rice exhibited a moderately high antioxidant activity indicating its potential to be used in the functional foods industry.

928/E2/Poster

Investigation of the interaction of caffeine with three selected drug molecules: A molecular modeling approach

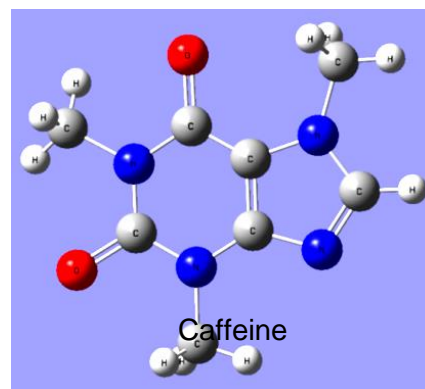
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Caffeine is the most widely consumed psychoactive stimulant drug as a majority of the world's population consumes coffee and tea on a daily basis. It is an intensely bitter, odorless white crystalline xanthine alkaloid of plant origin. Caffeine possesses beneficial pharmacological actions as well as withdrawal effects on human health due to excessive ingestion.

Existing literature describes the affinity of caffeine to self-aggregate in aqueous environment and to form complexes with aromatic drug molecules. Upon complexation, the therapeutic efficacy of the drug molecules tends to reduce significantly.

Self- and hetero- interaction between caffeine and three drug molecules that are currently prescribed for cancer, diabetic and Alzheimer's diseases (Cytarabine, Dapagliflozin and Rivastigmine) were investigated using molecular dynamics (MD) techniques. GROMACS software package on a LINUX operating system was employed to perform the MD simulations and analysis of the MD trajectories. The MD simulations were carried out for 40 ns in each molecular system containing two or four molecules (however with the same concentration) under isothermal-isobaric condition maintaining the temperature and pressure at 300 K and 1 bar, respectively. The analysis of data incorporating techniques such as center-of-mass distances variation, correlation of interaction energies, studying the free energy of complex formation, diffusion coefficient and surface accessibility leads to the determination of caffeine-drug complexation ability. Significant interactions of caffeine with cytarabine, dapagliflozin and rivastigmine were not observed in the current study. Therefore, it may be concluded that under low caffeine concentrations, caffeine consumption has no impact on the activity of the above three drugs.



Keywords: Caffeine-drug interactions, molecular dynamics.



929/E2/Poster

Optimization of the osmotic dehydration process to prepare coconut chips and value addition of sweet coconut chips

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The osmotic dehydration (OD) in coconut chips was standardized by optimizing the drying efficiency, evaluating shelf life, palatability and overall acceptability. In the determination of drying efficiency, mass transfer, weight reduction, sugar gain and water content loss were measured at different concentrations of sugar (40, 50 and 60 °brix) at different temperatures; 30, 35, 45 and 55 °C. In order to identify the optimum drying time, oven drying was carried out after the osmotic process. Data were analysed by Completely Randomized Design (CRD) method using analysis of variance (ANOVA). Water loss and sugar gain for the coconut chips increased with increasing sugar concentration up to 60 °brix and temperature up to 45 °C. Weight of OD chips decreased and weight reduction was lower at 60 °brix and 45 °C compared to the other conditions tested. Optimum sugar gain, weight reduction and water loss at 60 °brix and 45 °C were 0.28 ± 0.02 , 0.16 ± 0.01 and 0.44 ± 0.01 g/ unit mass. The optimum moisture content of 2.1% in dry basis was achieved in five hours for the same sample. OD process was optimum at 60 °brix and 45 °C and oven drying time was 5 hours at this sugar and temperature level. Four types of sweet coconut chips were prepared for value addition. Three samples were flavoured by natural medicinal ingredients; ginger, lemon and cinnamon and another sample was used as the control, without flavouring. Shelf life was evaluated over a period of two months. All the products were within the acceptable limits given in Sri Lankan standards (acceptable limits of total plate count, yeast and mould count, moisture content and free fatty acids content are below 10×10^4 (CFU/g), 50-100 (CFU/g), 3.5% and 0.3% respectively). At the end of the second month, total plate counts were 88, 42, 30 and 30 (CFU/g), yeast and mould counts were 33, 5, 18 and 18 (CFU/g), moisture contents were 0.93, 0.95, 0.92 and 1.19% and free fatty acids contents were 0.13, 0.14, 0.14 and 0.17% for ginger, lemon, cinnamon flavoured chips and control respectively. It is recommended that the products may be stored at ambient temperature up to a period of two months. The calorie values were obtained by means of the proximate analysis and those values were 465, 467, 459 and 443 (kcal/100 g) for ginger, lemon, cinnamon flavoured and sweet coconut chips respectively. Ginger flavoured coconut chips were identified as being more palatable and to have the highest overall acceptable conditions.

Keywords: Coconut chips, drying efficiency, osmotic dehydration, shelf life, value addition



930/E2/Poster

Development of a ready-to-drink beverage from mature coconut water

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This study was conducted to develop a ready-to-serve beverage from mature coconut water discarded from various coconut-based industries. The brown skin of de-shelled coconut was removed and the water inside was collected into a can and transported at ambient conditions immediately after collection. Coconut water was brought to the laboratory of the Coconut Research Institute, Lunuwila. Pasteurization was carried out at 65 °C for 20 minutes using a mini-pasteurizer and kept overnight at 4 °C to separate fat and sediment as a pre-treatment. A preliminary experiment was carried out to find the suitable brix level (6, 7 and 8) using coconut sugar and treacle. pH was adjusted to 5.5. NaCl 0.3% was added to one set and NaCl was not added to the other set. Sensory evaluation (5 point hedonic scale) was conducted to find the best brix and salt level. Data from sensory evaluation were analysed with "Friedman test" using a MINITAB software package. The selected beverages were pasteurized using three treatments P₁ (65 °C for 30 minutes), P₂ (75 °C for 15 minutes) and P₃ (95 °C for 10 minutes) and stored at 4 °C ± 2 and ambient condition for shelf life evaluation. During the storage period sedimentation was observed in all treatments. Therefore, selected stabilizing agents were tested and stabilizing ability was evaluated. As stabilizing agents, carboxy methyl cellulose 0.4%, pectin 0.4% and guar gum 0.05% were added to pre-treated (65 °C for 20 minutes) mature coconut water and kept at 4 °C ± 2 for 24 hours. After the settling process, pH, brix, turbidity and sugar profile were evaluated. The treatments were arranged according to the complete randomized design (CRD). SAS software package was used to analyse the data quantitatively. Of the three treatments 7°Bx was the best level with salt. The P₃ treatment gave a longer shelf life of 2 months at ambient conditions while five months at refrigerated conditions. Pectin showed the best stabilizing ability.

Keywords: Coconut sugar, coconut treacle, mature coconut water, ready-to-drink beverage



931/E2/Poster

Optimization of extraction conditions for astaxanthin from shrimp waste and investigation of antioxidant activity

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Astaxanthin is a xanthophyll carotenoid, which exhibits many important biological activities including a high degree of antioxidant capacity (AOC), hence has a significant applicability in food, pharmaceutical and cosmetic industries. An attempt was made towards optimization of astaxanthin extraction conditions from uncooked, cooked and acid-treated shrimp waste using different extraction methods (maceration, sonication and soxhlet extraction) and five different solvents (acetone, ethyl acetate, acetone:ethyl acetate (1:1), hexane and methanol). Further studies were carried out to investigate the antioxidant capacities of extracted astaxanthin. The percentage yield of crude astaxanthin was calculated for each trial and the UV-visible absorbance spectra were compared with a standard astaxanthin spectrum. All extracts showed a comparable UV-visible spectrum, confirming the presence of the pigment. Presence of astaxanthin and its esters in the extracts were confirmed by running thin layer chromatograms against anastaxanthin standard. Furthermore, the percentage of astaxanthin in each crude sample was calculated using the Beer-Lambert law. The best astaxanthin percentage of 68% has been observed through the use of acetone: ethyl acetate (1:1) solvent system facilitated by maceration of cooked and acid treated shrimp, whereas the best crude yield was found to be in the acetone extract of the acid-treated shrimp sample. Folin-Ciocalteu reagent was used to investigate the AOC of astaxanthin extracted by each method. The highest AOC of 65 µg pyrogallol equivalents (PGE)/mg of the crude was observed for the macerated ethyl acetate extract of the acid-treated shrimp sample and an AOC of 56 µg PGE/mg was calculated for the macerated ethyl acetate extract of the uncooked sample. The highest AOC by sonication and soxhlet extraction methods were also obtained with ethyl acetate. Concluding, it is reasonable to state that the highest amount of astaxanthin can be extracted by maceration with either acid treatment or cooking, when acetone: ethyl acetate solvent system is used. The highest AOC retention was found to be in the extract obtained by macerating the acid washed shrimp waste in ethyl acetate.

Keywords: Antioxidant capacity, astaxanthin, Folin-Ciocalteu



932/E2/Poster

Preparation and characterization of bioactive microcapsules of neem oil and clove oil

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Neem and clove oil are well known for their valuable medicinal properties such as antibacterial and antioxidant activities. However, direct usage of these oils on a daily basis is limited because of their strong odor, taste and oiliness. Microencapsulation of these oils helps to overcome these fore stated problems and allows the controlled release of the encapsulated oil under desired conditions. During this research, efforts were made to encapsulate clove and neem oils using gelatin-gum Arabic wall materials. Optical microscope was used to observe the morphology of the synthesized microcapsules and both neem and clove oil microcapsules appeared to be spherical. The amount of encapsulated oil was found to be $0.30 \pm 0.03 \mu\text{l/mg}$ for neem microcapsules and $0.16 \pm 0.01 \mu\text{l/mg}$ for clove microcapsules. A comparison of the UV visible, FT-IR and GC-MS spectra of pure oils and crushed microcapsules confirmed the successful encapsulation of each oil inside the microcapsules. A significant increase in the UV absorbance was seen once the microcapsules were crushed. Assays were carried out using Folin-Ciocalteu reagent to investigate the antioxidant (AO) activity of the prepared microcapsules. It was found that the AO activities were preserved in the encapsulated oils. The AO capacity of crushed clove microcapsules ($126 \pm 2 \mu\text{g}$ pyrogallol equivalents PGE/mg) was significantly higher than that of crushed neem microcapsules ($8 \pm 1 \mu\text{g}$ PGE/mg). Antibacterial activity of the clove microcapsules investigated using the disk diffusion assay indicated significant antimicrobial activity against *Staphylococcus aureus* and *Bacillus cereus*. For both pure and encapsulated clove oil, the diameters of inhibition zones (DIZ) were 2.9 ± 0.4 cm against *S. aureus*, whereas the DIZ were 2.6 ± 0.3 cm and 1.9 ± 0.4 cm against *B. cereus* respectively. A smaller zone of inhibition was observed for pure neem oil but an inhibition zone was not observed for the crushed neem microcapsules, possibly due to the low antimicrobial activity of pure neem and lower amount of neem oil released from crushed microcapsules. Upon subjecting the microcapsules to a range of temperatures and pHs, it was observed that the encapsulated oils retained the bioactivities exhibited by the original oils. In conclusion, neem oil and clove oil were successfully encapsulated using gelatin-gum arabic as coating materials. Both clove and neem microcapsules retained the antioxidant activities of the pure oils. Clove microcapsules indicated significant antibacterial activity similar to its pure oil. Neem microcapsules did not show any significant antimicrobial activities against the tested species similar to pure neem oil used in this study. Both types of microcapsules did not hold a strong odor as the pure oils.

Keywords: Antibacterial, antioxidant oil, microencapsulation



933/E2/Poster

Apportionment of selected heavy metals among abiotic and selected biotic components of the Negombo lagoon

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The present study investigates the apportionment of heavy metals among selected abiotic and biotic components of the Negombo lagoon, for which no information on this aspect is currently available. Water, soil and sediment samples (n=25), mangrove bark/leaves (n=25), snails, fish and shell fish (n=10) were collected and analyzed for heavy metals using microwave digestion followed by ICP – OES. The toxic heavy metals As, Cd, Cr, Pb and Hg were recorded in abiotic and biotic components, in varying amounts. Of these only Cr (N/D - 0.05 mg/ dm³) was detected in water. Highest ranges in both sediment and soil were also of Cr (sediment 14.45 - 23.24 and soil 5.44 - 32.88 mg/kg), with some sites having limits that exceeded CEA values. From among the abiotic components analyzed, the lowest levels were recorded in water. What was of significance is the fact that, despite the concentrations of the toxic metals in water being below detectable limits, bioaccumulation was evident in the sampled mangrove plants and fauna, implying bio-concentration. Mangrove bark and leaves recorded the presence Cr, Pb and Hg. Toxic heavy metals were also recorded in snails (e.g. up to a maximum (mg/ kg) of 0.12 for Hg, 5.17 for As and 0.83 for Cr, Pb not detected) and in edible species of fish and shell fish (eg. up to a maximum (mg/kg) 21.42 for As, 0.42 for Pb, 0.48 for of Hg and 3.31 for Cr). From among the essential heavy metals (Ba, Cu, Fe, Ni, Sb, Se, V and Zn) the field levels of some exceeded permissible levels at some locations. For example, the levels of Fe (0.82 - 39.70 mg / dm³) exceeded the acceptable limits of the CEA at one location. Some of the bio-concentration factors recorded were soil: snails for As (4), Cu (79) and Zn (13), water: fish (dm³ kg⁻¹) for Cr (122), Cu (551), Fe (63) and Zn (2229), water: crab (dm³ kg⁻¹) for Fe (187) and Zn (2719), water: fish (dm³ kg⁻¹) for Fe (1169), and Zn (17070). Although some of these metals are essential, the recorded bio-concentration factors may suggest potential toxicity, if present in concentrations beyond threshold levels. Overall most heavy metals depicted the trend sediment > soil > fauna > bark > water > leaves. However, interestingly the specific patterns of accumulation differed between the taxa. For instance, in snails the trend in terms of concentration was Cu > Zn > As, while in crabs it was Zn > Ba > V > Fe. These findings, particularly the levels of As, Cr, Hg and Pb, highlight the dangers to flora and fauna inhabiting the lagoon environment as well as for those consuming these contaminated species, reiterating that seemingly harmless levels of toxic waste in water may mask the realistic accumulation levels in other components of the environment.

Keywords: Heavy metals, lagoon, biotic and abiotic components, bioaccumulation



934/E2/Poster

Investigation of the effects of polyphenols present in *Phyllanthus debilis* Klein ex Willd Plant on antioxidant activity and evaluation of cytotoxicity against RD (Rhabdomyosarcoma) cells

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Oxidative stress is associated with many diseases including cancer, diabetes, liver diseases and inflammation. Plant polyphenols have the capacity to scavenge free radicals and contribute to minimize the oxidative stress. *Phyllanthus debilis* Klein ex Willd (Elapitawakka) belonging to the [genus *Phyllanthus*](#) has many medicinal values. This study was carried out to evaluate the effects of polyphenols present in *P. debilis* on antioxidant activity and to evaluate its cytotoxicity against RD cells. Aerial parts of the mature plants were collected from the Colombo District. Dried sample was refluxed with deionized water and lyophilized samples were used for experiments. Polyphenols were removed from the same after reconstitution with water to investigate the effects of polyphenols. Total polyphenolic content was determined by Folin-Ciocalteu reagent as Gallic acid equivalents (GAE). Antioxidant activity was carried out using DPPH (2, 2-Diphenyl-1-picrylhydrazyl) radical scavenging assay. Ascorbic acid was used as the positive control. Light microscopy and the percentage leakage of lactate dehydrogenase (LDH) to the medium (LDH present in the medium to that of medium and the lysate x100) against plant extract concentrations were carried out to determine the cytotoxicity of RD cells after 48 hr treatment. Negative control without the extract and cycloheximide as the positive control were used simultaneously. The EC₅₀ values were calculated and expressed as Mean ± SD. Polyphenolic content of *P. debilis* was 12.02 ± 0.44% (w/w % of lyophilized sample GAE). The EC₅₀ value for DPPH radical scavenging assay was 8.6 ± 0.4 µg/ml and 3.3 ± 0.2 µg/ml for the plant extract and ascorbic acid respectively. The DPPH scavenging capacity is negligible for polyphenol free extract of the plant extract. Fifty percent LDH leakage (EC₅₀) was showed at a concentration of 161.6 ± 7.7µg/ml. Shoot extract of *P. debilis* contains high antioxidant capacity and lower cytotoxic effect compared to the positive controls. Further, it shows that polyphenolic compounds are responsible for the antioxidant capacity.

Keywords: Antioxidant activity, cytotoxicity, EC₅₀, polyphenolic content.

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935/E2/Poster

Concentrations of six heavy metals in water, sediment and benthic snails of the Bolgoda lagoon network

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Anthropogenic inputs from industries have resulted in the rise of heavy metal levels in the Bolgoda river system, which nourishes the Bellanwila – Attidiya Sanctuary, one of the last remaining urban freshwater wetlands in Sri Lanka. This wetland supports many species of flora and fauna. The majority of the studies carried out have focused on examining the levels of heavy metals in selected fish species and water samples while attempts to correlate levels in different abiotic and biotic media are scarce. The assessment of heavy metals in benthic sediments in particular, as they act as a sink for heavy metals in water bodies, is important to ascertain the risks to a wide range of fauna, especially to those inhabiting the water. The present study aimed to ascertain the levels of six heavy metals (Cd, Cr, Pb, Ni, Cu and Zn) in water, sediment and benthic fauna (snails) and to identify the association between these components for any of these metals. A total of 75 locations in the Bolgoda river network were sampled for each abiotic component, whilst benthic fauna were collected from 21 locations. The levels of selected heavy metals were analyzed using Flame Atomic Absorption Spectrophotometry. The study revealed that the ranges of the recorded levels in water were Cd: ND - 0.044 mg dm⁻³, Cr: ND- 0.10 mg dm⁻³, Pb: ND - 1.6 mg dm⁻³, Ni: ND -0.26 mg dm⁻³, Cu: ND - 0.069 mg dm⁻³ and Zn: ND -1.5 mg dm⁻³). The heavy metal levels at most of the locations exceeded safety values for aquatic species (Cd: 0.25 µg dm⁻³, Cr: 11 µg dm⁻³, Pb: 2.5 µg dm⁻³). Additionally the ranges for sediments (Cd: ND - 2.3 µg g⁻¹, Pb: 21.9 – 148 µg g⁻¹, Ni: ND – 481 µg g⁻¹, Cu: 7.20 – 196 µg g⁻¹, Zn: 26.8 – 575 µg g⁻¹) have shown to be toxic to aquatic fauna according to the United States Environmental Protection Agency. The benthic snails also accumulated high levels of the toxic elements (Cd: 1.14 – 6.89 mg dm⁻³, Cr: ND- 12.6 mg dm⁻³, Pb: 17.4 -72.4 mg dm⁻³). A significant correlation was however, obtained only for heavy metal levels in sediments and snails, and only for Cr ($r = 0.92$, $P < 0.05$), although an inverted hormetic response was observed for Ni. The results obtained show that the Bolgoda river system is contaminated by toxic heavy metals such as Cr, Cd and Pb. Furthermore, accumulation levels in snails indicate possible dangers for other benthic species, such as earthworms and detritivorous fish.

Keywords: Benthic fauna, benthic sediments, lagoon network, heavy metals



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**Assessing bioaccumulation of cadmium and lead in the Golden apple snail,
Pomacea diffusa, under empirical conditions**

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Bioaccumulation studies can be used to evaluate the level of pollution in aquatic ecosystems. Snails typically serve as good indicators due to their relatively low mobility in comparison to fish or other macroinvertebrates. The overall aim of the present study was to ascertain the accumulation levels for cadmium (Cd) and lead (Pb) using the Golden apple snail (*Pomacea diffusa*) through empirical exposure trials. Accordingly, five concentrations (5.0 to 25 $\mu\text{g dm}^{-3}$) were used with 12 snails per treatments/ control tank conducted in triplicate and continuously exposed over 28 days. Snails were collected from an aquarium. The weekly accumulation levels in dry snail flesh were analyzed using Atomic Absorption Spectrophotometry. Exposure to Cd and Pb at 5.0 $\mu\text{g dm}^{-3}$ and above, caused accumulation of the heavy metals with the accumulation levels increasing with exposure in a significant and dose-dependent manner ($r = 0.95$, $p < 0.05$ for Cd and $r = 0.95$, $p < 0.05$ for Pb). The levels of accumulation at all exposures was also time dependent. Based on the results at the end of the trial (i.e. at day 28), the BAF (Bio Accumulation Factor) for Cd ($6.58 \mu\text{g kg}^{-1} \text{day}^{-1}$) was greater than that for Pb ($4.03 \mu\text{g kg}^{-1} \text{day}^{-1}$) indicating that, at least for *Pomacea diffusa*, there is a higher tendency for Cd uptake relative to the uptake of Pb. This suggests that a given species may show differential accumulation patterns for various heavy metal contaminants. Of significant concern is the fact that the concentrations used in the empirical trials fall within the levels Cd and Pb recorded from many local water bodies that support aquatic biota and from where mussels, fish and shell fish are frequently harvested for human consumption. The documented dose-dependent relationships between accumulation and exposure of heavy metals can be used to make predictions about the levels of contamination. In this respect, due to the absence of an apparent adverse effect on mortality and behavior, the invasive Golden apple snail (*Pomacea diffusa*) could be used as an ideal biomonitoring tool for pollution studies.

Keywords: *Pomacea diffusa*, cadmium, lead, accumulation



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Atmospheric deposition of polycyclic aromatic hydrocarbons (PAHs) around two metropolitan areas in the western province of Sri Lanka, using moss (*Hyophila involuta*) as a biomonitor

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Atmospheric deposition of 16 selected polycyclic aromatic hydrocarbons (PAHs) which are defined as priority pollutant by the American Environment Protection Agency (EPA) was investigated using moss (*Hyophila involuta*) as a bioindicator. Monthly sampling was conducted from March 2013 to February 2014 at two different metropolitan areas in Sri Lanka (area around Sapugaskanda oil refinery and area around Kelanitissa power plant). The background level was monitored using moss (*Hyophila involuta*) collected from Kalupahana rural area (in Badulla District) where anthropogenic influence is assumed to be very low. PAHs were extracted by ultrasonic extraction and cleaned-up using Silica gel column. Identification and quantification of PAHs in the moss samples were carried out using HPLC system (Agilent 1100 series) and UV-DAD (Agilent 1200 series). A C-18 PAH column (VYDAC PAH column) as the stationary phase, acetonitrile: water as the mobile phase and 16 PAH standards (Supelco) were used as calibration materials. The average concentrations of total detectable PAHs during a year were determined on a dry weight basis. The average concentrations of total detectable PAHs around the Sapugaskanda sampling location were in the range 0.74–3.86 mg kg⁻¹ dry weight of moss (*Hyophila involuta*) with a mean value of 1.43 mg kg⁻¹ dry weight when it ranged 0.91–3.06 mg kg⁻¹ dry weight of moss (*Hyophila involuta*) with a mean value of 1.55 mg kg⁻¹ dry weight around the Kelanitissa sampling location. The total detectable PAHs for selected two metropolitan areas were higher compared with the total PAHs in remote area, Kalupahana which was 0.01 mg kg⁻¹. The percentage of low molecular weight PAHs (Two-ring and Three-ring PAHs) was in the range of 67.0–78.0% around two metropolitan areas. The 2-3 ring/ total PAH ratios showed no statistically significant differences between the area around Sapugaskanda oil refinery (0.71(±0.07)) and the area around Kelanitissa power plant (0.73(±0.07)). The vehicular and industrial emissions of study areas may cause the formation of total detectable PAHs.

Keywords: atmospheric deposition, bioindicator, PAHs, mosses, Sri Lanka

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Heavy metal contamination in road dust from Colombo- Katunayake Expressway, E03

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Surface dusts are a complex environmental media and often contain elevated concentrations of inorganic and organic pollutants such as heavy metals, metalloids, and polycyclic aromatic hydrocarbons. Their composition reflects inputs from variety of sources, including water transported material from surrounding soils, dry and wet atmospheric deposition, road surface wear, road paint degradation, vehicle wear (tires, body, brake linings, etc.), vehicle fluid and particulate emissions. Use of road dusts as a background investigation of heavy metal concentrations has been used to identify the level of pollution and this study was conducted to investigate the concentrations of five heavy metals (Pb, Cu, Cr, Zn and Ni) in road dusts along the newly built Colombo-Katunayake Expressway (E03). Road dusts samples were collected at 2 km intervals from 26 sampling points up and down along the expressway in two different function areas, as 13 samples from the Colombo to Katunayake lane and another 13 samples from the Katunayake to Colombo lane. Heavy metals in road dust samples were analyzed using atomic absorption spectrophotometry (AAS). The concentrations of metals in road dust are expressed in mg/kg of the dry weight of the dust sample. Concentrations of Pb and Cu in road dust samples from E03 express way were found in the range of 14.15–21.60 mg kg⁻¹ with a mean value of 34.39 (±20.35) mg kg⁻¹ and 101.86 (±56.33) mg kg⁻¹ with a range of 33.05–241.80 mg kg⁻¹ respectively. The average concentrations of Cr, Zn and Ni were obtained as 78.56 (±10.50), 284.01 (±42.30) and 28.17 (±4.30) mg kg⁻¹ respectively in road dust samples. The level of heavy metal contamination was compared with the background samples obtained from Uda Peradeniya road Kandy, where the anthropogenic influence is comparatively low. According to the results of heavy metal concentrations at 26 sampling points, Zn concentrations were the highest followed by Cu and Cr concentrations. Further, Pb concentrations of road dust investigated in the E03 expressway were relatively lower than recorded in the literature of similar studies. This may be due to the use of unleaded gasoline in Sri Lanka. However, average concentrations of all the heavy metals studied were comparatively higher than the background level. This shows that there is heavy metal pollution at the sampling points in the E03 expressway.

Keywords: Heavy metal pollution, road dust



939/E2/Poster

Screening of bacteria for restriction enzymes

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Restriction endonucleases (REs) are enzymes that are capable of cleaving double stranded DNA in a sequence specific manner, irrespective of the source of DNA. The cleavage occurs either within or adjacent to the restriction site (recognition sequence). The majority of recognition sites are four, six or eight bases long and are palindromic. There are four major types of restriction enzymes and are designated type I, II, III and IV. This classification is based on their subunit structure, cofactor requirements, specificity of cleavage and associated methylase activity. Restriction enzymes have a wide variety of applications in genetic engineering including cloning, molecular diagnosis of diseases etc. There is a growing demand for restriction endonucleases exhibiting new specificities. To date no research has been carried out to screen and/or isolate REs from the microbial flora in Sri Lanka. Being a tropical island with a rich microbial diversity it is likely that many bacteria producing novel REs could be identified. The objective of this study was to screen bacteria for isolation of restriction enzymes. Bacteria from different regions and habitats in Sri Lanka including Matale, Matara, Galle, Anuradhapura and Kandy were isolated from soil and /or water samples collected into sterile tubes (50 ml). Five milliliter cultures of the isolated colonies were grown in LB broth medium. The bacteria were then screened for restriction enzymes. Briefly, an extract of bacteria was made by disintegrating the cell mass by sonication. After centrifugation the supernatant was collected and used directly in the screening assay. The assay was carried out by incubating lambda DNA with the extract. To determine the presence of restriction enzyme(s) an aliquot of the reaction mixture was separated by agarose gel electrophoresis. The presence of distinct bands indicates the presence of restriction endonucleases. Initial screening of many isolates revealed the presence of restriction enzymes in two isolates. The putative restriction enzymes cleaved lambda DNA producing several bands. Further characterization of the bacteria is in progress.

Keywords: Restriction enzymes

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