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Oral Presentations

Section A

101/A

Distribution of α1 subunits of nicotinic acetylcholine receptors in lymphoid tissues of Balb/C mice and humans: a comparative study

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The cholinergic innervation of lymphoid organs, through autonomic nerves is not well understood. Several nicotinic acetylcholine receptor (nAChR) subunits were identified in mononuclear lymphocytes of humans, though the specific subtypes of nAChR and their distribution in lymphoid tissue is still debatable. This study was conducted on lymphoid tissues of humans and Balb/C mice to localize and compare the distribution of α1 subunit of nAChR by immunohistochemistry. The tissues were processed for Hematoxylin & Eosin staining and indirect immunohistochemistry. The tissues were labeled by monoclonal anti-nAChR (α1 subunit) and linked to biotinylated anti-rat IgG. Labeled StreptAvidin Biotin technique was used with DiaminoBenzedene (DAB) as chromogen to detect the receptors by the development of brown colour. Skeletal muscle was used as positive control of α1nAChR. The microscopic images were computerized and digital image analysis was performed on immunostained slides. The intensity of the staining was determined based upon a score of 0, 1+ (focal staining, > 10% cells), 2+ (focal to diffuse staining, 10% > 50% cells), 3+ (diffuse staining, 50>100% of cells).

The capsule and red pulp areas of spleen were highly immunoreactive to anti-α1 nAChRs in both species while, low grade immunoreactivity (IR) was observed in peri-arteriolar lymphoid aggregations and germinal centres. A high IR of α1 nAChR were recorded closer to central venules of liver in mice while a similar, diffused (1+) distribution of α1 AChR were observed in the hepatocytes and portal tract of both species . Similar intermediately diffused IR of α1 nAChR was observed in the Peyers patches in both species. Overall the α1 nAChR IR was high in regions predominantly having T cells and macrophages, such as subscapsular sinus, medullary cords & trabeculae of lymph nodes, and an intermediate to low IR was present in the regions having B cell subsets of both lymphoid tissues. These findings confirm that the neuroimmune modulation could be brought by the presence of neuronal cholinergic nerves in lymphoid tissues in both species depending on the distribution of α1 nAChR. Further investigations need to be carried out using antibodies available for different nicotinic and muscarinic receptor subunits, vesicular acetylcholine transporter protein and several components of acetylcholine synthesis for clear understanding of neuro-immune modulation.

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102/A

Reduced susceptibility to synthetic pyrethroids in malaria vectors, *Anopheles culicifacies* and *Anopheles subpictus* in three districts of Sri Lanka

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The status of pyrethroid insecticide resistance in malaria vectors *Anopheles culicifacies* and *An. subpictus* was monitored in Kurunegala, Moneragala and Batticaloa districts of Sri Lanka from January to October 2010. Adult female mosquitoes (2 – 3 day old) were tested against former and current World Health Organization (WHO) recommended discriminating dosages of pyrethroids: bifenthrin (2%), cyfluthrin (0.15%), λ-cyhalothrin (0.1% former; 0.05% new), deltamethrin (0.025% former; 0.05%; new), etofenprox (0.1% former; 0.5% new) and permethrin (0.25% former; 0.75% new). Resistance studies were carried out using WHO standard bio-assay techniques. Involvement of mono-oxygenases in metabolic resistance was tested by exposing the mosquitoes to the mono-oxygenase inhibitor piperonyl butoxide (PB) prior to bio-assays. All *An. culicifacies* populations were fully susceptible (100% mortality) to bifenthrin, cyfluthrin and new dosages of deltamethrin, permethrin and etofenprox and former dosage of λ-cyhalothrin. All populations showed moderate resistance with former dosages of deltamethrin, permethrin and etofenprox and new dosage of λ-cyhalothrin. New recommended dosages of deltamethrin, permethrin and etofenprox were higher than the former recommended dosages but for λ-cyhalothrin new dosage was lower than the former. Therefore, current dosages may hide deltamethrin, permethrin and etofenprox resistance but may allow identifying λ-cyhalothrin resistance. *An. subpictus* populations from all three districts were fully susceptible to bifenthrin. Kurunegala and Moneragala populations showed resistance to former and new dosages of all other insecticides tested. Batticaloa population was fully susceptible to cyfluthrin, new dosages of deltamethrin and permethrin but showed resistance to former dosages of deltamethrin and permethrin and both new and former dosages of etopfenprox and λ-cyhalothrin. Pre-exposure to PB reduced the resistance in both species from all three districts indicating the active role played by monooxygenase in pyrethroid resistance in *An. culicifacies* and *An. subpictus* populations in all three districts. This study highlights the need for specifying discriminating dosages for local vectors in order to detect species specific resistance levels which can be effectively used for malaria vector control interventions in Sri Lanka.

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103/A

Comparison of different RNA extraction methods for Dengue Reverse Transcription –Polymerase Chain Reaction (RT-PCR)

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Reverse Transcription Polymerase Chain Reaction (RT-PCR) is currently used on a routine basis for the early laboratory diagnosis of dengue infection. Dengue viral RNA for RT-PCR can be extracted using different RNA extraction methods. It is important to select an appropriate RNA extraction method that gives a consistent high yield of pure RNA at an affordable cost for the routine laboratory diagnosis of dengue. The objective of this study was to select an efficient and cost effective RNA extraction method for dengue RT-PCR. Five RNA extraction methods (Quagen kit, Tryzol, detergent lysis by Np-40, direct boiling and size-fractionated silica) were compared using 3 criteria: amount of pure RNA extracted; result of RT-PCR based on the intensity of DNA band in agarose gel; and cost per test. Considering the amount of RNA extracted (mean value for five samples), the five RNA extraction methods listed according to the descending order are as follows: direct method by boiling (57 µg), size fractionated silica (52 µg), Tryzol (43 µg), Quagen kit (36 µg) and detergent lysis using NP-40 (4 µg). All RNA extraction methods gave satisfactory products in RT-PCR. The tryzol method gave a product with high intensity in RT-PCR. Considering the cost per test, the five RNA extraction methods listed according to the descending order are as follows: Quagen kit (Rs.1000), size fractionated silica (Rs. 546), detergent lysis using NP-40 (Rs. 114), Tryzol (Rs. 98) and direct method by boiling (Rs. 23). The Tryzol method could be recommended for routine laboratory diagnosis based on intensity of the resultant on intensity of resulted DNA band in agarose gel, purity and amount of RNA extracted and consistency and cost of extraction.

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104/A

Occurrence of a dengue epidemic in Minipe valley of the Kandy district: evidence for *Aedes albopictus* being an epidemic vector of dengue in Sri Lanka

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A dengue epidemic that occurred between April and October 2010 in Hasalaka and Pallewatta Medical Officer of Health (MOH) area, Minipe, was investigated to determine the density and breeding habitats of dengue vectors (*Aedes aegypti* and *Ae. albopictus*) in the affected areas. The epidemic was identified with the notification of an index case by the Medical Officer in-charge at the Divisional Hospital Hasalaka in June 2010. Details of all 267 clinically suspected and serologically positive Dengue Fever (DF) and Dengue Haemorrhagic Fever (DHF) cases were collected in consultation with MOH Minipe and 100 randomly selected cases were investigated to identify the source of infection. Entomological investigations were carried out to determine the density and breeding sites of *Aedes aegypti* and *Aedes albopictus*. 32 venous blood samples were collected from randomly selected in-ward patients with clinically suspected dengue (investigated cases) at Divisional Hospital Hasalaka and Base Hospital Mahiyangana and tested for dengue by Reverse Transcription Polymerase Chain Reaction (RT-PCR). Of these, 10 (31.3%) were positive for dengue indicating there is dengue activity in the area. Occurrence of dengue in children <5years of age and among people who have not travelled to dengue prevalent areas during the past 6 months revealed that there was local transmission of dengue in the area. Entomological investigations carried out before during and after the epidemic showed that there was no *Ae. aegypti*, but there was high density of *Ae. albopictus* (Container index: 4.6 – 22.0, House index: 4.6 - 21.7, Breteau index: 4.6 – 25.0). The major breeding sites of *Ae. albopictus* were water storage containers (cement tanks and barrels, n=38, 52.1%), and discarded containers (n=20, 27.4%). This study indicates the potential of *Ae. albopictus* to be an epidemic vector of DF/DHF in Sri Lanka. Dengue preventive and control activities needs to be extended to areas with high density of *Ae. albopictus* when the epidemiological conditions are conducive for dengue transmission.

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105/A

A study on the hypoglycaemic effect of the aqueous extract of dried flowers of *Aegle marmelos* in diabetic Wistar rats

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Aegle marmelos (*beli*) has been used in ayurvedic medicine for treatment of Diabetes Mellitus (DM) in Asian countries. The present study was designed to evaluate the oral hypoglycaemic effect of the water extract of dried flowers of *Aegle marmelos* (WEAM) in diabetic male, Wistar rats. Diabetes was induced by administering a single dose (40 mg/kg) of alloxan monohydrate and rats with a serum glucose concentration of > 6.67 mmol /L were used. The diabetic rats were divided into 2 groups (Test and Control, n=6 per group) and fasted for 12 hrs. The Test and Control rats received 2.5 ml of a single dose (500 mg/kg, the optimal dose determined previously) of WEAM and distilled water respectively, orally by Sondi needles. This was followed by glucose (3 g/kg) ½ h later. Blood was drawn from the lateral tail vein and serum glucose was determined at 2 hrs by glucose oxidase reagent kits. To compare the activity of WEAM, diabetic rats were divided into 4 groups (n=6 in each); Group 1, 2, 3 and 4 which received a single dose of WEAM (500 mg/kg), metformin (15 mg/kg), glibenclamide (0.1 mg/kg) and distilled water respectively. Group 1, 2 and 3 continuously received the extracts and drugs for 42 days as a single dose. On day 42, fasting and post glucose challenge serum glucose and glycated haemoglobin (GlyHb) levels were measured. Statistical analysis was done in Microsoft Excel. The single dose of WEAM (500 mg/kg) showed a significant (p=0.02) oral hypoglycaemic activity in alloxan-induced diabetic rats. Serum glucose level of the test group was 13.67±1.5 mmol/L, while it was 17.20±2.1 mmol/L in the control group. When compared with oral hypoglycaemics, the percentage reduction of serum glucose level of the test group was 21% (14.43±1.4 mmol/L) compared to the control (18.27±0.3 mmol/L) group, while it was 26% (13.45±1.2 mmol/L) and 25% (13.61±1.7 mmol/L) for metformin and glibenclamide respectively. There was a significant reduction of the blood glucose (p=0.007) and GlyHb (p=0.005) levels after feeding for 6 weeks in WEAM and metformin groups. The water extract of the dried flowers of *Aegle marmelos* possess significant hypoglycaemic activity in diabetic rats.

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106/A

Heat stability of the amylase and lipase inhibitors in methanol extracts of some spices

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Hyperlipidaemia and hyperglycaemia have become serious public health problems, which lead to vascular diseases and diabetes mellitus. Dietary therapy is important and could be considered as the first choice of prophylactic treatment. Decreasing digestion and absorption of dietary lipids and carbohydrates could be beneficial in controlling hyperlipidaemia and hyperglycaemia. Previously, we have reported that some spices which are commonly used as food additives in Sri Lanka show lipase and amylase inhibitory activities. The objective of the present study was to evaluate the heat stability of the lipase and amylase inhibitors of those spices which have previously shown the inhibitory activities. Crude methanolic extracts of seven spices which have shown inhibitory activities in our previous study were used. Inhibitory activities against pancreatic α-amylase and pancreatic lipase were analyzed. Boiling of the extracts was carried out at 100 °C for 20 min. The lipase and amylase inhibitory activities of the boiled and un-boiled extracts were measured *in vitro* and the inhibitory activity that remained after boiling the extracts was expressed as % residual inhibitory activity.

Unboiled extracts of *Trigonella foenum-graecum* (Ulu-Hal), *Cuminum cyminum* (Suduru), *Elettaria cardamomum* (Enasal) and *Coriandrum sativum* (Kotta'malli) demonstrated 25.42 ± 0.32, 19.17 ± 0.54, 11.76 ± 0.55 and 6.19 ± 0.15 % inhibition on lipase activity respectively. A significant reduction of the lipase inhibitory activity of the extracts was observed in all four extracts after boiling. Residual lipase inhibitory activities remained after boiling the respective extracts were 38.46%, 57.11%, 73.76% and 63.17% respectively. Further, results show that the stability of lipase inhibitors of four extracts is variable. Un-boiled extracts of *Syzygium aromaticum* (Karabu), *Cinnamomum zeylanicum* (Curundu), *Foeniculum officinalis* (Ma'duru) *and Trigonella foenum-graecum* demonstrated 58.10 ± 0.24, 32.39 ± 0.91, 28.79 ± 0.22 and 8.69 ± 0.35% inhibition, respectively, on α-amylase activity. Boiling of these four extracts, did not cause a major decline in the amylase inhibitory activities. Residual amylase inhibitory activities remained after boiling of the respective extracts were 95.38%, 97.60%, 92.57% and 93.04%, respectively. Our studies revealed that boiling the extracts had no major effect on the activity of α-amylase inhibitors, whereas boiling resulted in a significant decline in the lipase inhibitor activity.

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107/A

A study of the oral hypoglycaemic activity of the ethanol extract of *Munronia pinnata* in healthy Wistar rats

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This investigation was carried out to study the effect of the ethanol extract of *M. pinnata* (MPEt) on serum glucose levels of healthy Wistar rats. The extract was prepared by Soxhlet extraction and rotary evaporation. Healthy, adult, male Wistar rats were divided into 4 groups (3 Test and 1 Control with n=6 in each). To detect the most effective dose, three doses of the ethanol extract (50.0 mg, 100.0 mg and 200.0 mg/kg body weight) were administered orally via Sondi needles to respective Test groups. The Control group was treated with 2.5 mL of distilled water. After 30 minutes, a glucose load of 3.0 g/ kg body weight was given. Blood (0.1 ml) was drawn from the lateral tail vein of rats under light anesthesia with diethyl ether 90 minutes after the glucose administration. Serum was separated and the glucose concentration was measured by the glucose-oxidase method. Another experiment was done to determine the optimal time of activity (time course) of the ethanol extract, with 2 groups of Wistar rats; Test and Control, receiving 2.5 mL of MPEt (200.0 mg/kg body weight) and 2.5 mL each of distilled water respectively. The same protocol as above was followed and blood samples were obtained at 1, 2, and 3 hrs and glucose levels in serum were determined. All the tested doses had a significantly lower serum glucose levels (5.2±0.43, 5.1±0.26 and 4.2±0.34 mmol/L in Test 1, Test 2 and Test 3 respectively) compared with the control group (5.4±0.22 mmol/L). The maximum hypoglycaemic effect (22.2 % reduction) was exerted by the dose of 200.0 mg/kg. The dose of 200 mg/kg showed statistically significant oral hypoglycaemic effects at all 3 hours but the maximum hypoglycaemic effect (26.7%) was elicited at the 3rd hour from the administration of MPEt. ($p \leq 0.001$, 4.1±0.13 mmol/ L in Test vs 5.6±0.13 mmol/L in Control). According to the results of this study, the maximum effective dose of the ethanol extract of *M. pinnata* is 200 mg/kg and the highest reduction in the serum glucose is given at 3 hours. Further studies are being conducted to study these effects in diabetic rats.

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Cooking conversion factors of commonly consumed Sri Lankan food items

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Cooking conversion factor is defined as what is retained in the food after preparation, i.e., the proportion between the cooked and raw food. It mainly depends on the cooking method and type of the foods. It is important to find out the nutrient content of cooked foods and recipes and also to find out the raw purchased amount of foods. Information on the effect of wide range of cooking practices on nutritive value of cooked foods is not available in Sri Lanka.

This study was done to determine the cooking conversion factors of commonly consumed Sri Lankan food items using different cooking methods. Commonly consumed food items from different food groups such as cereals, legumes, vegetables and animal based foods were purchased from local markets (Pannala and Makandura) and the inedible portion was trimmed off. A weight of 100g raw edible portion was taken for processing. This edible portion was processed using various cooking methods such as frying, tempering and boiling. The final weight of each food item was measured using a digital scale. Cooking conversion factor of food was calculated as follows:

$$= \frac{\text{Weight of cooked food (g)}}{\text{Weight of raw food (g)}}$$

Table 1 shows the conversion factor of studied food items.

Food types	Boiling	Tempering	Frying
	Mean (SD)	Mean (SD)	Mean (SD)
Rice, red, long grain (raw)	3.03 (0.01)		
Rice, Basmati	2.87 (0.01)		
Rice, samba, white, short grain (raw)	2.82 (0.01)		
Dhal (Mysore)	2.20 (0.01)		
Cow pea, dried, raw	2.23 (0.01)		
Potato, without peel	1.00 (0.01)	0.82 (0.01)	0.54 (0.02)
Mukunuwenna	0.97 (0.02)	0.76 (0.01)	
Spinach	0.96 (0.01)	0.78 (0.01)	
Egg, chicken	1.01 (0.01)		0.87 (0.01)
Meat, chicken, (with inedible part)	0.73 (0.01)		0.67 (0.01)
Fish, tilapia, boiled (with spine)	0.86 (0.02)		0.64 (0.02)

Conclusion: In Sri Lanka, commonly used nutrition composition table contains nutrient content of raw edible foods. Determination of conversion factor is important to find out the nutrient content of cooked food.

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109/A

Evaluation of undergraduate research experiences among the pre-intern medical graduates of the Faculty of Medicine, University of Colombo

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The Faculty of Medicine Colombo (FMC) has a well-structured research programme in the Community Stream and electives programme that yields a wealth of research annually. It is a vital opportunity for students to go through the process of research and contribute to research publications. This study describes the undergraduate research experience at the FMC. A descriptive cross sectional study was done at FMC involving 192 undergraduates who had completed their end of course examination in 2010. A self administered questionnaire was used to assess the research experience in undergraduates.

The Community Stream research programme studies were mainly done in a hospital setting: 49% (92/192). Clinical topics such as rheumatology, neurology, cardiology etc together made up 31% (59/192) of the areas studied and reproductive health 27% (53/192). Patients were used as the population by 22% (43/192). 75% (144/192) of research was descriptive. 44% (85/192) of studies were communicated at a scientific forum. Only 6 (7%) presented their work as publications in indexed journals. The elective programme was utilized for research by only 19% (36/192) and 70% (26/36) of them were descriptive and chose the hospital setting and 17 did it on patients. 58% (21/36) were communicated in scientific fora, of which 5 (14%) were indexed publications. In both research programmes, lack of interest was the reason for not attempting publication. Eight undergraduates had presented at foreign fora. Grants were received by only 4 undergraduates. None of the travellers were fully sponsored. 40% of undergraduates preferred a career as a medical researcher. It can be concluded that most of the undergraduate research of FMC goes unpublished. The clinical set up yields majority of the research. Clinicians may have a role to play in encouraging clinical research and publication.

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110/A

Assessment of food from different food groups and nutrients intakes of a sample of adolescent school girls

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Adolescence is the transition period between childhood and adulthood during which rapid physical, mental, emotional and social developments take place. Adolescent girls are especially considered to be a nutritionally vulnerable segment since they need more Fe, Ca, folate etc, to achieve peak bone mass and to compensate for menstrual iron loss. Most of the adolescent girls in Sri Lanka have micronutrient deficiencies as a result of their monotonous diet. Thus, the objectives of this study were to assess the food intakes from different food groups and macro and micro nutrients intakes of adolescent school girls.

Adolescent school girls (n=143), aged 14-16 years were randomly recruited from three schools out of 16 schools which have classes from grade 9 to 13 in Pannala sub-zonal educational division. A self administered life style questionnaire was used to obtain socio-demographic characteristics of the subjects. Their food intakes from different food groups and nutrient intakes were determined by using a Food Frequency Questionnaire and 3 Day Diet Diary. The nutrient intakes were analyzed by using Food Base 2000 which was modified with Sri Lankan food composition data, and food composition tables.

Almost all adolescent girls (100%) consumed cereal based diets. Daily consumption of fish and meat (4.5%) and animal products such as egg, milk were very low (13.5%) and only 9.9% of girls consumed sweets and short-eats daily. Nearly half of the adolescents (47%) had consumed 4-5 types of vegetables per day and 33% of the adolescents had consumed less than 3 types of green leafy vegetables per week. The daily consumption pattern of fruits among the study subjects was very poor and only 3.3% school girls had consumed 1-2 types of fruits on a daily basis. The mean energy, carbohydrate, protein, and fat intakes were 2007.5 (± 941.4) kcal/d, 343.5 (±141) g/d, 52.5 (±26.7) g/d and 53.1 (±30.1) g/d respectively. The mean Ca, zinc, and iron intakes of the sample were 488.2 (±331) mg/d, 7.7 (±4.2) mg/day, and 15.6 (±9.6) mg/day respectively. In the case of vitamins, they were 405.3 (±384.1) µg/day for Vitamin A and 98.8 (±80) µg/day for folate.

All of the adolescent girls consumed cereals for the three major meals while half of subjects (46%) consumed 4-5 types of vegetables daily, and 97% of girls did not achieve RDA of Ca. Low intake of Ca may be due to poor consumption of milk and dairy products. When comparing the Sri Lankan recommended servings for different food groups, daily fruits, milk, fish, meat and egg consumption were not up to the recommended levels. According to the results, only 36% had daily achieved RDA for energy, 33% for protein and 35% for fat. Special attention should be directed towards the nutrition of adolescents through schools.

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Section B

201/B

Nutritional analysis and shelf life evaluation of cassava flour biscuits supplemented with mango flour

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Research was conducted to develop cassava flour biscuits supplemented with mango flour and to assess the quality of biscuits during storage. Cassava roots were processed into flour using a standard method. Moderately ripe mangoes were washed, peeled off, sliced and dried in a heat pump dehumidified dryer at the temperature of 40°C for 3 hours and ground to produce mango flour. The mango flour was used at different levels, namely 10, 15, 20 and 25 %, to substitute the cassava flour in the preparation of the biscuit formula. Biscuits developed accordingly were packed in sealed laminated packaging material lined with an aluminum foil and stored under ambient conditions of average temperature at 30±1°C and relative humidity (RH) of 75-80% for evaluation of the shelf life.

Biscuits were subject to nutritional, microbial, sensory and shelf life evaluations at two week intervals for the entire storage period of 12 weeks. Among the treatment, the biscuits supplemented with 20 % mango flour (T_4) had the highest value of protein, fat, ash and soluble carbohydrate of 8.11, 15.90, 2.71 and 64.0 % respectively, and the fibre content was found to be 2.33 % at the end of 12 weeks of storage. However, the moisture content of these biscuits (T_4) increased from 4.02 to 4.21 % which is within the acceptable range for long term storage. The findings of microbial studies showed that there was no growth of microorganisms in the biscuits. The results of organoleptic assessment revealed that there were significant differences between the treatments in terms of sensory attributes. Cassava biscuits supplemented with 20 % mango flour showed the best overall acceptability compared to the other combinations and the control. From the results of quality assessments, the cassava flour biscuits supplemented with 20 % mango flour was found to be superior and could be stored at ambient conditions of 30±1°C and 75-80% RH for a minimum period of 12 weeks without any significant changes in the quality attributes. The supplementation of cassava flour with mango flour could be successfully used for the formulation of biscuits of good quality and with characteristics within the standards for biscuits.

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202/B

Development of composite flour mix enriched with fish powders

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A study was conducted to develop a composite flour mix replacing wheat flour with dry powders of three fish species. Enrichment of wheat flour with fish powders would increase the protein, iron and calcium to a greater extent than that possible with wheat flour alone. The three selected fish species are *Amblygaster sirm* (Hurulla), *Sardinella gibbosa* (Salaya) and *Stolephorus indicus* (Handalla) which are under utilized but possess a high nutritive value. Preliminary studies were conducted to select the best ratio of wheat flour to fish powder with a suitable texture. Then the best formula was selected by sensory parameters of taste, appearance, colour, odour, fish flavour and overall acceptability. Sensory evaluations were conducted with 29 panelists and results were analyzed using Minitab statistical software.

The ratio of 60 % wheat flour to 40 % fish powder was rated the best with a significantly higher ($p<0.05$) number selecting biscuits with this texture. As the best formula, 60 % wheat flour, 13.3 % powder of *Sardinella gibbosa*, 13.3 % *Stolephorus indicus* and 13.3 % *Amblygaster sirm* was rated significantly higher ($p<0.05$) than the other evaluated formulas. Proximate analysis results revealed that composite flour mix contained 8.13 % moisture, 1.91 % total ash, 0.96 % acid insoluble ash, 22.42 % protein, 4.04 % total fat and 2.36 % crude fiber. The amounts of minerals (mg) in 100 g of composite flour mix were 160.5 Na, 143.4 Ca, 61.47 Mg, 198.0 K, 7.88 Fe, 0.29 Cu, 2.73 Zn and 0.48 Mn. Therefore 100 g of composite flour mix provides more than 1/3 of the recommended daily protein and iron intake of children in the age group of 2 - 14 years and adult men and women including lactating and pregnant women. 100 g of the composite flour mixture also provides 1/5 of the daily calcium requirement of children of the age group 2-14 years and of adult men and women (excluding lactating and pregnant women).

As the best packaging material, a combination of Aluminum/ Polyethylene Terephthalate and Linear Low Density Polyethylene was selected due to the lowest moisture absorption and peroxide value variation within the tested sixteen weeks. At the end of 16 weeks of storage the moisture content, peroxide value, total plate count and yeast and mould counts of the composite flour mix were below the minimum required level for consumption as given in the SLS standards.

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203/B

A technique to rescue inter-specific hybrids of *Camellia sinensis x Camellia sasanqua*

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Camellia sasanqua, an allied species of tea, shows a high degree of resistance to blister blight, a major disease of tea (*Camellia sinensis*) caused by a fungus, especially *Exobacidium vexance.* Introgression of this trait into cultivated tea through inter-specific hybridization is difficult owing to incompatibility barriers.

To overcome pre-fertilization barriers the following treatments were used. 1) Cut style method (removing half of the style) prior to depositing pollen, 2) Deposition of 200 ppm Boric acid + 10 % sucrose solution on stigma after pollination and 3) Deposition of 200 ppm Boric acid, 10 % sucrose incorporated with 2 g/l agar. The treatments were tested during controlled hybridization in comparison with standard controlled hybridization. Results revealed that three months after pollination the percentage of fruit set was 10 % when pollen was treated with Boric acid and sucrose solution without incorporating agar. The treatment with agar showed 8 % fruit set followed by 7 % fruit set in standard controlled hybridization method. However, there was no significant difference ($P > 0.05$) between the above treatments, 3 months after pollination. In contrast, no fruit retention was observed in the cut style method.

To prevent the post-fertilization barriers and to enhance retention of immature fruits, the following growth regulator combinations were used: 1) 10 mg/l NAA + 10 mg/l Kinetin; and 2) 10 mg/l IAA + 10 mg/l Kinetin. These were injected into the pedicel and ovary of pollinated flowers at 3 day intervals for a one month period. Results showed that treatment with NAA + Kinetin was effective in retaining fruits (20 %) as compared to treatment of IAA + Kinetin as well as standard controlled hybridization, both of which recorded zero fruit retention 3 months after pollination.

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204/B

Effects of different growing systems on chemical profiles and plumbagin content of *Plumbago Indica* Linn. (S. Ratnitul)

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Plumbago indica Linn. (Family: Plumbaginaceae) is a shrubby perennial herb, native to South Asia and widely cultivated throughout India and Sri Lanka. Plumbagin (5-hydroxy-2-methyl-1,4-napthoquinone), is a therapeutically important natural naphthoquinone, which occurs mainly in the roots of *P. indica*. This plant is heavily used in Sri Lankan traditional systems of medicine for the preparation of formulations used to treat a variety of disease conditions. The slow growth rate, absence of seeds and the lack of a fruiting stage of *P. indica* in traditional agricultural methods necessitate the search for an alternative and effective source to meet the enhanced commercial demand. Therefore, the aim of the present investigation was to compare the chemical profile and to quantify the plumbagin content in *P. indica* grown under different growing systems using roots of (a) conventionally field grown (b) tissue cultured field grown (c) hydroponically grown plants and (d) *in vitro* developed callus from leaf explants. Quantification of plumbagin was done using the Thin Layer Chromatography-densitometric method.

Phytochemical evaluation on methanolic extracts of *P. indica* roots and callus revealed the presence of tannins, steroid glycosides, flavonoids and alkaloids. Further, the above extracts did not show the presence of saponins. Four prominent spots (R_f: 0.16, 0.35, 0.55, 0.93) were observed in conventionally field grown and tissue cultured field grown *P. indica* root samples. An additional spot (R_f: 0.73) was observed in hydroponically grown *P. indica* root samples while callus samples consist of only 3 spots (R_f: 0.16, 0.55, 0.93). There were no significant differences in chemical constituents of *P. indica* grown under different growing systems. However, the intensity of the spots present in the callus samples was lower than in the other tested samples.

Among the tested samples, plumbagin content decreased in the following order when considering the plumbagin content (g) in 100 g of dry material (dry weight basis): tissue cultured field grown plants (1.80 ± 0.25) > conventionally field grown (1.33 ± 0.15) > hydroponically grown (1.08 ± 0.01) > callus (0.26 ± 0.02). In conclusion, tissue culture and hydroponic techniques can be used as alternative methods to the conventional field grown system for the cultivation of *P.indica* and the maximum plumbagin content was present in the roots of tissue cultured field grown plants.

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205/B

Influence of synthetic aggregates as a soil amendment on the grey soils in Okinawa Japan

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The objective of this study was to produce pellet aggregates (PA) from coal fly ash with paper wastes and evaluate their potential utilization as a soil amendment to problematic grey soil in Okinawa, Japan for the production of the leafy vegetable *Brassica campestris*. Furthermore, this can be considered as an effective method of waste management. Two types of pellet aggregates (PA) with 5 mm [small PA (SPA)] and 10 mm [large PA (LPA)] diameters were produced from coal fly ash (CFA) and paper waste (PW). Problematic grey soils in Okinawa Japan were amended with SPA and LPA to improve deprived physic-chemical parameters for the cultivation of *Brassica campestris*. Different treatments of the experiment were grey soil with SPA alone, LPA alone and both SPA and LPA. Soil without any amendment was used as the control. The study was conducted in experimental plots with dimensions of 2.5 m × 0.8 m × 0.6 m. The physicochemical properties of soil-PA amendment mixtures were then analyzed. The growth and yield parameters of *Brassica campestris* were determined. PA addition as a fertilizer and as a soil amendment improved the physical and chemical properties of soil such as bulk density, hydraulic conductivity, water holding capacity, electrical conductivity and the nutrient concentration (K, Mg, Ca, Zn, Cu). The heavy metal concentrations in the PA added media were well below the permissible levels. Moreover PA addition increased the growth and yield parameters of *Brassica campestris* compared to the grey soil control. Plant height, plant fresh weight and plant dry weights of PA amended soil were increased by 15 – 43 %, 44 – 101 % and 44 -73 %, respectively, compared to the control. Moreover, the heavy metal content of the plant tissues were well below the permissible level and no phytotoxic symptoms were observed. It can be concluded that PA can be utilized as a soil amendment to improve crop production in the problematic grey soils in Okinawa, Japan.

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206/B

Evaluation of coffee introductions with the local selections in the mid country wet zone of Sri Lanka

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Coffee is a perennial seed crop, cultivated as a beverage, It has been an export agricultural crop since 1503. Two species of coffee are commercially cultivated, namely *Coffea arabica* (Arabica coffee) and *Coffea canephora* (Robusta coffee). Arabica coffee is the most important species as it occupies 80 % of the world market and has a more favorable flavor and aroma, but is adapted to higher elevations i.e. above 600 m mean sea level (MSL). The total extent of coffee plantations in Sri Lanka is 5975 ha, with about 50 % of this lying in the Central Province. The annual export volume of coffee was 60.8 t earning Rs. 15.8 million in 2007. There is a huge opportunity to further improve coffee cultivation in the mid country of Sri Lanka. Therefore, a new Arabica line S4711 and a promising hybrid CxR were introduced from India. This study was carried out to evaluate the effectiveness of these two lines with the cultivar Catimor and two local lines [H(K), and S(K)] for increasing the yield in coffee grown in the mid-country wet zone. The experiment was established in the year 2000 at Stallenburg Estate, Pupuressa (800 m AMSL) in a Randomized Complete Block Design with three replicates. The experiment was maintained using recommended general management practices published by the Department of Export Agriculture. Yield data were recorded by harvesting fresh berries which were processed and weighed. Berry and leaf characters were also recorded and the data were analyzed using ANOVA of the SPSS software package.

According to the results, the best performing line is the local selection, H(K) giving the highest average parchment coffee yield (2502 kg $ha^{-1}yr^{-1}$). The introduction of S4711 generated a similar yield (2409 kg $ha^{-1}yr^{-1}$). Catimor produced 2223 kg $ha^{-1}yr^{-1}$ while CxR and S(K) produced about 2000 kg $ha^{-1}yr^{-1}$. The highest diameter (1.4 cm) of fresh berries was observed in Catimor while the longest fresh berry (1.5 cm) was from S4711. Line H(K) has the highest dry seed weight (0.288 g) as well as a low fresh berry : dry weight ratio (5.11 : 1). Leaf characters show that the hybrid CXR has the largest leaves with the highest leaf area (124.14 cm^2), petiole length (1.1 cm), leaf length (19.27 cm) and leaf width (9.23 cm). Therefore, the local selection, H(K) and introduction of S4711 could be recommended as the best yielding Arabica coffee lines for the mid country wet zone of Sri Lanka.

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207/B

Screening of some selected local black pepper (*Piper nigrum* L.) accessions for their chemical quality and yield

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Black pepper is the largest commodity (37%) of the world spice trade. In Sri Lanka, it earns about Rs 3,500 million from the annual export of 9000 t. The special features of black pepper are the pungency and aroma that give it a value as a spice. The main pungent chemical constituent is piperine. The unique aroma and flavor of pepper are given by volatile oil and oleoresin. A total of 43 local accessions with two introductions, Panniyur1 and Kuching were selected and field planted at the Export Agriculture Research Centre, Matale, for further evaluation. The main objective of the study was to select the best accession/s by evaluating the chemical components (dry basis) of the local pepper accessions. Therefore, the harvested berries were oven dried at 50 °C and the moisture content was determined using 5 g of dried pepper using the Dean and Stark method. Volatile oil content was measured by subjecting 30 g of the sample for water distillation for 4 hours. The oleoresin content was determined by the Soxhlet extraction method with 10g of the sample. Data were analyzed using ANOVA procedure of the SPSS computer software package. Results revealed that the accession BD/MW24 has high amounts of volatile oil (4.15%), oleoresin (18.20%) and piperine (11.92%) content. For the volatile oil content, accession BD/MN42 has the highest amount (4.24%) whereas the local accessions BD/KG38, BD/MW24, RP/NA1, MN1, BD/MW23, KWW10, BD/HM37 and MT/RT2 have more oil contents than the introduction, Kuching (3.60%). For the oleoresin content, local accession, BD/ST1 has the highest amount (21.95%) while BD/MW24 has more oleoresin (18.20%) than the introduction, Kuching (17.55%). For Piperine content, local accession BD/MW24 shows the highest amount (11.92%) whereas MN1, RP/NA1 and BD/MW23 also have about 11%. Accessions, BD/WA2, BD/GM29, KWW10, WGB1 and RP/KO3, resulted in higher piperine contents than the introduction, Kuching (7.91%). Introduced cultivar Panniyur 1 has a very low content of oil (3.14%), oleoresin (14.60%) and piperine (7.73%). The highest average processed black pepper yield (2672 kg ha^{-1} yr^{-1}) was observed in the accession BD/MN41, whereas the accession MT/DM 7 has 2502 kg ha^{-1} yr^{-1} of yield. The local accession, BD/MW24 has higher volatile oil (4.15%), oleoresin (18.2 %) and piperine (11.92%) on dry basis when compared to the other local accessions.

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208/B

Relationship between canopy PAR distribution and conversion ratio of fresh berry weight to dry berry weight of Black pepper (*Piper nigrum* L.)

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Black pepper is a perennial climbing plant which needs a live or dead support to maintain a vertical and cylindrical canopy and also for capturing enough solar radiation. The cylindrical shape of the pepper canopy results in light penetration that is quite different from that seen in other crop species, which may in turn affect the productivity of the crop. The conversion ratio of fresh berry weight into dry weight is an important yield determining factor in pepper which also helps in selection of high yielding varieties in plant breeding research. Therefore, an investigation was carried out with the objective of examining the relationship between canopy PAR distribution and berry conversion ratio (fresh weight to dry weight) of different black pepper selections.

Five different black pepper selections of BD/WA2, BD/MN42, BD/HM35, BD/GM29 and BD/NK27 were selected for the study. PAR absorption measurement and collection of mature spikes were done in each layer and fresh and dry berry weights were recorded. The study revealed that the percentage of PAR absorption drastically decreased from the upper layers to lower layers of the pepper canopy. Black Pepper selections BD/MN 42 and BD/GM29 facilitate more PAR penetration into the canopy as compared to other selected pepper lines. The conversion ratio of fresh berry to dry berry weight significantly increased from upper layers to lower layers of pepper plant canopy while decreasing the light penetration for lower layers of the canopy. Therefore, a negative correlation between percentage of PAR absorption and conversion ratio of fresh berry to dry berry weight can be observed in the canopy of black pepper.

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209/B

Production and reproduction performance of village chicken under different diversification systems

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A study was conducted to evaluate the performance of village chickens under different diversifications such as ruminants (cattle, buffalo and goat), other poultry species, perennial plants, annual or biennial crops and monocultures of village chickens. A total of 150 farms were randomly selected in Batticaloa (Kaluvankeni, Mylavaddan and Kiran) and Ampara (Malwatta, Sammanthurai, Valathapitiya and Nintavur) districts and four adult birds from each farm were selected in order to gather the information on productive and reproductive performance. The parameters measured were live weight of both cockerel and hen, age at fist lay, monthly egg production, egg weight, productive period, hatchability of eggs, fertility of eggs and life time. The collected data were analyzed using Statistical Analysis Software (Version 6.1). The results of the study revealed that the village chickens diversified with annual/biennial crops recorded the highest ($P<0.05$) mean value for egg weight (47.3±2.5 g), live weights of both hen and cockerel (2.16±0.2 kg and 1.67±0.3 kg respectively), productive period (20.4±2.9 months) and life span (2.2±0.3 years). The village chickens diversified with perennial plants recorded the lowest mean values for monthly egg production (15.8±0.8), live weight of cockerel and hen (1.70±0.40 and 1.22±0.25 kg respectively), productive period (13.4±1.5 months) and life span (1.2±0.2 years). The village chickens diversified with ruminants showed the highest mean value ($P<0.05$) for the monthly egg production (19.4±1.8) and the hatchability of eggs (81.5±3.9%). Furthermore, the village chickens diversified with ruminants had the lowest age at first lay (5.5±0.63 months) while the village chicken diversified with other poultry species had the highest age at first lay (7.3±0.96 months). Moreover, the monoculture of village chickens recorded the highest mean value (83.0±4.1%) for the fertility percentage of eggs while the village chickens diversified with other poultry species recorded the lowest (67.8±6.1%). Hatchability of eggs was found to be lowest (69.7±7.5%) in the monoculture of village chicken when compared to the others. According to the study it was concluded that village chickens perform better under diversified systems than as a monoculture.

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210/B

In vitro antioxidant activity and phenolic activity of water extract of selected plants with antidiabetic properties

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Many medicinal plants used in Ayurveda in the treatment of diabetes mellitus contain different phenolic compounds with antioxidant properties. The objective of the present study was to determine antioxidant activity of some medicinal plants used to make medicinal preparations for treating diabetics. The plants selected were *Syzygium cumini* (Madan, bark), *Cassia auriculata* (Ranawara, flower) and *Scoparia dulcis* (Walkottamalli, whole plant). Plant materials grown in different locations were collected for the analysis. Commercially available dried samples were also collected from an outlet specially intended for selling medicinal herbs. Samples were cleaned, washed and dried in a dehydrator at 55 ^{0}C for 24 hours, ground to obtain a fine powder. Water extracts were prepared by boiling 60 g powdered sample in 960 mL of water over a low flame, (final volume 240 mL) filtered and freeze-dried. The total phenolic content of each extract was determined using Folin-Ciocalteu reagent and evaluation of free radical scavenging activity was assessed using DPPH assay.

The total phenolic content of plants collected from various locations ranged from 163 – 883 mg GAE/g. The water extracts of *S.cumini* had the highest total phenolic activity (817 – 883 mg GAE/g) with no significant difference ($p < 0.05$) among the phenolic contents of the plants collected from different areas. However, commercial sample of *C. auriculata* contained a higher total phenolic content (458 mg GAE/g) compared to freshly collected counterparts (214 – 268 mg GAE/g). This may be due to the differences in the drying method used or the maturity of the samples used.

The highest antioxidant activity was observed in *S. cumini* (30–68 ug/ml) which had the highest phenolic content. The IC_{50} value of *S.cumini* was one third that of butylated hydroxy tolune (BHT) which is the standard (20 ug/ml). *C. auriculata* (247– 523 ug/ml) followed by *S.cumini* had decreasing antioxidant potentials which correlated with the total phenols. Thus *S. cumini* having the highest total phenolics and the antioxidant potential followed by *C. auriculata* may have successful application in the treatment of diabetes.

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211/B

Development of a vegetarian blended sausage

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The aim of the study was to develop a Kohila (*Lasia spinosa*) added Vegetarian Sausage. It has been shown that dietary-fiber rich food like Kohila may reduce the occurrence of constipation, haemorrhoids or anal fissures. Meat or fish sausages have animal proteins that coagulate with the temperature and it acts as the binder of those sausages. When producing this new vegetarian sausage it was a challenge to find a replacing binder for meat or fish protein. After several trials and errors a successful binder was made out of a combination of Soy Protein extract, Kiri Ala *(Colocasia esculenta),* and flour of Jack Seed *(Artocarpus heterophyllus).*The sausage mixture was prepared by adding Kohila rhizomes, Kiri ala and Jack seeds The Soy Protein extract was then added. Finally minor ingredients were added and mixed well. The prepared sausage mixture was filled into artificial casings and cooked. Then the artificial casings were removed and sausages were packed and stored in a cold room at -4 ℃.

According to the proximate analysis, the produced sausage was analyzed and found to contain, an average fiber, moisture, protein, total fat, free fat and ash content of 3.08, 49.04, 7.13, 12.03, 5.05, and 4.04 % respectively. According to the shelf life analysis for six months by the Total Plate Count (TPC) and coliform test, the microbial count did not exceed the recommended levels. Peroxide value (PV) was zero for a six month period. With regard to the sensory evaluation, this new soy-based Kohila-added vegetarian sausage showed a high level of acceptance compared to the vegetarian soy sausage available in the local market (Kruskal – Wallis test).

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212/B

Development of curing drum with sandwich structure for dried ginger production

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Curing ginger in the form of whole rhizomes by sun-drying needs a minimum of seven days. This method is not cost effective as it results in a poor quality product. The objective of this study was to develop a new drying technique to reduce duration and to improve the quality of cured ginger. The system possesses a rotating type drying plate to sandwich rhizomes and an electrical heat source to supply hot air for drying. The new system was tested against sun drying and electrical tray drying systems. Ginger rhizomes (Rangoon variety) at a maturity stage of eight months, were dipped for 2 minutes in 1 % Sodium hydroxide solution, followed by blanching for ten minutes. Rhizomes were peeled and dipped for ten minutes in 4 % Calcium oxide solution. Drained rhizomes were sandwiched in drying plates and curing was done. Soaking of semidried rhizomes in the Calcium oxide solution and re-drying was carried out until the colour of the final product turned to white. Significant improvement was shown in the new system by four to five times reduction in drying duration compared to sun drying. The sandwich structure and rotation of drying plates produced market-attractive flat rhizomes with the original shape, resulting in a lower packing volume than when sun-drying or electrical tray drying. No significant difference in duration was seen between the new system and electrical drying. The new curing system could be scaled up for commercial production. Further studies are being carried out to shift the system towards heat recovery via incorporation of exhaust air-recirculation, preventing short-circuit of the drying air and partly utilizing solar energy. Therefore, the economic analysis has not been carried out under the present study.

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213/B

Development and nutritional profile assessment of ready to eat rice-based fruit pudding

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Value addition, product diversification and different preservation techniques will increase the utilization of a surplus rice harvest and the nutritional impact of the product. Therefore, this study was conducted to develop a ready to eat rice based fruit pudding and further to assess the nutritional profile of the product. Different combinations of the products were developed by using cooked rice, rice flour, fruit pulp, sugar, milk and egg and the most acceptable pudding was selected by a simple ranking test (5 point hedonic scale)(38 untrained panelists). The developed product was analyzed for proximate composition, minerals, and calorific value. The Glycaemic Index (GI) of the product was calculated using 10 subjects with glucose as a reference. Shelf life of the product was evaluated in refrigerated (4 ±1 ℃), freezing (-18 ±1 ℃), and ambient conditions (30 ±1 ℃). The energy value of the developed fresh rice-based fruit pudding was 478 KJ/ 100g. It contained carbohydrate 41.93 g, proteins 3.87 g, fat 2.87 g, Fe 237.54 µg, P 65.40 mg, Ca 22.18 mg and dietary fiber of 2.89 % that influence the health value of the product. GI of the product was 38, which falls within the Low GI food (55 or less) category, by virtue of their slow breakdown (or digestion) and absorption. During the storage period of up to fourth weeks under refrigerated (4±1 ℃) conditions, there was no significance difference of acceptability of the pudding and no obvious changes were observed in the titrable acidity and pH values. Results revealed that rice can be used to produce pudding that has a storage life of four weeks without addition of any preservatives under the refrigerated conditions. The developed rice-based fruit pudding is economically feasible due to the low cost of production of Rs. 12.00 for 80 g.

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214/B

Formulation and development of low cost pet food using fish processing waste

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This study was designed to develop a semi-moist type adult dog food using fish processing waste and to assess its keeping quality, overall acceptability and digestibility when stored at room temperature (28 °C) in vacuum packaged material. A basic semi-moist adult dog food formulation was prepared by using fish processing waste such as fish-saw-dust, skin, gonads, dark meat and bones. Bread crumb powder, corn flour, soy flour, carrot, Mukunuwenna (*Alternanthera sessilis*), salt, sodium trypolyphosphate, citric acid, vitamin E and rice bran also were added (AAFCO, 1994). Aerobic and anerobic contents and the initial histamine level was measured on day one (AOAC, 1996) and pH, 2-thiobarbituric acid reactive substances (TBARS) and water holding capacity (WHC) were determined for four week of storage at weekly intervals.

Six local cross bred adult dogs were caged individually and feeding trials were conducted to determine palatability and digestibility of pet food. The formulated pet food was within the standard ranges for crude fibre, ash content and crude fat requirements of adult dogs. The crude protein and crude fat percentage in the semi-moist pet food were higher than ($P<0.05$) in the control diet and it exceeded the requirements of the minimum standard of AAFCO (1994) adult dog nutrient profile. TBARS, pH and WHC of pet food were within the acceptable range and no changes were observed ($P>0.05$) within the four weeks of storage at 28 °C.

Negative results for the commercial sterility test indicated the absence of anaerobes and aerobes and flat sour organisms. The histamine level at the initial stage of the pet food sample was 2.3 mg/kg which was within the acceptable range. Digestibility and overall acceptability in the semi-moist pet food was higher ($P<0.05$) than that in the control diet.

Through the cost analysis, it was verified that fish processing waste such as fish-saw-dust, dark-meat, bones, skin and gonads with appropriate preservative compounds could be utilized for the production of a low cost semi-moist adult dog food.

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215/B

Changes in postmortem quality and shelf life determination of frigate mackerel (*Auxis thazard*) and ray (*Dasyatis margarita*) during ice storage

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Postmortem changes of two commercially important marine fish species, Frigate mackerel (*Auxis thazard*) and Ray (*Dasyatis margarita*) were evaluated during 21 days of storage at 0 ℃ (ice) by monitoring changes in physical, biochemical, sensory and microbiological parameters. The protein content of Frigate mackerel and Ray was 18.8% and 19.0% (% dry weight), respectively and the crude fat content was high ($P<0.05$) for Frigate mackerel (6%) but low for Ray (1%). The moisture content was higher in Ray (78 %) than in Frigate mackerel (77.7%). The bacteriological counts, total volatile basic nitrogen (TVB-N), pH, Water holding capacity (WHC), trimethylamine (TMA) and thiobarbituric acid reaction substances (TBARS) values increased ($P<0.05$) while sensory results decreased ($P<0.05$) with the days of storage in ice.

Physical quality parameters such as pH and the WHC changed ($P < 0.05$) in two fish species during ice storage. pH fluctuated from 6.27±0.04 to 6.24±0.02 and 6.8±0.02 to 6.83±0.03 in Frigate mackerel and Ray, respectively. In Frigate mackerel TVB-N value was less than the critical limits with initial value of 9.47 mg TVB-N/100 g muscle and 28.37 mg TVB-N/100 g muscle, at the time of rejection at day 12. The TVB-N (45 mg/100g) and TMA-N (3 mg/100g) level exceeded the rejection level on day 16. When spoilage starts, TBARS value in ray was 3.64 malonaldehyde /100g at day 16 whereas it was 4.78 mg malonaldehyde/100g at day 12 which is close to rejection limit of 5 mg malonaldehyde/100g.

According to the sensory data, overall acceptability of raw and cooked fish samples were acceptable for 12 days for Frigate mackerel and for 16 days for Ray samples. The results of bacteriological counts within the reported acceptable limits of 10^8 log CFU/g until day 11 in Frigate mackerel whereas until day 16 in ray. The overall results of this study indicated that the edible quality of Frigate mackerel and ray could be maintained for 12 days and 16 days, respectively on ice storage.

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216/B

Assessment of climate change effects on selected climatic parameters at six agro-ecological zones in Sri Lanka

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Global warming is a growing concern in this century. Green house gases that cause global warming are major contributors to global climatic changes. It is imperative to identify the effects of climate change in agricultural growing areas on water demand, crop suitability and production in all agro-ecological regions of the country. The study of climate change and assessment of its consequences are long felt needs.

This study focuses on the evaluation of the effects of climate change on six selected agro ecological zones (AEZs) in the Western, Southern and Central parts of Sri Lanka, and is aimed at creating GIS maps of spatial and temporal changes in rainfall (RF) and temperature (T) in these regions. This study used secondary data of 1980-2007 obtained from various sources. Data pertaining to six AEZs such as Low country wet zone (WL), Mid country wet zone (WM), Up country wet zone (WU), Up country intermediate zone (IU), Low country intermediate zone 3 (IL3), Low country intermediate zone 1 (IL1) were analyzed. Agro ecological maps and meteorological data were also used. Spatial data and information on attributes were incorporated into GIS to generate spatial maps of climatic parameters. Climatic factor maps were generated using rainfall and temperature data under two time frames (1980-1992 and 1993-2007) and they were compared to identify the temporal changes of each climatic parameter using ArcGIS Software. Dynamics of different climatic parameters were then identified. Geographic shifts of climatic classes were examined.

Data on 65 rain gauges were analyzed. Long term annual rainfall significantly decreased in WM; whereas the mean temperature of the study area has increased by 1.4 ^{0}C during 1980-2007. Although WL, WU, and IU indicated decreasing trends of rainfall and IL1 and IL3 demonstrated an increasing trend, these were not statistically significant. The rainfall class of 3500-4000 mm yr^{-1} moved 13.67 km South-West, which is reflected in declining rainfall in the WM zone. It is now possible for the authorities to selectively concentrate on these areas with special needs. Results of this study could help in planning appropriate land-use changes, not only for new plantations and in replanting, but also for formulating strategies to maximize returns.

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Section C

301/C

Investigation of traditional technology of production of wall paintings in Sri Lanka

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Traditional artists who produced traditional Sri Lankan wall paintings used a production technology that employed a vast majority of materials and production processes. The following methods were used in this study to investigate these methods and processes: obtaining information from the traditional technical texts and generating information by scientific analyses. Manjusri basitha chitrakarma shasthra is the only available traditional technical document relevant to this study. Indian technical texts such as Vishnudharmottara-purana, Samarangana-sutradhara, Manasollasa and Silparatna also give useful information. Traditional Sri Lankan wall paintings consist of four main layers, namely support, ground, paint receiving layer and the paint layer. They were prepared using three main painting techniques, namely classical, medieval and southern techniques. The scientific investigation was done by preparing samples using traditional technology and the analysis of survival patterns of samples. The samples were prepared using the methods described below and their long-term survival patterns were determined by detecting temperature and humidity variations of the samples and growth of microorganisms in them. The support of classical paintings was rock surface prepared by flattening with a chisel but with a number of foldings, teeth and incisions to make it rough. Lime containing CaO:MgO in the ratio of 97:3 mixed with sand and clay was used to prepare the classical ground. The medieval ground was prepared by mixing fine brown clay and sand in the proportions of 2:1, with wood-apple gum. The southern support contained laterite cubes and lime mortar, sea sand, pure lime with Ca:Mg less than 0.05 and lime-sand mixture in proportions of 11:9. Very fine white burnt lime was used in the classical paint-receiving layer. Huntite and wood-apple gum was used in the medieval paint-receiving layer to prepare a white putty of thickness of not more than 1 mm. White kaolin was used for the paint-receiving layer of southern paintings. The medieval paint was prepared by mixing wood-apple gum with finely powdered cinnabar, orpiment and lead white pigments. The indigo pigment was prepared by beating Indigofera tinctoria leaves in water and allowing oxidation to occur. Gamboge was obtained from the Garcinia morella tree to prepare yellow paint. Finely powdered cinnabar was used as red pigment of southern paintings. Powdered Prussian blue synthetic pigment mixed with wood-apple gum or other suitable plant gum was used. Intermediate colours were prepared by mixing pigments appropriately. Following actions were performed to prepare classical paintings: sketch drawing with a pencil, furnish line drawing with brush, apply colour, perform shading or tonal variation, carryout final outlining and perform finishing touches. The medieval paintings were sketched in black paint using a fine brush. The background was filled in pink leaving white figures and figures filled in yellow. They were carefully outlined in red. The background was filled in pink covering it with red and adding details of figures in red and then neatly outlined

it with a firm black line. Southern paintings too were sketched with a pencil, completed the line drawing with a brush using black paint, applied colours with variations in hue and saturation, reinforced lines with black and completed with finishing touches. This study did not make use of information available in the ola leaf manuscripts and books available in a few southern temples because these provided misleading information. Usage of dorana oil is mentioned in these books but oil obtained from Dipterocarpus glandulosus tree had not been used during the southern period. Dorana oil is prohibited to be used in conservation as this results in the absorption and fixing of waste on paintings increasing their rate of decay.

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302/C

Present condition of wall paintings at the Polonnaruva Citadel

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This project was started at the Polonnaruva citadel with the intention of digital graphic documentation of wall paintings. Information about the present condition of the documented paintings is given in this research paper. Two main traditional image houses are in this citadel. These are Lankatilaka image house and the Tivanka image house constructed by King Parakramabahu in the twelfth century, when Polonnaruva was the capital city. These brick vaulted image houses are huge, with Lankatilaka being the largest image house in the country. They consist of the chambers of cella, entrasol, pronaos and porch with a large number of wall paintings in them. The scientific investigation was done by examining survival patterns of paintings. The long-term survival patterns were determined by detecting temperature and humidity variations of paintings and the growth of microorganisms in them. Cracking in the paint layer, fracturing, flaking of paint, presence of lacunae, cracking and fracturing of ground and deposits present were the observations made in each area of paintings. There are paintings on the walls of all chambers of the Tivanka image house although paintings in the cella are totally deteriorated. The total area of painting is about 340 m^2. A large portion of this area is in lacunae at present exposing the paint-receiving layer. Powdering, lacunae and cracking were observed in paintings. The lack of adhesion between support and ground was evident in few places of the porch. Voids were present in the ground. White eggs of insects were present in the cavities of external surface of the left wall. Bore-holes were also present. White fungal spores were present on the walls of porch. White lacunae were present in the entrasole. Some of them had turned brown, possibly due to the application of a synthetic polymer. Support is strong and can bear weight. Emergence of cup shaped lacunae in the surface layer destroys paintings. Dissolution and dislodging of pigment particles give a blurred appearance. Paint fades rapidly. It powders and disintegrates. *Microspora* and *Cunninghamella* spores were present in air samples of the interior chambers. No growth of fungi was taking place on the surface of paintings. Fungal and algal spores present in the porch deposit on walls, grow as soon as the relative humidity rises to 90 % during the rainy season. The Lankatilaka image house was in a state of ruin with walls overrun by shrubs; roof and parts of wall caved in and with disintegrated outer facades. About 4 m^2 of paintings are present in some areas in a good condition. The total area of existing paintings including small patches is about 20 m^2. Patches of red and yellow paint are still present on lime paint-receiving layer all over the internal and external walls. Red ochre and yellow ochre remain at present. Some external paintings are detached. Detachments are in between support and ground and ground and the paint-receiving layer. These paintings withstand direct exposure to solar radiation and precipitation. However the paintings were in a totally dry condition exposed to direct solar radiation at the time of observation. Microorganisms were found on walls and in the air. The support and ground still have adequate strength and stability. Adhesion between layers and cohesion of particles

were adequate. Behavior is different to the original condition due to the absence of the surface coating, i.e. the paint layer, and roof. The whole mass was totally dry. Movement was under 0.0001 % in all surfaces measured. This is an obvious indication that the surface movement of paintings is almost totally within the paint layer. It is a result of absorption and evaporation of water. *Monosporium* and *Cunninghamella elegans* were present on walls. A green lichen was present in the porch. Investigations done at Lankatilaka proved that the paint layer was responsible in maintaining ideal behavior and conditions.

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303/C

Development of a natural decoration system for ceramic ware

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Ceramic is an ancient craft which has developed in several ways over the past few years, such as introducing new technology identifying new body and glazing mixtures, new designs and design variations. Glaze is an important element in the ceramic body. Ceramic can be divided as glazed ware and non glazed ware. Glaze application depends on the firing temperature and body composition.

Glazing adds advantages to the clay body. It helps to give non-porosity, strengthens the body, permits different types of colours, textures, provides a good finish and a clean surface. Different types of colours, textures and a variety of effects can be obtained by glaze application. It can be decorated by different types of methods and effects. The ceramic body is like a canvas for the artist, which can be played with in different ways, but has many more limitations.

Most of the ceramic products are decorated with pigments and stains. Colours can result from chemical reactions. Hand painting and Decal printing are the main decoration methods in ceramic products. Decoration is one of the main aspects of the ceramic body; it helps to enhance the shape and form and quality of the product. In this research, I have used natural materials to decorate the clay body. Natural plant leaves are one of the best materials which can be used to decorate the ceramic clay body. It can be used as an under glaze decoration method. It is difficult to repeat the same design, however, and each design used becomes unique. The designs differ from one to another and are very elegant in appearance. Its manufacturing cost is low, but the products can be sold at a high price in the market. It is a new decoration method that can be used in the Sri Lankan ceramic sector.

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304/C

Current situation of earthenware cooking pots in Sri Lanka

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Clay is a natural material. It feels soft and flexible in the hand. When gradually pinching and pressing it, it takes shape almost by itself. It changes behavior when combined with water and fire. There are several types of clayware in Sri Lanka. They can be identified as terracotta ware, earthenware, stoneware, porcelain and bone china, depending on body composition and firing temperature. Earthenware has a long history. It has been more popular than others from the beginning of civilization and is more familiar to humans. Earthenware is a suitable material for keeping on a hearth and is often used to manufacture cooking pots which play a major role in the kitchen. But at present, the earthenware industry is not updated to cater to the present social needs. This research was carried out to investigate areas for development and the key factors that should be developed in earthenware pots to cater to the present social needs. It will be helpful for the consumers as well as for the manufactures. This will also help to regenerate the earthenware industry in Sri Lanka.

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305/C

Implementation problems in waste management through an anaerobic digestion process: a case study at the Open University of Sri Lanka

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Despite rising costs in meeting domestic energy needs, especially for cooking, the uptake of renewable energies, such as biogas, solar and wind power is remarkably slow. This paper presents problems identified in organic solid waste management through an anaerobic digestion process. A biogas plant of 8 m^3 was constructed and put to use with the participation of certain stakeholders of the institution in order to identify practical difficulties, evaluate the general awareness of biogas technology and to demonstrate the feasibility of anaerobic digestion as a method of institutional waste management, supplying energy and manure production for an organic agricultural plot. The study commenced with the assessment of awareness of biogas technology, followed by a participatory program in construction and commissioning. The project successfully addressed the misconceptions about the high costs involved, usage of complex technology, difficulties in maintenance and gas purity. The project also created interest among participants to construct their own plants. Lack of knowledge about the multi-facet benefits, misconceptions related to the level of technology involved and maintenance were identified as some of the main obstacles.

306/C

Perceptions of inhabitants of a settlement vulnerable to natural hazards

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Peradeniya is a town which is vulnerable to landslide hazards and the National Building Research Organization (NBRO) has been involved in landslide mitigation activities in the town centre since 2009. The town has evolved due to its strategic location at the intersection of a main road. Presently it provides services in three main areas, functioning as a creator of livelihood opportunities for the communities in surrounding localities, catering to the needs of a transit population and satisfying the needs of a large number of government institutions located in close proximity. Hence, the existence of the town center is important particularly with population growth in the area despite the threat of landslides. The finding of the socio economic survey conducted in the town area reveals that 92% of the building units are used only for the purpose of economic activities, while 8% of the building units are used for dwellings along with the economic activities. The majority of the businesses are groceries, cafeterias, textile shops, vegetable and fruit selling outlets due to the demand for consumable goods. People may be using the location for their day to day market needs. Customers are abundant throughout the year since due to the strategic location of town center. Goods and services for economic activities are mainly found within Peradeniya itself and in the surrounding localities which indicate that the town centre is well established. Hence, the business community in the area demands the continued existence of the present location for their business activities, emphasizing the need for upgrading the present town center. Improving the facilities such as banking, vehicle parking, pedestrian paths, shopping complex etc, while mitigating the risk of landslides, are also demands of the community. Despite the relocation option of the present town center proposed by Urban Development Authority (UDA), landslide risks to the town center have been significantly reduced with completion of the first phase of the landslide mitigation project undertaken by the NBRO. The entire town center will be liberated of landslide risk on completion of the second phase of the project. According to the perceptions of the community, it is highly desirable that the town is developed through an appropriate urban design plan that incorporates proper landslide mitigation principles, without losing a vital human settlement due to natural hazards.

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307/C

Sound mapping and sound barriers for mitigating noise pollution in metropolitan areas in Sri Lanka

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Environmental noise is a worldwide problem. The increase in the number of vehicles in Sri Lanka results in high vehicular traffic which has become a major source of noise pollution in the country. Exposure to high noise levels for long periods may lead to serious diseases including low hearing sensitivity and mental illness. Hence, it is very important to identify noise sensitive places in order to protect the general public and to facilitate policy decisions. Therefore, this study was aimed to identify the affects of noise pollution on the community, develop a sound map to identify the distribution of noise and to design sound barriers to mitigate noise pollution in metropolitan areas in Sri Lanka.

The Rajagiriya area was selected as the focal point of this study. A questionnaire was developed to gather information from affected people on noise. To investigate the peak hours of noise, noise levels were measured from 0600 - 2000 h using a noise level meter and the respective positions were recorded using a GPS monitor. A frequency analysis was done to identify the frequency levels of the noise sources in the area. Finally, a sound map was developed for the study area to identify critical locations. Further noise barriers were designed considering acoustical and structural considerations. Barrier dimensions, material, absorption ratios (ground and materials), transmission loss insertion loss, etc., were considered in the acoustic design.

The average noise level along the Kotte road was identified as 85 dB, while the highest noise level recorded in the area was 108 dB. The peak hours were identified as 1530 – 1845 hours on Monday. The results showed that most of the noise sensitive places such as schools, hospitals, government and private offices in Rajagiriya area are located within 80 - 75dB sound contours. Concrete walls of 2 - 3m height and 175 mm thickness could be used as noise barriers that can reduce noise levels to about 23 – 24 dB.

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308/C

Phosphorus removal from a small wastewater stream using *'Kabook'* in the bio geo filter

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Nutrient enrichment of natural water systems due to wastewater disposal is a critical issue in Sri Lanka. The Diyawanna Oya water system which includes the Kirulapone Canal, is an important water resource in the Colombo metropolitan area. However it is polluted due to haphazard wastewater disposal practices of the surrounding communities. One of the streams, connected to the Kirulapone Canal, flows across the premises of the Open University of Sri Lanka (OUSL), carrying wastewater from a neighboring community. Therefore, it was decided to purify wastewater in this stream to an acceptable quality by using natural environment functions before it flows into the Kirulapone Canal whilst providing a pleasant aesthetic view to the OUSL. The studies showed that the stream water contains a considerable amount of plant nutrients i.e., phosphates and nitrates. Moreover, the phosphate level is higher than the permissible level particularly during the dry season. This study was carried out to design and develop a Bio Geo Filter (BGF) by focusing mainly on the removal of phosphates.

The length of the stream within the OUSL is about 82 m and the entire length was subjected to this treatment. The purification system contains three components, namely the treatment unit, the BGF and the polishing pond. Biological treatment performs in the treatment unit with a 25-minute retention time. The treatment unit was designed with a dam across the stream. This unit treats the streamwater and controls the flow. Hydrological, geotechnical and structural features of the treatment unit were designed considering in-situ data. The BGF contains three main components such as, 1) an impermeable clay layer at the bottom, 2) a geo/bed material which helps adsorption and supports roots 3) vegetation above the surface which takes up nutrients from the wastewater. The BGF was designed with three cells each having a retention time of 20 minutes and a surface area of 63 m^2. Kabook is to be used as the bed material of the BGF. Phosphate removal of Kabook is about 50 % for a retention time of 20 minutes and about 80 % for a retention time of 1 hour. The polishing pond was placed downstream relative to the BGF to visualize the condition of treated stream water before it enters the Kirulapone Canal. The complete purification system was able to reduce the pollutant concentrations below the permissible level during the dry season, when pollutant concentrations are usually high, and to withstand harmful impacts at high tide flow during the wet season.

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309/C

Wastewater treatment for the desiccated coconut industry by using an up flow anaerobic filter and a facultative pond

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Desiccated coconut is a dried kernel product which is prepared from coconuts for direct human consumption. There are about 60 desiccated coconut mills spread over six districts of the country which produce 33,375 metric tons of desiccated coconut per month. Most of the desiccated coconut mills are located in rural areas. These mills generally discharge wastewater into nearby streams or paddy fields without prior treatment. As a result, the surface water in these areas becomes unsuitable for drinking due to the presence of oily substances in the discharged wastewater. Crop damage could also occur due to discharge of wastewater into paddy fields. Hence, it is necessary to introduce proper wastewater treatment systems for the desiccated coconut industry to maintain standards in wastewater characteristics. This study was carried out to propose such a system.

The causes of the problem were identified through a questionnaire survey, conducted in five selected mills. They indicated that the mills do not treat wastewater before discharging into surface water sources. The desiccated coconut mill at Lunuwila was selected for the pilot survey and the total wastewater flow of this mill was recorded as 46 m^3/d. Judging by the wastewater characteristics of the selected mills, it is recommended that screening, oil skimming tanks, and up flow anaerobic filters with facultative ponds, be introduced for the maintenance of wastewater quality within the recommended standards stipulated by the Central Environmental Authority. It was found that oil skimming tanks should consist of four compartments to maintain the required retention time. Also 3 units of up flow anaerobic filters with 2 sets of facultative ponds should be used to further clean the water. The cost for the proposed treatment system will be approximately 3 million rupees as per the rates given by the National Water Supply and Drainage Board.

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310/C

Design of a wastewater management system for a low income housing scheme

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Wastewater management is an essential part for any community. Most water is simply discharged into cesspools. Wastewater management serves a vital role in maintaining safe environmental conditions and public health. Waste disposal is a major problem faced by any community. This study was based on a low income housing scheme of at Arunodaya Mawatha, Rajagiriya Colombo. There are about 1000 houses of which about 700 houses are authorized constructions while 300 are unauthorized. Each authorized house is a privately-owned 2 perch lot with streets and back alleys. At present this scheme uses conventional septic tanks with an anaerobic filter as a wastewater management system. A questionnaire **survey was designed to investigate monthly water consumption patterns, the current status** of wastewater disposal practices and function of toilets in order to provide the most appropriate solution. The levels along the sewer line leading to the septic tank were also taken to investigate the cause for overflowing of manholes.

The housing scheme has a high population density and the area has a high water table. The septic tank effluent is discharged directly into a stagnant canal around the scheme. Considering the existing situation of septic tanks, methods were proposed to improve the treatment system. Rehabilitation was carried out by using the manpower, machinery and equipment at one selected septic tank. Model designing was done through dimensional analysis to improve the septic tank by using baffles and coir fibre. The model test was carried out using baffle walls and coir fibre since an environmentally sound treatment unit is proposed. The model was designed using 6 independent parameters such as the hydraulic retention time, the number of compartments, peak up-flow velocity, and compartment width: length ratio, reactor depth and up-flow to down-flow ratio of compartments.

The Anaerobic Baffled Reactor, which was related to model with collecting tank and five equal compartments for 40 houses. The dimensions Length, width and the height of the onsite ABR for 40 houses are, 7.61m, 3.43m and 3m respectively. The length of the collecting tank is 2.54 m and the length of the each compartment is 1.02m. These dimensions can be adjustable according to number of houses by changing the design parameters.

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311/C

Analysis of commuter traffic trends in Colombo

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Roads in Colombo City have become increasingly congested, especially during the peak hours. An enormous number of vehicles enter Colombo city during the morning peak hours and leave during the evening peak hours. However, there is little knowledge about the number of vehicles, their composition and the number of passengers entering or leaving the Colombo city and also on the contribution of each transport corridor radiating from Colombo. This information is vital for many professionals and organizations that deal with planning, designing, operation and maintenance of transportation related aspects, and for other areas such as land use, environmental aspects, and new developments. Unfortunately this vital information or updated analysis is not readily available due to two main reasons: the complicated nature of the road network with many corridors contributing to commuter traffic, and the high resource requirements for data collection. Thus, the main objectives of this study were to identify and analyse the commuter traffic entering Colombo for various reasons.

There are two main modes of access into Colombo city: the road transport system and the railway system. Most traffic entering Colombo uses the national road network. There are 5 "A" class roads catering to Colombo and seven other "B" class roads. In addition, a few other roads also carry heavy traffic to Colombo, although they are not categorized as national roads under national road classification system. From all these corridors on an average day over 190,000 vehicles come into Colombo; about 64% through "A" class roads. During the peak hours more than 67,000 vehicles enter Colombo which is 35% of the daily traffic flow. When vehicles type is considered, the majority of the vehicles coming into Colombo city are motor cycles (25%), cars (23%), three wheelers (21%) and vans (18%). Buses contribute little to the number of vehicles (5%) though they carry more passengers. Approximately 605,000 passengers enter Colombo through this transportation mode (road network) and highest contribution is from buses (49%). Vans carry about 17% and cars and three wheelers carry about 12% each.

Further analysis identified unique features in each corridor. For example, the percentage of cars on certain corridors is high compared to the others, especially where the rail option is not available or not satisfactory. For an example, Nawala road, High level road and Horana road carry more cars compared to other corridors and thus if an alternative transport mode is provided, this could reduce traffic to a certain level. The proportion between peak and whole day contribution also vary from corridor to corridor. When Galle road is considered, the contribution for daily traffic is 11%, but during the peak time contribution has come down to 6% showing a significant difference.

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312/C

Application of a computer model to enhance the efficiency of property tax collection: a case study at the Sri Jayewardenepura Kotte Municipal Council

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Administrative and planning aspects of local authorities get higher priority, especially since most plans prepared at national and regional levels are implemented through the respective local authorities. However, local authorities frequently seem unable to complete their tasks because the estimated income is not received.

Rates, or consolidated tax, constitute a major source of overall revenue in municipalities as well as urban councils. Pradeshiya Sabhas also collect a considerable amount of revenue from rates. However, these local authorities collect only 45 – 55 % of the total receivables. Thus local authorities annually forego a large amount of revenue.

Under this study, several problems and aspects relating to tax collection were examined. A detailed examination was carried out in the administration phase and of the responsiveness of tax payers to both estimation and collection. Quantitative and qualitative analyses were done for estimation, collection and payment thorough questionnaire surveys, observations and interviews. This analysis revealed that many of the issues can be solved.

With the assistance of global examples, a computer based model was then prepared to overcome issues relating to the collection of rates, which leads to the increase in revenue which is acceptable to both the collector and the payer.

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313/C

Design of a low cost wastewater treatment plant for milk factories

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The Sri Lankan dairy industry annually processes about 80 million liters of milk and produces dairy products such as milk, milk powder, cheese, butter, ice cream and yoghurt. The milk farmers and milk farms bring their daily collection of fresh milk to the milk collection centers and unload milk into chilling storage tanks. Subsequently the chilled milk is transported by bowsers to the main Milco factories in Colombo, Kandy and Nuwara Eliya. A typical dairy factory which produces various dairy products carries out processes such as raw milk reception, pasteurization, standardization and filling, yoghurt processing and filling, ice cream processes and filling, sterilized milk processing, milk powder spray drying and packing.

The milk collection and chilling centre located at Dikhenpura, Munagama, and Horana collects about 4500 litres of milk per day and the collected milk is then transported to the Narahenpita Milco Factory. The chilling tanks, milk carrying cans, milk storage tanks, are washed thoroughly twice a day. About 4500 litres of wash water is discharged into nearby lands without treatment. Before designing an appropriate treatment process for the chilling centre, the characteristics of soil and wastewater were analysed and the topography of the land and the rain fall patterns of the area were studied. Considering all of these results, a wastewater treatment plant was proposed for the Horana Milco milk collection centre. The proposed system consists of preliminary treatment and secondary treatment (biological treatment). Preliminary treatment includes a primary settling tank. Anaerobic ponds and maturation ponds come under the secondary treatment.

Coarse particles are removed from the screens. The sedimentation tank removes oil and grease and suspended solid remnant will be used for animal food at a later stage. Water from the anaerobic pond will be discharged into maturation ponds and at this stage the BOD is reduced to 30 mg/l. This water is then safe to be used for cultivation. The solidified sludge from the sedimentation tank will be used for the production of animal feed. The cost of the proposed system is approximately Rs 1.1 million.

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314/C

Multi objective optimization of municipal waste management systems adapted to the Sri Lankan context

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Decision making related to integrated solid waste management is a complex process as it combines a number of activities such as waste generation, collection, thermal and biological conversion, material recovery, land filling, etc. In such circumstances energy recovery through thermal conversion of municipal solid waste is been considered world wide as a potential waste management technique and as a solution to ever-increasing energy demands. In order to evaluate the applicability of these phenomena in Sri Lanka, this project models energy flow, material flow and cash flow for three cases i.e. direct thermal conversion of waste, thermal conversion through Residue Derived Fuel (RDF) and land filling. Based on the mathematical model Net Present Value (NPV) of the entire cash flows and the land filling capacity of the entire life cycle were taken as the objective functions to be minimized. The fraction of waste to be directly incinerated (W_{DI}), converted to RDF (W_R), directly used at land fills (W_{LF}), and thermal conversion method for RDF, direct incineration were taken as the decision space variables. The steady state ε evolutionary multi objective optimization technique was used to obtain the Pareto fronts. The results show that direct thermal conversion is the only option when there are limitations with the land filling option. With the increase of land filling a significant increase in W_R can be observed while the NPV is reduced.

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Section D

401/D

A survey on raw materials used as Jatamansa in Sri Lanka

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Nardostachys grandiflora DC (Valerianaceae) is a perennial herb, which is found in high elevations of the Himalayas and is not found in Sri Lanka. The rhizome of this species which is known as Jatamansa is a very important raw material used in Ayurveda. *Balanophora fungosa* JR & G. Forst (Balanophoraceae) is known to be used deliberately as an unauthorized substitute for Jatamansa in the local herbal industry. An extensive survey was carried out by collecting information from Ayurvedic physicians and analyzing samples of raw materials sold in the crude drug market. Five representative provinces, i.e., Northern, Southern, Eastern, Western and Central provinces were selected for the survey. Samples of Jatamansa were collected from ten raw material dealers while distributing a common questionnaire among another ten in each province. The same questionnaire was distributed among fifty traditional ayurvedic physicians in the above provinces to obtain information on the nature of raw materials they use as Jatamansa. Based on the macroscopic and organoleptic characters studied, the collected samples could easily be separated into two distinct groups which in turn were identified as *Nardostachys grandiflora* and *Balanophora fungosa* According to the samples collected, an average of 80 % consume *Balanophora fungosa* as Jatamansa. Based on the information gathered from raw material dealers, an average of 74 % use *Balanophora fungosa* as Jatamansa while an average of 66 % of traditional physicians unintentionally prescribe *Balanophora fungosa* as Jatamansa. Hence it could be concluded that the majority consume *Balanophora fungosa* as Jatamansa instead of *Nardostachys grandiflora*. Further, it was noted that consumers in the Northern Province used a considerable percentage of genuine material (*Nardostachys grandiflora*) as Jatamansa but in the Western Province, all market samples of Jatamansa were *Balanophora fungosa*. The results of this survey clearly prove the extensive deliberate substitution of genuine Jatamansa by *Balanophora fungosa* in the local crude drug market. This in turn opens up many questions to be answered with regard to the quality of drugs manufactured and the treatments for which Jatamansa is used as one of the major ingredients.

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402/D

Accumulation of camptothecin (CPT) in *Ophiorrhiza mungos* L., and the influence of climatic conditions on CPT content

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Camptothecin (CPT) is one of the most promising anticancer drugs of the 21st century. Currently, the CPT is extracted from two plant species, *Nothapodites nimmoniana* in India and from *Campotheca acuminata* in China which is not sufficient to meet the existing global demands. *Ophiorrhiza mungus* L. (Dathkatiya, family Rubiaceae) a small shrub, is also known to produce this alkaloid, but no comprehensive study has been made so far to investigate the feasibility of using this plant as a source of the drug. In view of this, a preliminary investigation was carried out to establish the basic patterns of accumulation of CPT in various tissues of plants growing in two different geographic regions. Chloroform: methanol (4:1) extracts of leaf, stem, root, flowers and immature fruits of *O. mungos*, collected separately from four different plants growing in each locality were tested and CPT was identified by high performance liquid chromatography (HPLC) and thin layer chromatogrphy (TLC). The quantification of CPT was done by HPLC–DAD using a reverse phase C18 column with detection at 256 nm. In plants grown in the Colombo region, the highest mean content of CPT, 611.9 ± 67.2 µg/g (dry weight basis) was observed in immature fruits followed by flowers (586.8 ± 60.5 µg/g), roots (316.2 ± 12.3 µg/g) and stem (218.4 ± 16.5 µg/g) while the leaves contained the lowest (81.3 ± 1.3 µg/g). A similar pattern of accumulation of CPT was observed in the root, stem and leaf tissues of the plants of Deraniyagala origin but the concentration of CPT was far greater than in those grown in Colombo. Of the tested samples, the highest mean value of 1429 ± 26.17 µg/g of CPT was observed in root tissues of the Deraniyagala plants which was about five-fold higher than that of root tissues of the Colombo plants. These preliminary results revealed an enormous influence of climatic conditions on the CPT content while indicating the potential of further screening of *O. mungos* plant to identify high yielding sources.

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403/D

Antioxidant properties of *Moringa oleifera* leaves cultivated in Sri Lanka

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Epidemiological studies have shown that foods rich in antioxidants provide protection against multiple diseases. Plants and their products are rich sources of phytochemicals and have been found to possess a range of biological activities including antioxidant activity. *Moringa oleifera* Lam. (Family: Moringaceae) known as Murunga in Sinhalese, is reported to have antioxidant activity. Recent research findings have shown that the agro climatic location has a profound effect on the degree of antioxidant activity of *M. oleifera* leaves. However, no study has been conducted in the country to evaluate the antioxidant properties of the leaves of the indigenous *M. oleifera* in Sri Lanka. The present study evaluated the antioxidant properties of the leaves of *Moringa oleifera* cultivated in Sri Lanka.

Freeze-dried 70 % methanolic extract of *Moringa oleifera* leaves was used in this study. Antioxidant properties were evaluated in terms of the total polyphenolic content (TPC) (n=9), and *in vitro* 1,1-diphenyl-2-picryl-hydrazyl (DPPH) radical scavenging (n=3), and 2-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid [$ABTS^{\bullet}$] radical scavenging (n=3) antioxidant assays. Mean TPC was 10.08 ± 0.70 mg gallic acid equivalents/g of leaves. The IC_{50} of DPPH and $ABTS^{\bullet}$ radicals scavenging activities were 2.31 ± 0.04 and 0.36 ± 0.00 mg/ml (Trolox IC_{50}: DPPH =7.60 ± 0.30 µg/ml; $ABTS^{\bullet}$ = 3.45 ± 0.30 µg/ml) and Trolox equivalents of DPPH and $ABTS^{\bullet}$ radicals scavenging activities were 243.39 ± 3.69 µmol/100g and 716.80 ± 11.71 µmol /100g leaves respectively. Radical scavenging activity by DPPH and $ABTS^{\bullet}$ assays were dose dependent (DPPH: R^2=0.99; $ABTS^{\bullet}$: R^2=0.97, $P < 0.05$). Methanolic extract of *Moringa oleifera* leaves demonstrated significantly high ($P < 0.05$) $ABTS^{\bullet}$ radical scavenging activity compared to the DPPH radical scavenging activity. It is concluded that *Moringa oleifera* leaves possess markedly high antioxidant properties and their daily consumption may play an important role in prevention of oxidative stress associated chronic diseases.

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Screening of endophytes from *Centella asiatica* L. for antimicrobial compounds

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A wide variety of bioactive secondary metabolites produced by endophytes are used in agriculture, industries and medicine. Several novel antimicrobial compounds have been isolated from endophytes in cultures. Occasionally; they produce compounds similar to those produced by their respective host plants. A few reports on the antimicrobial activity of the extracts of *Centella asiatica* L, prompted a preliminary investigation to isolate endophytic microorganisms from leaves of *Centella asiatica* L. and screen for potential antimicrobial activity against selected bacteria under *in vitro* conditions. Six species of endophytic fungi and two species of actinomycetes were isolated from the leaves of four morphotypes of *C. asiatica* L. growing in Sri Lanka. Two fungi, including *Aspergillus* sp. (SG-GWF_2), were identified as the members of the sub division Ascomycotina based on colony characters and morphological characters. Of the six fungi, three species, SG-GWF_2, NG-WF_1 and SG-BWF_1 showed promising antagonistic features on at least one representative of Gram-positive and Gram-negative test bacteria. The test was performed in triplicate and the antimicrobial activity was determined by measuring the mean growth inhibition zones on culture disk method using 10^6 Colony Forming Units of test bacteria. The highest mean inhibition zone, 23.0±0.8 mm was shown by *Aspergillus* sp. against *E. coli*. The fungus NG-WF_1 exhibited positive antibacterial activity on all tested bacteria species. When crude ethyl acetate extract of culture broth derived from the submerged fermentation of *Aspergillus* sp. was further evaluated against *E. coli*, the highest antimicrobial activity was shown by the extract derived from 25 ml Potato Sucrose Broth volume fermented for 14 days. The antimicrobial compound produced by *Aspergillus* sp. is heat stable at 100 ºC while those produced by the other two positive fungi are heat labile at 100 ºC. However, ethyl acetate extract of only two of the four *C. asiatica* L. morphotypes showed a poor antimicrobial activity on *E. coli* in the Kirby-Bauer disk diffusion test. This study reinforced the assumption that endophytes of *C. asiatica* L. could be a promising source of antimicrobial substances.

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405/D

Apatite solubilization by phosphate solubilizing bacteria

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In a previous study, phosphate solubilizing microorganisms including 30 bacteria were isolated, screened and characterized from different agro-ecological zones in Sri Lanka. The current study was aimed to evaluate the efficiency of 28 bacterial isolates, in solubilizing apatite to identify an effective phosphate solubilizer. The solubilized phosphate content and the change in pH value were used as parameters of measurement. To determine the inoculum size, the relationship between absorbance and cell density was used. Experimental conditions such as concentrations of the components in the growth medium and inoculum size were optimized in order to obtain detectable amounts of solubilized phosphate.

Ninety five milliliters of modified Pikovaskaya liquid medium with 7.5 grams of High Grade Eppawala Rock Phosphate (HERP) at pH 7 was inoculated with 5 mL of 24 hour old bacterial suspension having an absorbance value of 0.300 corresponding to 2.5 x 10^9 colony forming units per milliliter. Samples were incubated for 72 hours under 100 rpm constant oscillation at room temperature and filtered. The filtration was centrifuged at 10 000 rpm for 10 minutes and the supernatant was used to measure pH values and solubilized phosphate levels. Spectroscopic method of Murphy and Riley (1958) was used to quantify the solubilized phosphate levels. The data were analyzed statistically using SPSS (16.0 version) and Minitab (15) statistical packages. The solubilized phosphate concentration was significantly higher in all inoculated samples than in the uninoculated control. The highest phosphate solubilization of 54.72 (±0.33) mg Phosphorus/L was recorded with the bacterial isolate WRB3. There was a significant decrease in pH value in all the inoculated samples with respect to the control. Bacterial isolate WRB1 was the highest organic acid producer with a final pH value of 2.20 (±0.06). Mean phosphate solubilization and the mean pH among the bacterial isolates were significantly different at 0.05 level in the liquid media. The correlation analysis using SPSS (16.0) statistical software indicated an absence of a correlation between the decrease in pH and the amount of solubilized phosphates (r=0.293). The efficient phosphate solubilizing bacterial isolates will be identified and utilized for the production of a phosphate bio fertilizer.

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Compositional variations of nutrients and phytochemicals in two species of yams (*Dioscorea alata, Dioscorea esculenta*) and the tuber crop (*Xanthosoma sagittifolium*)

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A study was carried out to determine the levels of starch, protein, crude fat, crude fiber, ash and to compare the phytochemical content (saponins, flavanoids and alkaloids) and mineral elements (Calcium, Magnesium, Iron, Potassium and Zinc) in selected species of yams (*Dioscorea alata* (Rajala and Hingurala), *Dioscorea esculenta* (Kukulala)) and tubers (*Xanthosoma sagittifolium* (Kiriala)). Crude flour samples from each species were prepared by oven drying cut flakes at 40 ℃ for 30 hours followed by grinding. The chemical composition was analysed using the AOAC (1995) method while the starch content was analysed using the acid hydrolytic method. Three replicates from each sample were oven-dried and the dry ashing was followed by elemental analysis using an Atomic Absorption Spectrophotometer to determine the mineral elements. Phytochemicals were determined gravimetrically with slight modifications to the methods described by Okwu & Nadu (2006). The chemical composition, phytochemicals and mineral constituents were calculated on the dry weight basis and the results were analysed to compare the crude levels of nutrients and phytochemicals in the studied varieties using one way ANOVA of Minitab (version-14).

There was no significant difference in total starch ($P > 0.05$) between the studied varieties. The protein levels ranged from 2.66 ± 0.21 to 10.16 ± 0.64%, with *D. alata* having a higher protein level in comparison with the other species tested. The crude fat levels in tubers ranged from 1.5 ± 0.2 to 2.3 ± 0.1 %, with the highest level being observed in Kiriala. The crude fibre content in tubers was found to range from 1.8 ± 0.1 to 2.33 ± 0.15 % and the ash levels ranged from 1.66 ±0.21 to 2.33 ±0.21 %. Crude saponin levels were significantly higher ($P<0.05$) in yams while Rajala and Kiriala contained comparable levels ($P> 0.05$; 12.98 ± 0.61 and13.11± 0.52 mg 100 g^{-1}). Kukulala had the highest crude saponin content of 20.01± 0.46 mg 100g^{-1}. A high amount of crude flavonoids were observed in Kukulala and Kiriala (12.4 ± 0.46 and 11.26 ± 0.46 mg 100 g^{-1}). A considerable level of alkaloids was present in Hingurala and Kukulala (1.64 0.04± and 1.89 ±0.02 mg 100 g^{-1}). The yams were rich in Calcium and Iron while a high level of Magnesium was observed in Kiriala (45.27± 0.31 mg 100g^{-1}). High levels of Potassium were observed in all species. Results revealed a high nutritional significance and medicinal importance in the studied species due to the nutrients and phytochemicals present.

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Zooplankton composition and distribution in relation to physico-chemical parameters in the Negombo estuary

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The Negombo estuaries serve as a fishing ground and sink for many anthropogenic effluents from the surrounding urban area. The seasonal abundance and distribution of plankton were investigated in relation to some physico-chemical parameters of the estuary from March to December 2010. Zooplankton and surface water samples were collected from six sampling sites where effluent discharges to the lagoon and analyzed using standard methods. Salinity varied from 4.30±6.15 to 17.30±8.31 ppt, surface water temperature varied from 29.4 to 30.25°C, and mean pH ranged between 7.32 ± 0.22 to 7.88 ± 0.65 during sampling period. Dissolved oxygen ranged from 3.48±1.29 mg/l to 6.47±1.08 mg/l in Munnakkaraya and Dungalpitiya, water depth varied from 54.30±16.28 cm in Madabokka to 230.50±22.54 cm in Dandugam oya. Chlorophyll-a levels were ranged from 0.98±1.08 to 6.69±6.26 mg/m^3 in Dandugam oya and Pitipana Veediya respectively. The nitrite-N varied from 0.0061±0.0031 mg/l (Dungalpitiya) to 0.0214±0.0324 mg/l (Munnakkaraya), while phosphate ranged from 0.27±0.42 mg/l (Madabokka) to 0.70±0.53 mg/l (Pitipana veediya) during the study period.

Among zooplanktons, crustaceans represented the major component (55.93 to 80.84% of the zooplankton community) during the investigation period. More freshwater cladocerans were recorded during the low salinity period (May and Nov 2010) in Hamilton canal, which is the freshwater inlet in the lagoon. However, salinity was not significantly correlated with density of cladocerans in Hamilton canal (r^2 = 0.3029). A significant and positive correlation ($P<0.05$) was observed between water salinity and nauplius density (r^2 = 0.5598) in Dandugam oya. Nauplius density was also positively correlated with Nitrate-N (r^2 = 0.4246) in Pitipana area but this was not statistically significant. Rotifer density in Pitipana also showed a positive and significant relationship with nitrate-N content (r^2 =0.5574) and insignificantly correlated with Nitrite-N content in the same area (r^2 =0.3826). Rotifer density in other sampling sites was positively correlated with BOD and nutrient content of the area. However correlations were not significant. Highest density of molluscans (18.16±27.73%) and rotifers (34.55±3±1.59%) were recorded in Munnakkaraya and Pitipana respectively. High level of phosphate concentration (0.70±0.53 mg/l) and some pollution indicator species (rotifers) showed organic pollution in several locations of the Negombo estuary. Zooplankton assemblages and its correlation with environmental variables showed that salinity and nutrients were the main factors influencing the distribution of zooplankton.

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408/D

Detection and quantification of the cyanotoxin cylindrospermopsin from Girandurukotte water reservoirs and water sources using a biochemical method

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Most of the world's population relies on surface freshwater as its primary source of drinking water. The drinking water industry is constantly challenged with surface water contaminants that must be removed to protect human health. Toxic cyanobacterial (blue-green algae) blooms are an emerging issue worldwide due to the production of cyanotoxins. Among them, cylindrospermopsin is known as a potent cytotoxin which affects kidney and liver function.

This study was performed to address the issue of Chronic Kidney Disease of unknown aetiology (CKDu) prevailing in the North Central Province and related areas, targeting identification of the cyanotoxin cylindrospermopsin in water sources. Water samples were collected from eight reservoirs and different water sources used by eight CKDu patients living in Girandurukotte. All the samples were examined for the presence of cylindrospermopsin using an ELISA detection kit, and to quantify the toxin concentration. Twelve samples gave positive results for the toxin with concentrations of 0.0686, 0.0722, 0.0722, 0.1912, 0.0933 and 0.1145 ng/ml for Ulhitiya, Rathkinda, Henanigala, Bathalayaya and Belagana wewa respectively, and 0.0886, 0.0530, 0.3920, 0.2601, 0.0932 and 0.0619 ng/ml for patients' water sources (three from wells and three from streams respectively). The method is simple, rapid and highly sensitive and allows the detection of cylindrospermopsin concentrations between 0.05-2.0 ng/ml which is more than the HPLC method. Further, the test kit does not require any sample processing and therefore can be directly subject to ELISA test kit assay.

In conclusion, results confirmed the presence of cylindrospermopsin in water resources in Girandurukotte and therefore it might be a risk factor for CKDu prevailing in this area. More epidemiological studies are required to confirm cyanotoxins as a risk factor for CKDu.

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Application of molecular techniques for the detection of potentially microcystin-producing cyanobacteria in Kondawatuwana reservoir in Ampara

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The microcystins are a group of cyclic heptapeptide hepatotoxins produced by number of strains of cyanobacterial genera. The aim of this study was to determine the feasibility of using molecular probes to easily and accurately detect the potential for microcystin production by targeting the *mcyA gene* in microcystin biosynthetic (*mcy*) gene cluster. *mcyA* is responsible for the activation and incorporation of N-methyl-dehydro-alanin and L-alanin into the cyclic peptide which is essential for microcystin production.

Kondawatuwana tank (7° 17' 3" N 81° 38' 45" E) is a major irrigation tank located in the city of Ampara. The Ampara water supply scheme extracts raw water from Kondawatuwana reservoir and uses the Dissolved Air Flotation (DAF) technique to remove algae and other contaminants from water prior to filtration. Despite this treatment, the treated water from this water supply scheme turns dark brown from time to time. Predicting toxic blooms is important in view of both their increasing occurrence in the reservoir and the high cost of the current technology used for their removal.

Water samples were collected, inoculated into BG11 medium and incubated at 28+/- 2 °C with fluorescent light at a 16:8-h D/L cycle. Microscopic analysis was performed to investigate cyanobacterial composition and *Microcystis*-like species were tentatively identified from environmental samples. However, *Chroococcidiopsis* species was dominant in cultured isolates. Molecular analysis of the 16S rRNA region was used to detect cyanobacteria in water samples and cultured isolates. The 16S rRNA gene sequences confirmed that *Chroococcidiopsis* sp. AP2 (GU300772) was present in the cultured sample with 99% sequence similarity to *Chroococcidiopsis* sp. clone 1P-2-N12 (EU705152).

The presence and identification of toxic strains was studied by PCR amplification of *mcyA* gene in the microcystin synthesis pathway. Oligonucleotide primers (McyAF19/ McyAR47) were designed for the *mcyA* gene region. The presence of the *mcyA* gene involved in microcystin biosynthesis was found in one environmental sample (HQ848647), indicating the potential of this gene for producing the toxin. This PCR-based method could be a valuable tool for early detection of potentially toxic cyanobacteria in public water supply reservoirs in Sri Lanka before the appearance of cyanobacterial bloom and detectable level of toxin concentrations.

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410/D

Gastro-intestinal parasites of domestic, semi-domestic and stray dogs in Hantana, Kandy district

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Gastrointestinal (GI) parasites in dogs are found worldwide but they are more prevalent in the tropics and subtropics, especially in developing countries where communities are socioeconomically challenged. Some of these infections are zoonoses.

Faecal samples were collected from stray, domestic and semi-domestic dogs from Hantana (n=30/group) immediately after defecation, between June 2010 and March 2011. Samples were processed using modified salt flotation, Sheather's sucrose flotation and by direct iodine smears according to the WHO guide for morphological identification. Some helminth identifications were confirmed by amplification of ITS 2 and COI regions using appropriate primers. *Toxocara* and *Toxascaris* eggs were cultured to obtain larvae. Of the 90 dogs examined, 81 (90.0%) were infected with one or more GI parasites. Mixed infections were more common (72.8%) than single infections (27.2%). Prevalence of infection was higher in the stray dogs (93.3%) than in semi-domestic dogs (86.7%) and domestic dogs (86.7%), but this difference was not statistically significant (χ^2 test, P>0.05). However, worm burden and number of parasite species were much lower in domestic dogs. A total of 13 parasite species were found, of which *Ancylostoma sp.* was the most prevalent (73.3%). Other parasites found were *Toxocara canis* (27.8%), *Spirocerca lupi* (22.2%), *Entamoeba sp.* (17.7%), *Toxascaris sp.* (12.2%), *Trichuris vulpis* (12.2%), *Blastocystis sp.* (12.2%), *Strongyloides sp.* (11.1%), *Isospora sp.* (7.8%), *Capillaria aerophyla* (5.6%), *Giardia sp.* (2.2%), unidentified trematode sp. (2.2%) and *Cyclospora sp.* (1.1%). More females were infected with GI parasites than males, with a significant difference among the stray dogs (χ^2 test, p=0.0152). This may be due to immune suppression of females during pregnancy and lactation. No significant differences were detected in the prevalence of GI infections between puppies and adults.

The high prevalence of GI parasites, especially zoonotic species such as *Ancylostoma, T. canis, Strongyloides, T. vulpis* and *Toxascaris* may constitute a threat to the residents of Hantana and authorities should provide regular mobile veterinary clinics and educate the public. The use of broad scale anthelmintics may be the reason for the lower helminth species diversity and worm burden in domestic dogs. Regular deworming with specific antihelminthics and anti-protozaon treatments after faecal examinations should be carried out.

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411/D

Food habits and soil temperature tolerance range of *Aneuretus simoni* Emery (Sri Lankan Relict Ant) and its behavioural interactions with three insect species

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Aneuretus simoni is a critically endangered endemic ant species in Sri Lanka. Five preliminary laboratory experiments were conducted in May 2010 at room temperature to study several biological aspects of workers of this species that were collected from the Kirikanda forest in the Kalutara district. Five major and minor workers of *A. simoni* were introduced separately to the cavities which consisted of decaying plant material and small dead insects collected from the same forest, and honey. After an hour, all ants observed on each food source in each setup were recorded. Three trials were conducted for each food source. Soil temperature tolerance range of *A. simoni* at 40 % of soil humidity and soil pH of 6 was investigated by exposing nine major and minor workers each to twelve temperatures, ranging from 19 - 35 °C, for an hour. Each experimental setup consisted of three 50 ml beakers containing 5 g of soil collected from the Kirikanda forest. Three *A. simoni* workers were introduced to each 50 ml beaker. These beakers were placed in a water bath to maintain the soil temperature. A control setup was also maintained at room temperature. The soil temperature tolerance ranged from 23 – 32 °C while no mortality was recorded in the control.

To study the behavioural interactions between *A. simoni* and two other ant species (*Pheidole* sp. 10 in author's collection and *Odontomachus simillimus)* and a termite species (*Nasutitermes ceylonicus)*, which were common in the Kirikanda forest, a piece of rigifoam with two cavities of 7 cm diameter and a connecting middle canal, was used. Initially, the canal was blocked and ten major and minor workers of *A. simoni* were placed in one cavity and ten soldiers and workers of the other species were placed in the other cavity. After half an hour, the piece of rigifoam which blocked the canal was removed. Observations from three trials conducted with each species were recorded. *Pheidole* sp. 10 and *N. ceylonicus* avoided *A. simoni* workers while *O. simillimus* killed three, three and two *A. simoni* workers in the three trials, respectively. It can be concluded that *A. simoni* workers were omnivorous similar to the field observations of other researchers. Workers of *A. simoni* were eurythermal at 40% of soil humidity and soil pH of 6. *Aneuretus simoni* can mutually survive with *Pheidole* sp. 10 and *N. ceylonicus*, but *O. simillimus* appeared to be a natural enemy of this species.

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Morphometric and morphological analysis of prehistoric skeletal remains excavated from Pothana, Sigiriya, Sri Lanka

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Pothana-Sigiriya, a prehistoric Mesolithic heritage site in Sri Lanka has yielded three human skeletons dating back to 4500-5000 BC according to radiocarbon (C^{14}) dating. The detailed morphometric and morphological analysis was performed on human skeletons excavated from Pothana, Sigiriya and presently displayed at National Museum Sri Lanka, Sigiriya Museum and at Osteology laboratory, Postgraduate Institute of Archaeology (PGIAR), University of Kelaniya. The skeleton at National Museum with less prominent superciliary arches, the medium sized mastoid process, less prominent muscle attachment sites over the cranium and wide sciatic notch of the pelvic bone was comparable with that of females. The estimated age was around 25–35 years considering the complete eruption of all 3 molars and the wearing pattern. The skeleton presently at the Sigiriya museum with prominent morphological features of highly robust, heavy, prominent muscle attachment sites, the large mastoid process, highly marked superciliary arches, prominent external occipital protuberance and narrow sciatic notch of the pelvic bone was comparable with that of males. Since all three molars were fully erupted and showed no signs of wearing on their occlusal surfaces, the estimated age was around 25–30 years. The cranium displayed at PGIAR is probably female according to observed small size of the mastoid processes. The age and stature estimation was not possible as the available teeth were mineralized and limb bones were not available. Using the measured lengths of restored long bones and applying regression formulae of Trotter & Gleser (1952) and Krogman (1962), the reconstructed height of the extinct female and male is 170 cm and 173.61 cm respectively. This estimated height is more than the mean height of the present day population (164.6 cm and 151.3 cm for males and females reported in Priyanga *et al.* 2010). The current study confirms reports by Kennedy (1965) that with the male being 164.70 cm and the female 164 cm, Balangoda man was taller than the mean height of the modern Sri Lankan population. This contrasts with the reconstructed mean height of males 140.05 cm of Bellan bandi pallassa skeletal remains as reported by Kanthilatha 2008.

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413/D

Isolation of endophytic fungi from marine algae and their antimicrobial activity

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Marine macro algae or seaweeds have been shown to contain endophytic fungi which produce novel bioactive compounds with the potential to be exploited in the fields of medicine, agriculture, and industry. The current study was carried out to isolate and identify endophytic fungi from selected marine algae and to screen the biological activity of fungal endophytic isolates. A few species of seaweeds were collected from the Mt. Lavinia beach and identified according to their vegetative and reproductive characteristics, using available keys. The thalli were plated in Potato Dextrose Agar (PDA) medium with sea water. The emerging fungal colonies from inner tissues were picked up and plated in the same medium separately, to obtain pure cultures. According to the colony morphology and microscopic features and with the help of available keys, several genera of fungi such as *Penicillium* spp. Isolate (I) and (II), *Aspergillus* spp., *Colletotrichum* spp., *Rhizopus* spp., were identified as endophytes of the algae *Chaetomorpha antennnina, Ulva fasciata, Gracilaria corticata* and *Caulerpa racemosa,* respectively. Isolated endophytes were separately cultured in Potato Dextrose Broth (PDB) medium with sea water and the culture filtrates were separated using Ethyl acetate, except those of *Penicillium* spp. Isolate (I) and *Aspergillus* spp. which did not cause much colour change in the broth. The organic fractions were evaporated to dryness and dissolved in Ethyl acetate to yield a concentration of 40 mg/ml each. Bioassays were done in a Completely Randomized Design, using the disc diffusion method to test the biological activity of those extracts against pathogenic fungi *viz. Curvularia* spp. and *Fusarium* spp. and pathogenic bacteria *viz. Escherichia coli* (Gram -) and *Bacillus* spp. (Gram +). Results revealed that the *Fusarium* spp. was significantly and highly affected by the crude endophytic extracts than *Curvularia* spp and the crude extracts of *Penicillium* spp isolate 1 were highly effective than those of *Aspergillus* spp. against the two fungal pathogens ($P<0.05$). Also, organic fractions of the endophytic extracts were significantly and highly effective than inorganic fractions against pathogenic bacteria, and significantly and highly effective on *E coli* ($P<0.05$). Further, *Penicillium* spp. isolate 2 extracts had a significantly higher effect on pathogenic bacteria ($P<0.05$).

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414/D

Lichen family Graphidaceae: How much true biodiversity exists in Sri Lanka?

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In the past two decades biological sciences have shifted significantly from organismic research towards molecular and applied approaches. Very limited research is carried out on the taxonomy of lower plant groups in Sri Lanka. Lichens are one of the groups where taxonomic research has immense importance. Though lichens have long been believed to be most abundant in cool-temperature areas, their species richness clearly increases towards tropics. Crustose epiphytic microlichens have their highest diversity in the tropics. Family Graphidaceae is a chiefly tropical group of crustose lichens comprising more than 1200 species. The present paper discusses the existing biodiversity of lichen family Graphidaceae in the Knuckles mountain range. The sampling sites represented five forest types and nine different disturbed vegetation types in six elevation classes. Lichen species, their frequency and cover values were recorded together with environmental parameters in 100 of 100 m^2 plots. Lichen species compositions of different elevations were compared with non-metric Multi-Response Permutation Procedure (MRPP). The beta diversity was very high (Whittaker's beta diversity= 48.1). The lichen composition of six elevation classes differed more than expected by chance except one pairwise contrast having $p< 0.05$. For all pairwise combinations, MRPP yielded A–statistics ranging 0.014 to 0.09. In the pairwise comparison, group 4 (altitude = 1300-1399 m) vs. 3 (altitude = 1200- 299 m) had P=0.10 and A=0.007, indicating that lichen composition was more homogenous in different elevation classes. The sampling units in group 4 represent forest types such as disturbed montane and undisturbed montane. The forest type of group 3 was undisturbed sub-montane. Distribution of lichen species in study area indicated a considerable spatial variation among different elevations. MRPP revealed statistically significant difference in lichen communities among elevation classes, but with weak group separation. There were 360 different lichen species belonging to 86 genera among the 571 specimens identified. Of a total of 360 lichen species, 126 represented the lichen family Graphidaceae in 17 different genera. These included eight species new to science and 71 new records for Sri Lanka. This study highlights that previously unknown and unreported lichen taxa continue to be found in Sri Lanka at a remarkable rate although this study was confined only to Knuckles mountain range. This paper documents the extraordinary diversity of Sri Lankan lichens, especially of Graphidaceae, suggesting that many more species await discovery and could provide substantial additions to the Sri Lankan lichen checklist.

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415/D

Inhibition of pro-inflammatory cytokine secretion by human mononuclear cells and phagocytic activity of human neutrophils by aqueous leaf extracts of *Vitex negundo*

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The *in vivo* anti-inflammatory activity of the aqueous leaf extract (ALE) of *Vitex negundo* had been shown previously using the rat paw-oedema model. This *in vitro* study was carried out to investigate the specific *in vitro* inhibitory effects of ALE of *V. negundo* on human mononuclear cell and neutrophil functions. ALE concentrations of 31.3-500 µg/ml were selected based on having >80% viable human leukocytes in the *in vitro* cytotoxicity assay. Freeze-dried ALE inhibited the secretion of interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-α) by LPS-stimulated human mononuclear cells in a dose-dependent manner ($r = 0.858$; $P = 0.007$ and $r = 0.995$; $P < 0.001$ respectively). ALE at 500 µg/ml showed the highest inhibition of IL-6 and TNF-α secretion (58.0% and 26.1% respectively). However, there was no significant inhibition of IL-1β secretion by ALE with all the concentrations used. ALE was tested *in vitro* for its inhibitory effect on neutrophil phagocytic activity, production of nitric oxide (NO) and reactive oxygen species (ROS). ALE showed the highest significant inhibition of yeast phagocytosis (55%) and ROS production (54%) at 500 µg/ml ($P<0.01$) and these inhibitory effects were dose-dependent ($r=0.94$; $P=0.15$ and $r=0.76$; $P=0.007$ respectively). ALE showed significant, dose-dependent inhibition of NO production by human neutrophils as measured by the nitrite and nitrate in culture supernatants ($r = 0.90$; $P < 0.001$ and $r = 88$; $P < 0.001$ respectively). The highest percent inhibition was observed at 500 µg/ml of ALE (91%) and this was comparable to that of the positive control, N-monomethyl-L-arginine (95%). Moreover, ALE possessed significant membrane stabilising activity with a highest activity of 91.4±1.00 % at 0.01 µg/ml ($P<0.001$). Inhibition of inflammatory mediators such as ROS, NO, IL-6, TNF-α and inhibition of phagocytic activity of neutrophils demonstrated that immunomodulation is one of the mechanisms by which ALE of *V. negundo* mediates anti-inflammatory effect.

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416/D

Genetic differentiation of some *Artocarpus heterophyllus* Lam. (Jackfruit) varieties in Sri Lanka and development of varietal specific AFLP markers

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Artocarpus heterophyllus Lam. (Jackfruit) in the family Moraceae is considered to be native to the rain forests of the Western Ghats of India and the Malaysian Archipelago. It has been introduced to other south and Southeast Asian countries, including Sri Lanka, where it is considered a naturalized species. In Sri Lanka, it is an important fruit and timber tree, and the species is found in association with permanent human settlements, particularly in home gardens and plantations. Despite the importance of *A. heterophyllus*, coordinated efforts to improve the species have been initiated only recently, and effective ways to differentiate varieties have not been identified as yet. Therefore, the objective of this study was the genetic differentiation of *A. heterophyllus* varieties using AFLP markers. Genomic DNA was extracted and AFLP analysis was carried out using standard protocols with minor modifications. UPGMA based dendrogram was constructed by using PHYLIP package. According to the dendrogram, variety Rosa, Horana and Gannoruwa clustered together. Varieties Father Long and Kothmale clustered into one group. Other varieties were separated from them and further divided into two groups as Kuruwita, Mandoor, Thellappalai, A.V.Dias, Kuru Kos in one cluster and Ganegoda, Maharagama, Daha atamasaya and Kalpitiya varieties in another cluster. Furthermore, varietal specific AFLP fragments (markers) could be identified for all of the above jackfruit varieties except for Rosa, Horana and Gannoruwa varieties. Further studies to include more primer combinations and the use of morphological information for the clustering process are suggested to increase the efficiency of the identification process.

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417/D

Cross inoculating ability of rhizobia from wild non-edible legumes on *Vigna radiata, Vigna mungo* and *Glycine max.*

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The objectives of this study were to test the rhizobia isolated from 9 wild non-edible legumes for their effect on *Vigna radiata*, *Vigna mungo* and *Glycine max.* by determining the impact of cross inoculation on nodulation and dry matter production of the above host species. Cross inoculation experiments were performed as a pot experiment under semi aseptic conditions with 9 strains which were previously isolated and screened as effective strains from wild non-edible legumes (*Crotalaria* sp., *Mimosa* sp. and *Vigna* wild relatives). Two rhizobial strains obtained from each host crop was also used as reference strains. The treatments were arranged as a complete randomized design with four replicates. Inoculation of rhizobial strains was done 3 days after the seeding stage. Before harvesting, the plants were visually rated. Plants were harvested after 7 weeks and a nodule count was taken. The plants were oven dried at 70 °C for 48 hours and weighed. The data were analyzed statistically (at p= 0.05) using the SAS statistical package. According to the results of nodule formation all except one strain produced nodules in *V. radiata*. All 9 strains tested formed nodules in *V. mungo,* and all except two strains produced nodules in *G. max.* According to plant dry matter production of *V. radiata,* plants inoculated with 7 of the above strains showed dry matter production which was even higher than that with N fertilizer application (20–31%). When compared to the N-free treatment, the dry matter production was 30-40 % higher. Although the other two strains showed poor dry matter production, they showed higher nodulation, showing low effectiveness and high infectivity. In *V. mungo, 4* strains showed better performance in response to dry matter production (compared to the N fertilizer application [10-12%] and compared to N free treatment 29-44%]). Although one of the above strains resulted in a comparatively low average number of nodules, it exhibited the highest dry matter production showing that it is low in infectivity but high in effectiveness. With respect to *G. max.,* 4 strains showed a higher dry matter production than the other strains, which was greater than the N fertilizer application (15-20%). One of these was a strain that also showed a higher nodulation. Therefore, this strain has a high infectivity as well as high effectiveness.

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Section E1

501/ E1

Effect of long-range part of the potential on the elastic S-matrix element

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The quantum mechanical three-body Schrödinger equation can be reduced to a set of coupled differential equations when the projectile is easily breakable into two fragments and when scattering is a heavy stable nucleus. It has been found that the diagonal coupling potentials in this model take the inverse square form at sufficiently large radial distances and non-diagonal part of coupling potentials can be treated as sufficiently short-range to guarantee that numeral calculations are feasible. We will show that this long-range part of the potential has a small contribution to the elastic S-matrix element.

Let us consider the Schrödinger equation related to the long-range diagonal potential in the form

$$[\frac{d^2}{dr^2}+k^2-\frac{l(l+1)}{r^2}-\frac{2\mu}{\hbar^2}V(r)]U_l(k,r)=0$$

where $V(r)$ falls off as $\frac{1}{r^2}$ at large r . If we define $F_l(k)$ by

$$F_l(k)=1+ik^l\int_0^\infty U_l(k,r)\frac{2\mu}{\hbar^2}V(r)h_l(kr)dr$$

where $h_l(kr)=j(kr)+in_l(kr)$ in terms of spherical Bessel and Neumann functions.

S-matrix element $S_l(k)$ can be written as $S_l(k)=(-1)^l\frac{F_l^*(k)}{F_l(k)}$

Now, we will show that the long-range part of the potential has a minor effect on the S-matrix element. If the potential $V(r)$ takes the form of inverse square form beyond R_m,

$$F_l(k)=1+ik^l\int_0^{R_m}U_l(k,r)\frac{2\mu}{\hbar^2}V(r)h_l(kr)dr+F_l^{R_m}$$

and

$$F_l^{R_m}(k)=A_lik^l\int_{R_m}^\infty(kr)^{1/2}\frac{2\mu\gamma}{\hbar^2r^2}J_\nu(kr)h_l(kr)dr=A_l(-1)^{\frac{(l+1)\pi}{2}}ik^l\int_{R_m}^\infty(kr)^{\frac{1}{2}}\frac{2\mu\gamma}{\hbar^2r^2}J_\nu(kr)e^{ikr}dr$$

where $\nu=\eta+\frac{1}{2}$, $\eta(\eta+1)=l(l+1)+\frac{2\mu}{\hbar^2}\gamma$ and A_l is a constant. Due to the fact e^{ikr} is rapidly oscillating and $J_\nu(kr)$ is also oscillating taking positive and negative valves , $F_l^{R_m}(k)$ becomes very small since the cancellation of many terms occur in the integration ,and the integrand decays also as $O(1/r^2)$. We set $R_m\approx 30fm$ and calculated $F_l^{R_m}(k)$ and found that it is very small. Hence, we conclude that the long-range part of the potential has a very small effect on the elastic S-matrix element.

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502/E1

Physically meaningful zeros and poles of elastic S-matrix element

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It is found that an essential singularity is introduced at the origin of the complex k-plane in the S-matrix element in addition to the infinite number of zeros and poles apparently introduced due to the Coulomb potential. It can be shown that the essential singularity at the origin is a mathematical artifice and hence is unphysical. Necessary conditions for poles corresponding to decaying resonance states, capture states and closed states can also be derived using standard mathematical techniques in the presence of the Coulomb potential.

The partial wave radial wave equation of angular momentum l corresponding to elastic scattering is given by,

$$\left[\frac{d^2}{dr^2}+k^2-\frac{l(l+1)}{r^2}\right]u_l(k,r)=\frac{2\mu}{\hbar^2}\left[V(r)+V_c(r)+iw(r)\right]u_l(k,r)$$

where $V(r)$ is the real part of the potential containing spin – orbit potential and volume term, $w(r)$ the imaginary part of the optical potential , $V_c(r)$ the Coulomb potential and k is the incident wave number The S-matrix element $S_l^n(k)$ is now can be written as

$$S_l^n(k)=(-1)^l\frac{\Gamma(l+1-i\eta)}{\Gamma(l+1+i\eta)}\;\frac{W'_{i\eta,l+\frac{1}{2}}(2ikr)-P_l(k,r)\,W_{i\eta,l+\frac{1}{2}}(2ikr)}{W'_{-i\eta,l+\frac{1}{2}}(-2ikr)-P_l(-k,r)W_{-i\eta,l+\frac{1}{2}}(-2ikr)}$$

where $P_l(k,r)=\dfrac{u_l'(k,r)}{u_l(k,r)}$ and $r\geq R_m$, cutting off the potential tails at R_m. It is clear that there are infinite number of zeros and poles of the S-matrix element due to the fact that $\eta=\dfrac{\mu z_1 z_2 e^2}{\hbar^2 k}$ and the structure of the Gamma function. We have found that all salient features of physically meaningful zeros and poles of $S_l^n(k)$ can be derived from the above functional form of $S_l^n(k)$.

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503/E1

The equality of Schrödinger's Theory and Heisenberg's S-matrix Theory

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The main aim of this work is to show that the energy discrete eigen values given by the Schrödinger's theory and Heisenberg's theory are the same. To obtain this result, we have used Parabolic co-ordinates to solve the Schrödinger's equation for the Hydrogen Atom. By using the Hyper Geometric Confluent functions we have expressed the S-matrix element using Gamma functions;

$$S_l^n(k) = \frac{\Gamma(l+1+in)}{\Gamma(l+1-in)} \text{ where } n = -\frac{\mu e^2}{\hbar^2 k}$$

By the definition of Gamma function,

$$S_l(n) = \frac{\bar{z}}{z} e^{\gamma(-2in)} \prod_{p=1}^{\infty} \left\{ \frac{\left(1+\frac{\bar{z}}{p}\right)}{\left(1+\frac{z}{p}\right)} e^{2in/p} \right\}$$

Then it is apparent that the S-matrix element contains infinite number of poles and zeros. Considering the relevant simple pole, we have derived an equation for the energy eigen values of the form

$$E_n = -\frac{\mu e^4}{2\hbar^2 n^2}$$

This shows that it is the same as the equation we have obtained in Schrödinger's theory. Therefore Heisenberg's S-matrix theory and Schrödinger's wave mechanics give exactly the same eigen values in the cases we have examined.

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504/E1

Gamma ray dose rate survey in the coastal strip from Crow Island to Beruwala

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The coastal strip from Crow Island to Beruwala plays a major role in the Sri Lankan economy due to the tourism and fishery industries. The area is highly populated and is known to have locations with very high background radiation levels. The high radiation levels in the area are due to the occurrence of thorium rich monazite in beach sand. In this study, an attempt was made to determine the radiation levels along the coastal line from Crow Island to Beruwala in a systematic way. Beach sand was collected at 1 km intervals along the coast starting from Beruwala. The activity concentration of ^{238}U, ^{232}Th and ^{40}K in the sand were measured using high resolution gamma ray spectrometry. From the activity concentrations, gamma dose rate at a m above ground was calculated.

The maximum activity concentrations of ^{238}U, ^{232}Th and ^{40}K in the beach sand were 3100 ± 200 Bq/kg, 19600 ± 600 Bq/kg and 1200 ± 200 Bq/kg respectively. The minimum values were below detection limits. The detection limits of the ^{238}U, ^{232}Th and ^{40}K were 3, 5 and 10 Bq/kg respectively. The dose rates changed from 0.003 µSv/h to 9.57 µSv/h with an average of 1.12 µSv/h. The highest effective gamma dose rate was obtained from a location at Egoda Uyana, Modara. This value is comparable to the values measured in other high radiation background areas in the world. In 60 % of the sampling locations, the annual effective gamma dose rate exceeded the world average value of 2.4 mSv/year.

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505/E1

Characterization of composite films made from Tin (IV) Oxide and Magnesium Oxide with impedance spectroscopy

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Impedance spectroscopy (IS) subsumes the small signal measurement of the linear electrical response of a material of interest including electrode effects and the subsequent analysis of the response to yield useful information about physicochemical properties of the systems. In the majority of cases, the nano-structured films are better represented by a more complicated network of resistances and capacitances, so-called equivalent circuit. IS analysis generally makes a considerable use of these equivalent circuits.

Impedance of composite porous films has been taken into consideration and the behaviour of composite films made from homogenous mixtures of SnO_2 and MgO were analyzed using IS to describe the mechanism of charge carrier transportation. Analysing the Nyquist plots, the sheet resistance of the CTO glass was found to be around 610.47 Ω. But the parallel resistance of the film varied dramatically while altering the composition (Figure 1). 10% addition of MgO to the composite showed a high impedance which was of two orders of magnitude higher than pure MgO. The charge transport mechanisms at different levels of MgO in the composite films are being discussed in this study. Various compositions of MgO in the SnO_2/MgO composite films can be found in different applications of devices such as solar cells, capacitors and thin film transistors.

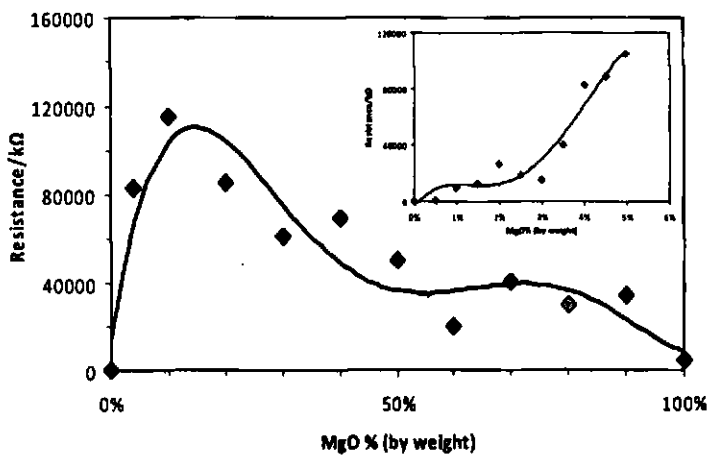

Figure 1: Resistance vs MgO % by weight of MgO/SnO_2 composite films

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506/E1

Convexifiable lagrangian and sufficient optimality

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Consider the following mathematical programming problem with bounds on variables:

$$(P) \quad \underset{x \in \mathbf{R}^n}{\text{Minimize}} \quad f_0(x)$$

$$\text{subject to} \quad f_j(x) \le 0, \quad j = 1, 2, \ldots, m,$$

$$u_i \le x_i \le v_i, \quad i = 1, 2, \ldots, n$$

where $u_i < v_i$, *for* $i = 1, 2, \ldots, n$ and $f_j : \mathbf{R}^n \to \mathbf{R}$, $j = 0, 1, 2, \ldots, m$ are continuously differentiable functions.

Recently a class of non-convex programming problems called "the convexifiable programming problem" was introduced which is of the form (P) where each function f_j, $j = 0, 1, 2, \ldots, m$ becomes convex under certain domain and range monotone transformations. Precisely, the programming problem (P) is called a (strictly) convexifiable programming problem if for each $j = 0, 1, 2, \ldots, m$ there exist $T_j : \mathbf{R} \to \mathbf{R}$ and $t : \mathbf{R}^n \to \mathbf{R}^n$ such that $T_j \circ f_j \circ t$ is (strictly) convex where t is separable, strictly monotone and continuously differentiable and T_j is strictly increasing and differentiable. It was established that the most desired property of convex (or generalized convex) programming problems, that "local minimizers are indeed the global minimizers" holds for convexifiable programming as well.

In this paper as an extension of the above result, the following KKT sufficiency is established. Whenever the Lagrangian function of (P),

$L(x, \lambda) = f_0(x) + \sum_{j=1}^{m} \lambda_j f_j(x)$, $x \in \mathbf{R}^n$, $\lambda \in \mathbf{R}^m$ is convexifiable, each Karush-Kuhn-Tucker point of (P) indeed becomes the global minimizer of (P). It is worth while noting that convexifiability of the Lagrangian function does not require convexifiability of the objective function and constraints as required by the convexifiable programming problem.

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507/E1

Shallow seismic activity of the offshore region southeast of Sri Lanka

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Although Sri Lanka is considered to be in an aseismic zone away from major plate boundaries or any active faults, during the last century there have been several hundreds of earthquakes reported in and around Sri Lanka. We therefore made an attempt to investigate earthquake activity of the offshore region of southeast Sri Lanka. Hypocentral data of a magnitude of 4.3, obtained from the Data Management Center at the Incorporated Research Institutions for Seismology for the period from January 1964 to December 2010, were used for the analysis. Spatial distribution of focal mechanisms was analyzed to investigate the geometry of faulting during earthquake fault slip using the data available from the Global Centroid Moment Tensor solution database for the period from January 1976 to December 2010.

Results of the analysis show that a large number of earthquakes take place at a belt that lies in southeastern parts of offshore Sri Lanka about 1000 km away from southeast coast of Hambantota although some events appear to be scattered probably due to location errors. Although different types of focal mechanism solutions exist in earthquakes of near coast events, we clearly noted that the earthquake belt in the southeastern part of Sri Lanka have mechanical solutions which are similar to that of strike slip fault mechanisms. More than 20 similar types of events were closely examined by dividing into several sub regions. A rotation of fault planes towards the direction of India-Capricorn pole of rotation can be seen from the analyzing results. Further, location analysis of earthquakes and the study of their mechanical solutions show that the earthquakes occurring in the identified belt in offshore southeast Sri Lanka may have originated in the boundary of the Indo-Australian plate.

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508/E1

Mathematical formulation of parasite dynamics of Lymphatic Filariasis using the range modelling approach

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Lymphatic Filariasis is a parasitic disease with complex dynamics. Range modelling tactics provide a parsimonious way to cope with variations in such dynamical processes. A parameter for anti-L3 immunity has been formulated here. Relevant mathematics involves accumulation of infection modeled through a hyperbolic function to incorporate boosting and saturation. Range for immunological memory can be formed after deciding on the reliable minimum and maximum lifespan of the immature worm. Host age should also be incorporated to fine tune this memory range. More range modeling tactics can be formulated for parasite regulations in the vector mosquito and for anti-fecundity immunity too. Ultimately, computer simulations would be useful in choosing reliable ranges for different epidemiological settings of Lymphatic Filariasis.

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509/E1

Predicting the blood glucose level for diabetic patients: mathematical modeling

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Good control of blood glucose levels significantly reduces the diabetes patients' risk of developing complications. If it is desirable to be able to make an accurate prediction, so that control actions can be taken before the glucose level goes beyond the ideal bounds. There are a number of factors that affect the blood glucose level, such as carbohydrate intake, level of exercise, level of stress, etc. In addition, there are a number of internal processes, such as absorption and production of glucose by the liver and renal excretion through urine. Therefore predicting the blood glucose level is important but is a complicated process.

In this research we attempt to predict blood glucose levels using the artificial neural network. The goal of this research is to construct an artificial neural network by combining principal component analysis and multilayer feed forward neural network that predicts the blood glucose levels reasonably for the morning and evening, using a number of factors affecting the blood glucose level, as inputs. For time intervals in the morning and evening, the corresponding root mean square error between actual data and predicted data is 1.1991 mmol/l and 0.039 mmol/l. Comparisons of the diagnostic accuracy with other neural network models that use the same dataset are made. The comparison results showed overall improved accuracy, which indicates the effectiveness of this proposed model.

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510/E1

On computing Sinhala grammar

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The computational model of grammar for the Sinhala language has been developed by considering the morphology and the syntax of Sinhala language. Finite State Transducers (FST) and Context-free grammar (CFG) have been used to describe the computational grammar for Sinhala.

The Sinhala language is a morphologically rich language when compared to the English language. Prakurthi, Pratya, Thaddhita and Upasarga are the morphological components of the Sinhala language. In addition to the above components, Sandhi rules are used to join two or more words in Sinhala. Further, Nama Gana and Kriya Gana show how each of the nouns and verbs are derived from its base form. These "gana" also gives the theoretical basics for the concept of Varanegeema (Conjugation) in the Sinhala language. To implement the Sinhala grammar, we have used 85 grammar rules for Sinhala Nouns considering the Nama gana in the Sinhala language. To implement the Kriya Gana, 18 rules have been considered. By using these computational grammars, the Sinhala morphological generator has been developed. This morphological generator can generate all the word forms for the given Sinhala base word.

Considering the syntax of the Sinhala language, a Sinhala sentence can be divided into eight components namely Attributive adjunct of Subject, Subject, Attributive adjunct of Object, Object, Attributive adjunct of Predicate, Attributive adjunct of the complement of Predicate, Complement of Predicate and the Predicate. These components are building blocks of the Sinhala sentence. By using the context-free grammar, Sinhala parser has been developed. This Sinhala parser can analyze the given simple sentences with the simple and complex subject and the object.

The Sinhala morphological generator and the Sinhala parser have been used to implement the English to Sinhala machine translation system. By using 400 sample sentences, the English to Sinhala machine translation system (BEES) has been evaluated. The Sinhala morphological generator and the Sinhala parser work with reasonable accuracy.

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Section E2

601/E2

Correlation between the *in vitro* antioxidant activity of *Osbeckia aspera* and its' polyphenol content

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Cellular damage from reactive oxygen species (ROS) is the fundamental mechanism underlying a number of human diseases or disorders. The literature reveals that ROS can be scavenged by natural antioxidants from medicinal plant extracts. An aqueous extract of *Osbeckia aspera* (*Sinh. Heen bovitiya*) is used to treat hepatitis and diabetes mellitus in traditional medicine. In order to investigate the pharmacological mechanisms of bioactivity of the aqueous leaf extract of *O. aspera*, the water phase antioxidant activity was determined in relation to its polyphenol content.

The total antioxidant activity was evaluated by DPPH (2,2-diphenyl-2-picrylhydrazyl hydrate) assay, FRAP (ferric reducing antioxidant power) assay and nitric oxide radical inhibition assay with L-ascorbic acid as the reference compound. The total polyphenol content was determined according to the Folin-Ciocalteu method.The antioxidant activity is expressed as IC_{50} in DPPH and nitric oxide scavenging assays.The IC_{50} of the aqueous extract of *O. aspera* in DPPH assay and in nitric oxide scavenging assay was 111.54 ± 6.99 $\mu gcm^{-3}$and 151.679 ± 8.86 μgcm^{-3} respectively. The FRAP value was 13.26 ± 2.40. Total polyphenol content of *O. aspera* was 14.96 ± 2.92 GAE (Gallic acid equivalents) mgg^{-1}. The reference values in the DPPH assay, FRAP assay and nitric oxide radical inhibition assay were 6.97, 2 and 19.33 μgcm^{-3} respectively. The aqueous extract of *O. aspera* exhibited a significant antioxidant activity measured as scavenging of DPPH radical, nitric oxide radical and reducing power. A positive correlation of (r= 0.826, 0.892, 0.869) between the antioxidant activity and phenol content was found in the DPPH assay, FRAP assay and NO inhibition assay, respectively. Results suggest that the antioxidant capacity of the aqueous plant extract is due to the large proportion of their polyphenols. Furthermore the determination of total phenol content is of interest for a comparative evaluation of *in vitro* antioxidant potential but it needs to be combined with *in vivo* data for adequate assessment of the antioxidant capacity of the aqueous leaf extract of *O. aspera*.

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602/E2

Determination of *in vitro* activity of 4-Phenyl-1-(2-phenyl-allyl)-pyridinium bromide as a potential antibacterial agent

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The continuing increase in the incidence of multi drug resistant pathogenic bacteria and the shortage of new antimicrobial agents are the prime drivers in efforts to identify the novel antimicrobial classes. It is essential to synthesize novel drugs and evaluate their antimicrobial properties. The present study mainly focused on the screening of the antibacterial activity of 4-Phenyl-1-(2-phenyl-allyl) pyridinium bromide (4-PPPB).

4-PPPB was synthesized according to a previously published procedure. First, 4-phenylpyridine was synthesized by reacting activated pyridine with phenylmagnesium bromide and then it was reacted with 3-bromo-2-phenylpropene in order to obtain 4-PPPB. Evaluation of the *in vitro* antibacterial property of above compound was carried out against *Staphylococcus aureus*, *Streptococcus* species, *Bacillus subtilis*, *Klebsiella aerogenes* and *Escherichia coli* using disc diffusion method. *S. aureus* was selected to determine the Minimum Inhibitory Concentration (MIC). Antibacterial activity of 4-PPPB was compared using the disc diffusion method with penicillin, cloxacillin, erythromycin and vancomycin, which are given to cure *S. aureus* infections.

A strong inhibitory effect was observed on *S. aureus* while *E. coli* showed very little sensitivity towards the compound. The MIC of 4-PPPB for *S. aureus* was found to be ≤ 20 μg mL^{-1}. According to the free diffusion model, MIC of the compound was 4.89 μg mL^{-1} and according to the dissipative diffusion model, it was 0.15 μg mL^{-1}. However better linearity was achieved from the dissipative diffusion model. Therefore diffusion of 4-PPPB in the solid agar medium can be considered as a dissipative process and dissipative diffusion model is the best suited model for the determination of MIC. According to the antibacterial comparison results, cloxacillin showed the highest antibacterial activity at the highest concentrations (2500 μg mL^{-1}, 500 μg mL^{-1}) but 4-PPPB was the only antibacterial compound which was able to inhibit *S. aureus* at lower concentrations around 20 μg mL^{-1}.

Although the uptake mechanism of this compound by bacterial cells or toxicity of this compound is still unknown, it can be concluded that there is a possibility to use 4-PPPB as an effective antibacterial agent against *S. aureus*. The same analysis was carried out for the acridine based compound 9-phenylacridinium chloride (9-PAC).

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603/E2

Effect of seaweed (*Ascophyllum nodosum*) based plant vitamin on the growth of spinach (*Spinacia oleracea*)

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Most cultivators are very keen on maximizing the quantity and quality of crop yield due to economic benefits. To achieve a high yield of crop, an optimal nutrition level in the plant has to be maintained. Although many soils have vast reserves of plant nutrients, only a small portion of these nutrients will be available to plants. Therefore chemical fertilizers and plant vitamins are used as external stimuli to increase productivity. Seaweed is rich in macro and micronutrients and it is used to produce plant vitamins. This research project was carried out to study the effect of a plant vitamin on NPK, trace metal residue levels and the growth rate in spinach.

The experiment was designed according to the Randomized Complete Block Design (RCBD) method and the plant vitamin was sprayed on spinach leaves except on those of the control. The growth rate of spinach was determined by measuring the length of the plant and the numbers of leaves. The macro and micro nutrients present in the seaweed, the plant vitamin and the spinach leaves were determined using the Kjeldahl method for N, molybdovanadate method for P, atomic absorption spectroscopic method for metals K, Mg, Ca, Fe and Zn and the gravimetric method for S. The seaweed, the main raw material used in producing the plant vitamin, was analyzed to monitor the amount of nutrients being transferred to the plant vitamin. Statistical analysis (MINI TAB 15.0) was performed to analyze the results obtained for all parameters.

The results indicated that K is the major constituent element in seaweed and that it does not contain Ca. The plant vitamin contains all the elements which were present in seaweed in a lower percentage. Further, results revealed that the plant vitamin directly affects the NPK levels; it increases the NPK residue levels and also increases the growth rate of spinach, but does not appreciably alter the levels of Mg, Ca, Fe, Zn and S.

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604/E2

Optimizing conditions for the electrodeposition of chromium in very diluted aqueous solutions

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Heavy metal pollution has become one of the major problems in the world. To overcome this problem, we have to minimize the generation of metal waste, while using techniques to treat the already contaminated environment. Phytoextraction is an environmentally friendly remediation method used successfully by several developed countries to treat existing heavy metals. After phytoextraction, heavy metals have to be re-extracted into aqueous solutions to complete the removal process. According to prior studies, these solutions contain heavy metals in very low concentrations (100 – 150 μg dm^{-3}). Electrodeposition is one possible metal recovery method in aqueous solutions having higher metal concentrations. Therefore, the present study investigated the applicability of the electrodeposition technique to recover heavy metals from re-extracted aqueous solutions having relatively low concentrations of the heavy metal. Chromium extraction and the conditions for electrodeposition were also optimized.

Model chromium solutions with a concentration of around 100.0 μg dm^{-3} were used. A three electrode system consisting of platinum, carbon and Ag/AgCl electrodes were used for the electrodeposition. Deposition voltage was supplied with Model 264 V Polarographic Analyzer/ Stripping Voltammeter (Potentiostat). Concentrations were determined with GBC 9 321B Plus Atomic Absorption Spectrophotometer with flame unit. The conditions optimized were deposition voltage, deposition time, temperature, pH and ionic strength and the optimum values were -3.00 V, 20 min, 50° C, 1.0 and 0.5 mol dm^{-3} respectively. However, the reduction of water occurs at -0.83 V and it may interfere with the electrodeposition at this optimum voltage. The optimization experiments were initially carried out assuming that the conditions were independent of each other. The analysis was repeated by considering their dependency, using sequential simplex optimization method. It was carried out using two conditions, deposition voltage and time. According to the results, the optimum values which were obtained from initial independent optimization studies were proven to be correct. Under the optimum conditions electrodeposition was performed and it resulted a mean percentage weight of 10.7 (±0.4) of chromium deposited.

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Characterization and quantification of polyphenolic compounds in refuse tea

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The polyphenols of the tea plant (*Camellia sinensis*) have been more thoroughly investigated than any other compound in tea. Polyphenols are well known antioxidants that have a variety of biological activities. Based on the current tea production the predicted annual generation of refuse tea would be $9.5x10^6$ Kg and only about 6 % of the refuse tea is being utilized for instant tea production while the rest is discarded. Hence this study was designed with the objective of characterizing and quantifying polyphenolic compounds in refuse tea to provide scientific evidence for adding value to refuse tea. Caffeine content was also quantified in order to compare it with the polyphenol content of refuse tea.

Refuse tea samples were collected from a tea factory in Sri Lanka and the extraction of polyphenolic compounds and caffeine was carried out using two methods. Extraction method 1 extracts polyphenols only, whereas extraction method 2 extracts polyphenols and caffeine. High Performance Liquid Chromatography (HPLC) was used to analyse and quantify the extracted polyphenolic compounds and caffeine. Chromatographic separation was performed on a guard and analytical column system (Phenomenex, Luna 3u C18 (2), column dimension 150 x 4.6 mm 3u micron). Preparation of standards and samples, and the chromatographic analysis were carried out according to the International Standard. Identification of individual polyphenols was done by comparing the retention time of samples and standards, and quantification was done by the external standardization method.

The quantities of polyphenols and caffeine in mg/g, from method 1 were: gallic acid (2.40); (+)-catechin hydrate (0.0334); (-)-epicatechin (0.232); (-)-epigallocatechin gallate (0.0806); and (-)-gallocatechin gallate (0.407). From method 2: gallic acid (2.45); (+)-catechin hydrate (0.157); (-)-epicatechin (0.254); (-)-epigallocatechin gallate (0.0710); (-)-gallocatechin gallate (0.0953); and caffeine (14.7). The presence of polyphenols and caffeine was evident in refuse tea. Hence it is evident that refuse tea could be used as a source of natural antioxidants, for the preparation of pharmaceuticals, food supplements and animal feed.

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606/E2

Effect of α-tocopherol on the stability of coconut oil processed by different techniques

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The study was conducted to evaluate the stability of coconut oil namely, dry processed virgin coconut oil (DVCO), wet processed virgin coconut oil (WVCO), white coconut oil (WCO) and pairing coconut oil (PCO) and during storage for a period three months. The oil samples were subject to heat processing by heating to different temperatures (100 and 150 ℃) and temperatures were maintained for a period of one hour. The control sample was kept at room temperature (30 ℃). Another set of heat processed oil samples were treated with 0 ppm, 100 ppm, 200 ppm and 300 ppm of α-tocopherol and stored at 30 ℃ for three months. The formation of free fatty acid (FFA) and conjugated diene (CD) were measured to evaluate the changes taking place during storage. The FFA levels of samples were increased during the storage. Wet processed virgin coconut oil resulted in the lowest FFA level at room temperature (0.035) at the initial stage while pairing coconut oil showed the highest value of FFA (1.28), at room temperature at the initial stage, which is beyond recommended standard values for edible grade oils. Then different concentrations of α-tocopherol were added to the oil samples maintained at room temperature (30 ℃) and after which the FFA levels were measured. Addition of tocopherol to all samples maintained lower level of FFA in both heat treated and control samples. The 200 ppm of α-tocopherol concentration was the best level which maintains the lower values for all treated coconut oils. This refers to the values comparative with samples treated and not treated with α-tocopherol. An increase in conjugated diene formation in different types of coconut oil was also observed during storage.

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607/E2

Citriquinone: a potentially new anticancer active 1,4-benzoquinone from *Penicillium citrinum*

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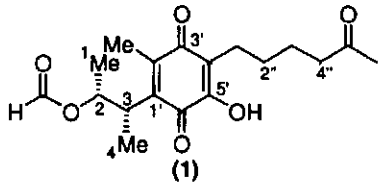
Fungal metabolites are an obvious choice for drug discovery today. As an initiation of research in this area, chemical investigation of *P. citrinum* was done and herein we report an isolation of a new fungal metabolite, citriquinone (**1**) having an inhibition activity on the human cancer cell line HEp2, when subject to the scratch wound assay. The fungus isolated from a soil sample collected from the garden of the Department of Botany, University of Sri Jayewardenepura, showed significant antibacterial activity against gram positive bacteria. The fungus was identified as *Penicillium citrinum* by studying its molecular characteristics. The MeOH extract of the fungal culture grown on Potato dextrose agar (PDA), was concentrated and subject to a series of solvent-solvent partitioning using EtOAc, hexane and CH_2Cl_2. The CH_2Cl_2 fraction having antibacterial activity was subjected to silica gel column chromatography followed by prep. TLC, and yielded citriquinone (**1**) as a yellow solid. Structure of **1** was established as 3-(5-hydroxy-2-methyl-3,6-dioxo-4-(5-oxohexyl) cyclohexa-1,4-dienyl) butan-2-yl formate by HRESI(+)MS data (*m/z* 337.1646 $[M+H]^+$ $C_{18}H_{25}O_6$ requires 337.1644) and 1D and 2D NMR experiments (Table 1). ^{13}C assignments were made with the help of both gHSQC and gHMBC experiments.



(1)

Table 1: NMR (600MHz, $CDCl_3$) data of Citriquinone (**1**)

#	δ_H (m, J (Hz))	δ_c	gCOSY (δ_H)	gHMBC
1	1.34 (3H, d, 6.0)	19.02		4, 3, 2
2	5.46 (1H, m)	72.83	1.34	4, 3, 1', 2-*OCHO*
3	3.04 (1H, m)	40.04	1.23, 5.46	2, 6'
4	1.23 (3H, d, 7.2)	15.42	3.04	1, 3, 2, 1'
2-*OCHO*	7.84 (1H, s)	160.19		
2'- *Me*	2.07 (3H, s)	12.53		2, 3, 4, 1', 2', 3', 6'
5'-*OH*	7.05 (1H, s)			
1"	2.39 (2H, t, 7.8)	22.60	1.43	3" 2", 5', 4', 3'
2"	1.43 (2H, m)	27.51	2.39, 1.57	1", 4", 5'
3"	1.57 (2H, m)	23.58	2.43	1" 2", 4", 5"
4"	2.43 (2H, t, 7.8)	43.36		1", 2", 5"
6"	2.11 (3H, s)	29.91		3", 4", 5"

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608/E2

Analysis of profenofos and diazinon residues in pineapple

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Pesticides are substances that kill or control unwanted organisms. Modern agriculture depends largely on pesticides for crop protection. Nevertheless, pesticides have caused severe problems. As pesticides cause harmful effects even at low concentrations, continuous monitoring of the levels of pesticides and their residues in crops is of great importance.

This study was carried out to determine the levels of profenofos and diazinon residues in the pineapple in Sri Lanka. These two insecticides are recommended by the Agricultural Department of Sri Lanka for the cultivation of pineapple and are widely used by farmers.

Fresh pineapples (n = 25) were collected from a wholesale market, a super market and fruit sale points in Colombo and Gampaha. A survey was also conducted during sample collection to obtain information such as origin of the fruit and the date of harvesting. The analytical method involved extraction of the samples by matrix solid phase dispersion (MSPD), where the pineapple samples were homogenized with the dispersant sorbent (silica gel) and eluted with ethyl acetate, followed by determination of the levels of profenofos and diazinon by GC/MS. Profenofos and diazinon were not within the limits of detection in any of the samples. MSPD has the advantage that the sample preparation, extraction, fractionation and purification are carried out in a single step. Therefore, it is less labour intensive, consumes lesser solvents and is more efficient than other technique. This method has been applied successfully in the analysis of pesticides in various fruits, vegetables, animal tissues, etc. Up to date there are no reports on the use of MSPD for pesticide residue analysis in fruits in Sri Lanka.

Prior to analyzing the samples, recovery studies were carried out by spiking pineapple samples with profenofos and diazinon at different concentration levels (0.01, 0.05 and 0.10 ppm) and carrying out the analysis. Average recoveries determined (three replicates) ranged from 94 to 101% and were in the satisfactory range of 80 - 120%. The percentage relative standard deviation (RSD%) of average recoveries ranged between 2 and 15%. Detection and quantification limits were 0.004 ppm and 0.01 ppm respectively for profenofos, and 0.001 ppm and 0.003 ppm for diazinon.

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609/E2

Use of magnetic nanoparticles for the extraction of DNA

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Functionalized magnetic nanoparticles have been widely utilized in biomagnetic separation and purification of DNA. Purified, high quality DNA has a wide variety of downstream applications such as PCR, restriction digestion, transfection and sequencing. Conventional DNA purification methods suffer from several drawbacks. They are often complex, time-consuming and involve the use of solvents and toxic chemicals such as phenol and ethidium bromide ultimately leading to low overall yield and high cost. In this study, a simple DNA purification process was developed which involves the use of iron oxide nanoparticles (IONP) functionalized with hydroxyapatite (HAp). The process is effective, low cost and has potential for commercialization. Hydroxyapatite [$Ca_{10}(PO_4)_6(OH)_2$] which is biocompatible and non-toxic, has a higher affinity for DNA, and its conjugation with iron oxide nanoparticles makes it an ideal candidate for rapid isolation of high quality DNA.

For this application samples with HAp/IONP molar ratios of 0.3, 1.2 and 2.3 were synthesized and were characterized with Fourier transformed infrared spectroscopy (FTIR). The spectra of the coated particles exhibit characteristic absorption bands of the functional groups of hydroxyapatite, indicating successful functionalization of the iron oxide nanoparticles. Subsequently, the coated samples were used in extraction of known amounts of DNA. A low ionic strength phosphate buffer was used for selective retention of double stranded DNA molecules on hydroxyapatite coated nanoparticles and the magnetic particles with its trapped DNA were immobilized by application of an external magnet. Elution of DNA was accomplished using high ionic strength phosphate buffer. The quality and the yield of DNA were then determined by agarose gel electrophoresis. These coated samples exhibit an average DNA binding capacity of 1.2 µg/mg (DNA/ IONPs) and high quality DNA was obtained. This magnetic bead DNA extraction procedure required less than 30 minutes compared to several hours taken by conventional protocols. The developed procedure eliminates the need for organic solvents, toxic chemicals or sophisticated equipment. Together with these advantages, further improvements and automation of this simple bio magnetic separation procedure may play an important role in the near future, and may be a potentially viable alternative to commercially available high cost DNA extraction materials and kits.

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610/E2

Development of a spectroscopic method to determine the crystallization stage of human bile

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Cholesterol gallstones also known as cholesterol cholelithiasis, is one of the most prevalent digestive diseases seen mainly in the western world and demands costly treatment. It is now becoming prominent in Asian countries due to the adaptation of western diets. In general, bile of patients with gallstones (lithogenic bile) has a different composition of its major constituents of bile salts, phospholipids and cholesterol. The method currently available to determine whether a patient has lithogenic bile or not is to do a microscopic study *ex vivo* for the appearance of cholesterol crystals. This is a tedious process as it is difficult to detect these crystals accurately. Here, we have investigated the possibility of developing a simple and novel spectroscopic method to identify lithogenic from non-lithogenic bile, using UV-visible spectroscopy by analyzing 20 samples (non-lithogenic - 2, lithogenic - 18). The absorption spectra obtained for lithogenic and non-lithogenic bile exhibit a remarkable difference even without any chemical treatment. Lithogenic bile shows maximum absorption (λ_{max}) at higher wavelengths than non-lithogenic bile, in the visible region as depicted in Figure 1.

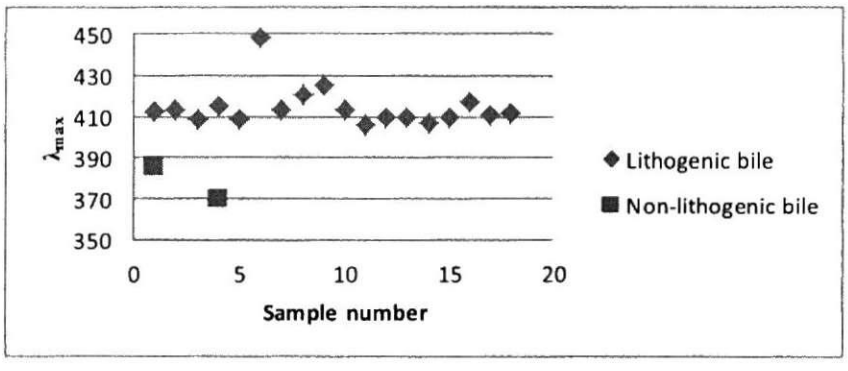

Fig.1: Distribution of λ_{max} for non-lithogenic and lithogenic bile

Further, an *ex vivo* study of the variation in absorbance at the respective λ_{max} with time for several samples revealed that non-lithogenic bile showed an increase in absorbance in the initial days of incubation while no such increment was observed for lithogenic bile.

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Chemical analysis of palmyrah (*Borrases flabellifer*) tuber flour produced in Jaffna and its application in traditional food (pittu) preparation

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This study was carried out to determine the chemical composition of palmyrah tuber flour produced in Jaffna and to evaluate the nutrient content and sensory attributes of its application in traditional food (pittu) preparation. Major nutrient and mineral contents of palmyrah tuber flour were analyzed using the AOAC (2005) method. The mineral content was assayed using the atomic absorption spectroscopy (AAS) method.

The moisture, total ash, crude protein, crude fat, crude fibre and available carbohydrate contents of palmyrah tuber flour were 10.5 ± 0.5 g $100g^{-1}$, 1.7 ± 0.01 g $100g^{-1}$, 6.6 ± 0.2 g $100g^{-1}$, 2.0 ± 0.03 g $100g^{-1}$, 0.8 ± 0.01 g $100g^{-1}$ and 78.4 ± 0.5 g $100g^{-1}$, respectively. It also revealed that Sodium, Potassium, Calcium and Magnesium in the flour were 12.5 ± 0.7 mg $100g^{-1}$, 387 ± 18 mg $100g^{-1}$, 54 ± 2 mg $100g^{-1}$ and 154 ± 6 mg $100g^{-1}$ respectively.

To study the possibility of the incorporation of palmyrah tuber flour in traditional food (pittu) and to evaluate its nutrient content sensory attributes, plain palmyrah tuber flour pittu, value added palmyrah pittu and wheat flour pittu were prepared. Only palmyarh tuber flour was used in plain palmyrah tuber flour pittu whereas onions and chillies too were incorporated in value added palmyrah tuber flour pittu. All three were subject to both proximate and sensory analyses and both types of palmyrah tuber flour pittu were then compared with wheat flour pittu.

This study revealed that there were no significant mean differences ($p<0.05$) between the analyzed sensory attributes of both types of palmyrah tuber flour pittu and wheat flour pittu. The total ash, crude fibre and available carbohydrate were higher in palmyrah tuber flour pittu than in wheat flour pittu whereas crude fat, moisture and crude protein were higher in wheat flour pittu.

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612/E2

Investigation of the effect of iron oxide nanoparticle impregnated activated carbon on removal of arsenic from aqueous solution

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Arsenic (As) contamination in water, especially in groundwater, has been recognized as a major problem of catastrophic proportions. After the arrival of nanotechnology, significant progress has been made to utilize the chemistry of nanomaterials for As removal from aqueous systems. Iron oxide nanoparticles (IONPs) with their high affinity for the adsorption of arsenite and arsenate have been shown to be extremely efficient at removal of As from contaminated water. In our work, we synthesized IONPs impregnated activated carbon composites using granular activated carbon (GAC) and powdered activated carbon (PAC) and conducted initial experiments to identify the As adsorption potential of the composites. For the preparation of these composites, three methods namely, insitu coating, post coating and spray method, were used and the iron content in each composite sample was tested by digesting the samples. None of these methods required sophisticated equipment. According to our results, neat IONPs, which were synthesized according to our own procedure, were extremely efficient at removal of As from contaminated water. This potential of neat IONPs was not lost due to impregnation. However, As adsorption ability of the IONP-activated carbon composite decreases gradually when the percentage of IONPs decreases. Although, the composites with PAC exhibit higher potential in As adsorption than that with GAC, the draw back in using PAC is, it is not suitable for packed-bed use because of the tight packing of the material. Column studies were conducted using IONPs impregnated GAC composites. The adsorbent material does not tend to corrode when it is in contact with water and iron oxide does not "flake" off of the composite media. At room temperature, the adsorption isotherm studies have revealed a better correlation with the Freundlich isotherm. Adsorption isotherm results clearly indicate that the best method for the preparation of IONPs impregnated activated carbon composites is spray method because in spray method, IONP loading on to GAC is higher than the other two methods and hence the composite exhibits the highest adsorption capacity (103.81 L/g). Also, by varying IONP: activated carbon ratio, 100% adsorption of As(V) could be obtained. The synthesized products were identified and characterized using FT-IR spectra, X-ray diffractometry (XRD) and transmission electron microscopy (TEM). Arsenic analysis was carried out by Graphite Furnace Atomic Absorption Spectrophotometer (GFAAS).

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613/E2

Electrochemical Impedance Spectroscopy and potentiostatic measurements for investigation of corrosion inhibition of Aluminium surfaces

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Electrochemical impedance spectroscopy (EIS) and potentiostatic measurements are valuable tools for quantitative determination of corrosion of metallic surfaces. Although aluminium shows corrosion resistance under normal environmental conditions, it undergoes pitting corrosion in chloride-rich environments. Corrosion inhibitors are therefore necessary to maintain long term stability of aluminium surfaces.

Polarization resistance (R_p) obtained from Nyquist plots increases and the open circuit potential (V_{oc}) shifts towards negative potentials when extracts of matured leaves of *Neolitsea cassia* (wild cinnamon) are introduced to aluminium specimens exposed to chloride environments. These measurements, together with smaller mass losses of aluminium specimens when it is in contact with the extract, conclusively demonstrate that the wild cinnamon extract has the ability to control corrosion. It is also determined that the ethanol extract is more effective towards corrosion resistance as compared to the aqueous extract.

The inhibition efficiency of corrosion of aluminum, determined by comparing R_p values in the absence and the presence of the extract, while maintaining the same chloride concentration, increases with the increase in concentration of the extract and the period of immersion. However, prolonged exposure of specimens to the extract decreases corrosion efficiency, probability due to the decomposition of substances responsible for corrosion inhibition.

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614/E2

Investigation of the potential ability of *Phyllanthus emblica* fruit and *Strychnos potatorum seeds* for removal of cadmium(II) ions from aqueous solution

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Use of biosorbents for the removal of heavy metals is an attractive alternative to chemical treatment, due to their availability, low-cost and environmental friendliness. In this regard, investigation of the potential ability of the pulp of *Phyllanthus emblica* ('Nelli') and seeds of *Strychnos potatorum (*'Igini'*)* to remove Cd(II) ions, a toxic heavy metal, from aqueous solutions is attempted by focusing on the effect of experimental parameters, such as shaking time, settling time, sorbent dosage and Pb(II) as a possible interferent.

Both Cd(II)/biosorbent aqueous systems reached sorption equilibrium within a short time duration of 20 minutes, while shaken at a moderate speed of 50 rpm under laboratory conditions, indicating the availability of adsorption sites for Cd(II). The percentage removal of Cd(II) at equilibrium, as determined by atomic absorption measurements, by *Phyllanthus emblica* pulp and *Strychnos potatorum* seeds were 94% and 88%, respectively, confirming stronger affinity of the former towards Cd(II). This was further supported by the extent of removal of Cd(II) being not affected upon prolonged exposure to each biosorbent, under no-shaking conditions. Introduction of Pb(II) solution to Cd(II) solution in the presence of seeds of *Strychnos potatorum* led to an initial decrease of Cd(II) removal, followed by leveling off at higher concentrations. When both Cd(II) and Pb(II) ions were present at equal concentrations of 5 ppm, the removal of Cd(II) decreases from 88 % [in the absence of Pb(II)] to 25 % showing competitive sorption of the two species.

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615/E2

Interaction of Cd(II) and Cr(VI) with thermally treated peat

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Peat, a naturally occurring inexpensive substance, possesses several characteristics as an effective solid adsorbent for dissolved metal ions. There are many modes of interactions, such as adsorption, absorption, ion-exchange and complex formation reactions between peat and metal ions, each of which is affected by thermal treatment of the adsorbent, owing to changes in chemical and physical properties, including surface charge, three-dimensional structure, mineral composition and combustion of organic components. These interactions also depend on solution variables, such as interfering species, pH of the medium and the temperature of the solution. Thus, the mechanism and the extent of metal ion removal by peat is a complex issue.

The objective of this research is to investigate the effect of heat-treatment of peat on the extent of interaction of Cd(II) and Cr(VI) species, representing cationic and anionic forms of metals, with peat particles, together with the investigation of the effect of stirring and settling on equilibrium properties of peat/metal ion systems. X-ray fluorescence studies indicate the presence of Fe and Ti in addition to common elements, while surface titrations are indicative of having negatively charged peat particles. Further, thermal gravimetric analysis of peat results in the identification of different temperature regions for evaporation of moisture and structural OH removal, and combustion of organic matter present in peat. The maximum interaction between peat and the metallic species takes place at 100° C for Cr(VI) and 200° C for Cd(II) species. Interestingly, the former shows a much higher removal despite the negative charge of peat particles indicating that Coulombic attraction would not be predominant in the metal ion-peat interaction process. Chemical reduction of Cr(VI) to positively charged Cr(III) prior to interaction with peat particles is another possibility for strong interaction between chromium species and peat. Peat fired at intermediate temperatures (400 to 500° C) results in high turbidity due to combustion products. Nevertheless, the peat-metal ion system attains equilibrium within a short period of time regardless of the firing temperature.

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616/E2

Non-linear optical properties of selected organic systems: high accuracy Density Functional Theory calculations

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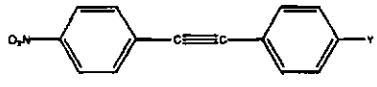
Electro optic materials have been extensively researched over the past few decades due to their potential applications in photonic technologies including all-optical switching and data processing. Our objective is to calculate the nonlinear optical properties of a range of three novel organic molecular systems. The approach is based on the concept of charge transfer (CT) between donor and acceptor through the spacer. In this research work, the first hyperpolarizability values (β) are calculated using the Density Functional Theory (DFT) method B3LYP, with the 6-31g(d) basis set of Gaussian98W software. The designing of systems with high charge transfer is key to this part, as intra molecular charge transfer between donor and acceptor will lead to a very large value of β. The first hyperpolarizability values (β) for the molecular system-1, a_1-a_3 and b_1–b_6 of system-2 have increased due to the substitution on nitrogen of NH_2 group (Figure 1). However the substitution on nitrogen may affect the planarity deviation of the molecules. The addition of a double bond to the spacer, which will enhance the conjugation, leads to larger hyperpolarizability values (β). But the consecutive double bond of the spacer will lead to the distortion of the molecule and it will disturb the charge transfer between the donor and the acceptor (Table 1).

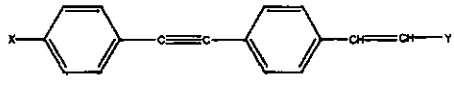
System 1



a_1 Y = NH_2 a_2 Y = $NH(CH_3)$

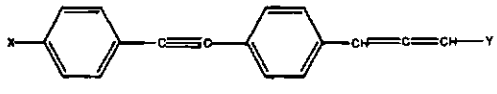
a_3 Y = $N(CH_3)_2$ a_4 Y = OCH_3

System 2



b_1 - Y = NH_2 b_2 - Y = $NH(CH_3)$ b_3 - Y = $N(CH_3)_2$ b_4 - Y = $N(C_2H_5)_2$ b_5 - Y = $N(C_3H_7)_2$ b_6 - Y = $N(C_4H_9)_2$ b_7 - Y = $NH(CH_3)$ b_8 - Y = $N(CH_3)_2$ (b_1.b_6)- X= NO_2 b_7-X = CN b_8 - X = CHO

System 3



c_1 - Y = NH_2 c_2 - Y = $NH(CH_3)$ c_3 - Y = $N(CH_3)_2$ c_1 - X = CN (c_2-c_3)- X= NO_2

Fig. 1: Designed organic systems

Table 1: Hyperpolarizability values of systems

Molecule	$\beta_{tot}\times10^{-30}$ (esu)	Molecule	$\beta_{tot}\times10^{-30}$ (esu)	Molecule	$\beta_{tot}\times10^{-30}$ (esu)	Molecule	$\beta_{tot}\times10^{-30}$ (esu)
a_1	161.534	b_1	210.241	b_5	324.229	c_1	56.917
a_2	190.699	b_2	256.303	b_6	331.355	c_2	138.357
a_3	271.249	b_3	289.407	b_7	138.122	c_3	143.622
a_4	114.084	b_4	307.763	b_8	193.791		

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617/E2

A new cytochalasin type fungal metabolite from a Sri Lankan isolate of *Hirsutella thompsonii*

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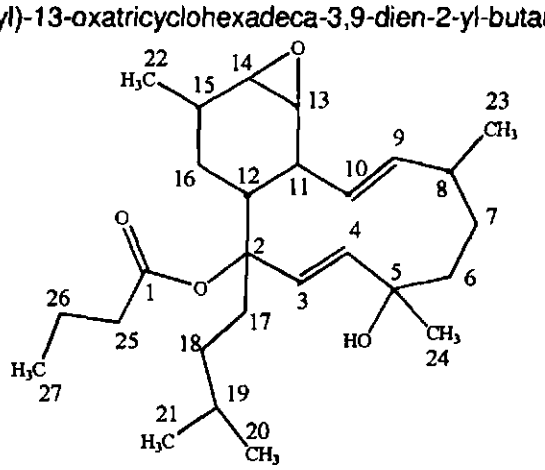
Hirsutella thompsonii (Fisher) is a fungal pathogen of eriophyoid and tetranychid mites that is reported to have insecticidal activity. The objective of this study was to isolate and characterize bio-active fungal metabolites from a Sri Lankan strain of *H. thompsonii*. The Sri Lankan strain of *H. thompsonii* isolated from dead coconut mites was grown on beer-waste and sugar medium for 11 days at 26° C. The mycelium was sequentially extracted with hexane, ethyl acetate and ethanol. Ethyl acetate extract was subject to column chromatography on silica gel using a gradient mixture of ethyl acetate and hexane followed by recrystalization of fraction F_{25} afforded the compound as white crystalline solid (71.0 mg). The structure was elucidated using ^{1}H NMR, ^{13}C NMR, ^{1}H-^{1}H COSY, HMQC and HMBC spectral data.

The presence of 27 carbons which include 6 methyl, 7 methylene, 11 methine and 3 quaternary carbons were supported by ^{13}C and DEPT NMR spectra. The ^{1}H NMR spectrum indicated 4 olefinic non conjugated protons at δ_H 6.2 (d), 6.4 (d), 5.1 and 5.2 (dd). The ^{13}C and DEPT spectrums assigned signals at δ_C 79.0 and 82.1 as quaternary carbons at C-2 and C-5, respectively and HMBC spectral data supported the connectivity of these two carbons with olefinic carbons at C-3 and C-4. Down filed ^{13}C NMR chemical shift of C-2 and C-5 indicated that these carbons are oxygenated. Broad singlet at δ_H 3.5 was assigned to hydroxyl group attached to C-5. HMBC, HMQC and COSY correlations strongly revealed the presence of isopentyl, propionate and epoxy groups in the molecule and were placed at C-2, C-5, C-8 and C-15 positions. Based on the coupling network established by HMBC spectral data and comparison of the NMR spectral data with those of known fungal metabolites of cytochalasin type from *Daldinia* species, established the structure to be 5-hydroxy-5,8,15-trimethyl-2-(3-methylbutyl)-13-oxatricyclohexadeca-3,9-dien-2-yl-butanoate.



Acknowledgement: We gratefully appreciate Prof. Iqbal Choudhary (Director, HEJ Research Institute) for NMR facilities and NSF grant No. RG/2004/C/05 for financial assistance.

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618/E2

Production and properties of xylanase from thermophilic *Bacillus pumilus*

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The thermophilic, xylanolytic bacterium was isolated from corncob decaying soil. The results of 16s rDNA sequence comparisons indicated that the isolate was closely related to *Bacillus pumilus*, exhibiting 99 % sequence similarity. Studies on the xylanase characterization from liquid culture with Birch wood xylan revealed that the enzyme produced highest xylanase activity [328.0 (±0.7) UmL^{-1}] at 45° C and pH 8.5. Crude xylanase from *B. pumilus* showed zero order kinetics for 4 min at an optimum temperature of 55° C, pH of 8.4 and at this optimum condition xylanase from *Bacillus pumilus* exhibited highest activities of 301.5 (±0.26) UmL^{-1}. Michaelis constant of the crude enzyme to soluble Birchwood xylan was 7.1 gL^{-1} and the Vmax value was 1666 $\mu molmL^{-1}$ at 55 °C and pH 8.4. In the absence of additives at 30 min the xylanase retained 5 (±0.92) % of its initial activity at 60° C and pH 8.4 while at 55° C and pH 8.4, it retained 38 (±1.0)% of its initial activity. At pH 8.0 and 9.0, decrease of about 54.4 and 79.4 % of its initial activity was observed respectively. Therefore xylanase produced by *B.pumilus* may be useful in industrial applications to remove hemicelluloses.

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Section F

701/F

Impact of livelihood training programs on women: Evidence from tsunami-affected women in the Batticaloa District

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The tsunami of December 2004 had affected the livelihood activities of many households in the Eastern Province, which resulted in many families losing their traditional income generating activities and were forced to live in abject poverty. A study was conducted in the Batticaloa District in 2008/2009 to assess the impact of training programs conducted by an international NGO to improve the livelihood skills of women affected by both the tsunami and the ethnic conflict and also to identify the weaknesses of such programs. Women who had undergone livelihood skills training conducted by an NGO were randomly selected from the Palameenmadu village in Batticaloa District for the study. A structured questionnaire was used to collect information from the women on the types of training undergone and the impacts of it on their livelihood activities. Based on their marital status, the women were stratified into two groups for analysis. A non-parametric test (Mann-Whitney) was performed to ascertain the impact of training programs on these two groups of women.

Results indicated that the training had no impact on increasing living standards, reducing dependency on external assistance, self-employment skills gained and the earning capability due to increased knowledge gained in the two tested groups. But the training had a significant impact on increasing income and self employment skills of married women, and on increasing employment opportunities of unmarried women. The results have implications on the type of training that is given for livelihood activities of women. The types of training imparted helped married women to increase their income from the current self-employment activities they are involved in and also on unemployed and unmarried women to engage in self-employment. However they need support facilities for this purpose. Hence, there is a need to correctly identify the training needs of different people and also to probe into the employment opportunities available or expectations related to the training provided to them.

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702/F

Living with devils and demons: Risk behaviour of street children in the Colombo City

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This qualitative, descriptive cross-sectional study was conducted with the objective of describing risk behaviour among street children in the Colombo city and to identify factors associated with such risk behaviour. Data were obtained through 20 semi-structured interviews with key informants, 10 focus group discussions and 25 semi-structured interviews with street children. Qualitative content analysis was used to analyse data. The participants of this study were from Fort, Pettah, Maradana and Slave Island areas of the Colombo City. The majority of the street children were boys. The children who participated in this study, whose ages ranged from 8-18 years, represented all three major ethnic groups as well as all four major religious groups.

The social norms of the environment of street children demand that s/he engage in several forms of risk behaviour to obtain social respect as well as to survive. Risk behaviour among girls include usage of pornography, sexual promiscuity, prostitution, consumption of alcohol and the use of narcotic substances, and transportation of illicit alcohol and narcotic drugs. Risk behaviour of boys are more complex and include usage of pornography, sexual promiscuity, homo-sexuality, male prostitution, violence and robbing, smoking (including cannabis), transportation and sale of illicit alcohol and narcotic drugs, pimping, and the use of services of prostitutes.

Norms of the social environment where street children live in, the existence of gangs and peer pressure promote risk behaviour among children. Other factors that encourage and promote such behaviour despite punitive action by law enforcement authorities include the lack of socially acceptable alternative recreational opportunities, close ties between such behaviour and their income generating activities, lack of adult carers and inadequate caring and supervision by existing carers.

Risk behaviour of street children not only endanger their lives but also pose a risk to society in general. Measures to address this issue and reduce such behaviour among them must target the elimination of the root-causes of the identified risk behaviour.

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703/F

Left-behind and struggling: difficulties and strengths of children of migrant women

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The objectives of this qualitative, descriptive cross-sectional study were to describe difficulties encountered and strengths demonstrated by children left behind by Sri Lankan women migrant workers (employed overseas) and factors associated with such difficulties. Ten focus group discussions with school teachers in suburban schools attended by children of migrant women in the Colombo, Gampaha, and Kurunegala districts and 30 and 10 semi-structured interviews, respectively, given to principal care givers of children of migrant women and to religious leaders in the above districts were conducted to collect data, which were analysed using qualitative content analysis.

Most children found it difficult to perform adequately in their academic work and extra-curricular activities. Other difficulties included coping with behavioural problems, inability to maintain health and hygiene, having to attend to household chores and caring for siblings, facing abuse or neglect (or both), lack of role models, and the inability to communicate adequately with substitute-carers. However, some children who recover early from initial reaction to mothers' departures, have the strength to withstand social and economical pressures, are more mature than their peers, survive in many situations without help from others, and have adequate access to human and physical resources.

Common factors perceived as associated with difficulties of left-behind children are poor emotional bonding between children and substitute-care givers, inadequacy of accessible financial and human resources, low educational level of and poor caring by substitute-care givers, changes in household composition, poverty and disadvantaged social conditions, abuse, neglect, and extra-marital affairs and subsequent abuse by adults in the family.

Although some children have the strength and resources to withstand adverse effects of the mothers' migration, such migrations force many of the left-behind children to live with numerous difficulties, which are also associated with complex interacting factors that arise from or have arisen as a result of the mothers' migration. Appropriate policy and other measures are required to ensure that migration of women does not have an adverse impact on the children left behind.

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704/F

Coping strategies towards idiosyncratic shocks among small scale marine fishing households in Southern Sri Lanka

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Marine fishing is associated with risk, uncertainty and danger resulting with idiosyncratic shocks and collective shocks, which lower the well-being of fishing families. Since idiosyncratic shocks affect individual households they are considered as manageable shocks at the community level. This study attempted to investigate the types of main idiosyncratic shocks and coping strategies adopted by fishing households in Southern Sri Lanka.

A stratified simple random sample of 50 respondents which included non-mechanized traditional craft owners, fiber reinforced plastic boat owners and crew members from two fishing villages, Kalamatiya and Rekawa, were selected. A structured questionnaire and informal discussions were the tools for data collection. The data were analyzed graphically and statistically.

The results show a positive relationship (r = 0.792) between fishing income and the level of household expenses. The severe income fluctuation was the crucial idiosyncratic shock. Inability to sail in harsh weather, inability to secure operational expenditure, and damage to fishing craft and gear are the others. Being small scale fishermen, the stress of such shocks is immense. Coping strategies have two motives; ex-ante, and ex-post. Kruskal-Wallis test confirmed that saving in formal and informal finance institutions and activity diversification such as engagement in paid labour, migration to other areas for shrimp and lobster harvesting or fishing gear repairing are the main ex-ante strategies. Ex-post strategies are borrowing from neighbours and banks and mortgaging and selling assets. Moreover, safety nets, mutual insurance strategies such as revolving funds, and co-operative societies are popular as collective shock absorbents. Out of the two types of collective coping mechanisms are popular and most desired.

In ensuring sustainable shock mitigation practices and policy formulation against the vulnerability among small scale fisher folk, it is important to focus attention on supporting the adoption of collective coping mechanisms, which appeared to be the most effective and popular.

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705/F

Legal framework in relation to the protection of coastal and marine resources in Sri Lanka: in pursuit of environmental justice

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This study seeks to set out broadly the legal framework on both international and national perspectives in relation to the protection of coastal and marine resources in Sri Lanka with emphasis on suitable amendments to the existing law. UN Conventions of the law of the sea have provisions to protect the resources of all seas. Sri Lanka is a party to the Law of the Sea Convention acceded to on the 10th December 1982 and exercises jurisdiction over the territorial sea, continental shelf, the exclusive economic zone and the contiguous zone in keeping with the definitions laid down in that Convention. With regard to Sri Lanka, legislation enacted since the British period in Sri Lanka confers the State significant rights in regard the protection of coastal and marine resources in Sri Lanka.

It is recommended that a complete study of existing laws, the experience in discharging functions under the statutes relating to coastal and marine resources in Sri Lanka and regulations necessary to be formulated, be undertaken by the government with the assistance of the special committee. A comprehensive policy framework is available for coastal environmental management. But the legislative framework is insufficient to achieve the policy objectives. Although the coastal zone remains with the Central Government, there are subjects assigned to the Provincial Councils that have a direct bearing on the coastal zone. Provincial Councils should make a major contribution for the proper implementation of the regulatory provisions.

There are additional areas that are necessary to be identified as offences. Unauthorized transfer of permits, obstructions of public access to beach, destabilizing the coastal environment from activities outside the coastal zone, transporting of sands and damage or injury to coastal habitats are some of these. Moreover fines and terms of imprisonment incorporated in the statutes relating to coastal and marine resources in particular the Coast Conservation Act of 1981 as amended have to be readjusted considering the monitory value as at present and the gravity of the offence. Provisions such as found in section 28 of the Coast Conservation Act where a vessel, vehicle craft, boat or machinery could be released on the basis that such was used without the knowledge of the owner should be repealed to prevent maneuvering by those claiming innocence of any knowledge that their properties were used to commit an offence under the Act.

Enforcement of the regulatory system needs more comprehensive provisions with mandatory imposition of fines and imprisonment for offenders. The efforts made by the government and non-governmental organizations through community based activities to educate the public including school children on the need for conservation and protection of coastal and marine resources in the country are praiseworthy. However, these activities need also to be duly recognized through proper regulations.

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706/F

On culture and shyness: a cross-cultural study comparing shyness in Great Britain and Sri Lanka

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Shyness is not classified as a psychological disorder either in the Diagnostic and Statistical Manual of Mental Disorders of the American Psychiatric Association (DSM-IV) or in the International Statistical Classification of Diseases and Related Health Problems (10th Revision) of the World Health Organization (ICD-10). Yet, considering its impact on individuals, shyness can be understood as a form of excessive self-focused pre-occupation with one's thoughts, feelings and physical reaction that could hinder a person from pursuing their own interpersonal and professional goals. Despite the prevalence of the condition in all cultures and nations, there is a dearth of shyness research outside of the USA. A cross-cultural study on shyness was conducted in Great Britain and Sri Lanka using the Henderson/Zimbardo Shyness Questionnaire (2000). As hypothesized, the socio-cultural differences (explained by nationality) had a statistically significant effect [$F(1, 206) = 12.85$, $p < .001$] on shyness quotients (Shy Q) of the two groups, where the British sample reported higher levels of shyness compared to the Sri Lankan sample. The British participants ($n = 112$) reported a shy Q of 2.75 and the shy Q for the Sri Lankan sample ($n = 118$) was 2.53. The collective group mentality appears to have contributed to the low shy Q in the Sri Lankan sample while the British individuals were more self-critical in areas that were perceived as "I'm not good enough". The results are discussed in detail in the theoretical frame of collectivism and individualism that demonstrate a notable distinction between the two cultures.

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707/F

Adults' perception of horizontality: A Sri Lankan experience

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Many studies highlighted that students' performance in Geometry at the GCE (OL) Mathematics is very poor in Sri Lanka. The concept of horizontality is very important to understand topics in geometry. Horizontality can be defined as the quality of being parallel to the horizon. The idea of horizontality and verticality, for example, is the ability to predict the inclination of the surface of a liquid in a jar about to be tilted in specific ways. The idea of horizontality and verticality is not acquired by children before nine to ten years of age; the perception of horizontality provides young children with a 'rough but an adequate idea of the relationship between the horizontal and their own line of vision and bodily positions'. The objective of the study was to identify Sri Lankan adults' perception of horizontality. The hypothesis was 'There is a significant difference in adults' perceptions of conservation of horizontality'. The method of study was quantitative. An experimental research design was used in identifying the conception of horizontality in adults. The sample was 90 second year students of the Diploma Programme at the Open University of Sri Lanka. Instruments used in the study were a glass bottle half filled with coloured water and an empty bottle of the brand kind. The bottle half filled with coloured water was placed on the table in a vertical position and the empty bottle and a picture showing a half filled bottle tilted at 45° from the surface of the table. The students were asked to draw a line on the picture representing the surface of the water in the half-filled bottle which was tilted. 26 (28.9%) students drew the line horizontally and 64 (71.1%) of them did not draw the line horizontally. Chi-Squared test showed that $\chi^2_{cal} > \chi^2_{critical}$. Therefore the null hypothesis is rejected. There is a significant difference in adults' perceptions of conservation of horizontality. Pre-school curricula implemented in many Sri Lankan pre-schools follow Piagetian concepts and methods to provide experience to students. Mathematics in Key-stage I is influenced by Piagetian concepts. Piaget noted that children gradually discover that the surface of water at rest in a container remains horizontal despite the orientation of the container. Findings of this study show that, there is a significant difference in adults' perceptions of conservation of horizontality and 71% of the adults' do not have the ability to represent horizontality. The results indicate that adults find it difficult to perceive horizontality. When compared with findings of Buton (1979) and Pulos (1991) the percentage of Sri Lankan adults who did not perform well in horizontality tasks are higher. These findings indicate the need of effective learning of horizontality at school.

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708/F

A study of teacher attitudes in relation to teaching mathematics in secondary grades

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Due to its abstract nature, the subject mathematics is difficult for some students. The students who are able to digest the abstract concepts are considered to be the "cream" of the class. As a result of the grade five scholarship examination, the "cream" gets the chance of learning in prestigious schools. Students who remain behind in rural schools are considered by teachers to be weaker, in terms of achievement. Thus, in the teacher community, there is an attitude of "no point in being committed and dedicated to work with the remaining students". Moreover, empirical evidence in the literature suggests that there is a very high level of correlation between, teacher attitudes and student achievement levels. The focus of the present study is to understand the nature of the teachers' attitudes, and its relationship with gender and professional qualifications. The sample consisted of 120 teachers, representing trained teachers, trained graduate teachers, and National College of Education Diploma qualified teachers selected from two educational zones. The data collection instrument was a Likert attitude scale consisting of 25 statements (12 positive and 13 negative) belonging to five themes (1. importance and nature of the subject; 2. teachers' attitudes regarding knowledge of the subject and motivation; 3. teaching methods; 4. curriculum materials and pupil text books; and 5. competency level of student and motivation). The questionnaire was pilot tested before administering to the sample. The first part had questions regarding the teachers' personal and demographic details. The sample data analysis revealed that teachers have shown 70.4% favorable attitudes. The highest percentage was observed in the theme "teachers' attitudes regarding knowledge of the subject and motivation". There was a significant attitudinal difference according to the teachers' professional qualifications. Teachers who had passed out from the National Colleges of Education had significantly higher favourable attitudes than the trained teachers and trained graduate teachers. There was also a significant attitudinal difference according to gender. Female teachers had higher favorable attitudes than male teachers. The findings highlight the importance of pre-service training. It can be suggested that teacher recruitment should be made only after pre-service training which can be given at the National Colleges of Education. The need for reorganization of teacher's professional development curricula that could influence desirable attitudinal changes in teachers towards teaching mathematics to all students is emphasized by this study.

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709/F

A cross sectional analysis of 19 case studies of students who obtained 0 to 5 marks at the grade five scholarship examination in 2009

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The problem that necessitated the present research was that as many as 1400 students who sat the Grade 5 Scholarship Examination (GFSE), scored zero marks. The main objective of the research was to identify the factors affecting the compulsory education needs of children who exhibited low achievement levels at the GFSE. The sample for the study included 19 students who had scored (0-5) marks at the 2009 GFSE selected from 19 schools representing all school types (1AB, 1C, Type 2 and Type 3) in 14 educational zones in 11 districts in 7 provinces. In-depth case studies of these students were conducted and a cross sectional analysis of these 19 case studies was performed. The students' home profiles revealed that most (16/19) did not have a conducive home environment for education and security and had less parental support. The majority of students (16/19) were admitted to schools when they were 5½ years or above and most of them (17/19) were healthy and had no deficiencies related to their health. The students' annual attendance for the three years prior to the GFSE (2007, 2008 and 2009) was above 80 percent. The majority of the low achievers (13/19) had shown above average level performance in extracurricular activities. The school principals and teachers had neglected these low achievers. Majority of the subjects were from Type 2 and 1C schools (16/19), and 15/19 of these schools are located in semi urban and rural areas. The majority of the schools in the sample (10/19) possessed sufficient physical and human resources. Despite these resources, the majority of students (16/19) did not reach the expected achievement level in mathematics and in the first language. Therefore, it is suggested that teachers should take responsibility to uplift the students to at least the minimum level of competence according to their level of development. The school should identify the low achievers and suitable remedial education programs must be implemented. Strategies such as peer learning and self learning in the classroom must be encouraged. School-based assessment systems should be revitalized and internal supervision must be strengthened. Educational officers should look in to these aspects and the supervision of schools should be strengthened.

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710/F

Is there equitable distribution of Science Education for eighth graders in Sri Lanka?

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With the introduction of education reforms in 1997, there were many changes in the science curriculum, assessment practices and in teaching science, to produce a classroom culture that enhances student learning through inquiry allowing the engagement in many activities, discussion and the application of their day-to-day life experiences in solving problems. This study investigated the equitable distribution in science achievement of the eighth graders in the country. Two educational districts from each province were selected from the nine provinces in the country representing all ethnic, religious and socio economic groups. Five schools from each district were selected to include urban, semi-urban, rural schools, unisex and mixed schools and the three types of schools: 1AB, 1C and 2, totaling ninety schools. Two classrooms from each grade (7, 8, 9 & 11) were chosen in each school after having a discussion with the school principal and sectional heads. Thirty in-service advisers were chosen and trained to develop the testing instruments, to collect and evaluate data by conducting residential workshops. Testing instruments were developed giving special emphasis for application and inquiry type of questions on difficult science concepts in the eighth grade curriculum. These were piloted, revised and then administered in ninety schools. In each school five students were interviewed and comments were collected from the teachers and evaluators. Analysis revealed that there were statistically significant differences in science achievement among the provinces. Two provinces showed highly significant differences to the other seven provinces. These two have quite different geographical locations. Four provinces did not show significant differences from each other. Analysis of student interviews showed that they had difficulties in answering application, inquiry questions as they have not had experience in answering these types of questions. In-service advisers also expressed the need for rethinking ways of conducting sessions for teachers to help them in developing questions for gauging students understanding to provide remedial actions for students. This study shows the urgent need for adapting teachers to student-centered and inquiry teaching and formative assessment practices to help in student understanding by engaging them in activities to understand the concepts behind "meaningful understanding."

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711/F

Making students interested in submitting their assignments

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This small scale action research was undertaken to motivate five tenth graders who were not interested in submitting their class assignments. The objective of the study was to investigate the reasons behind their failure in submitting assignments. A home task which was to write a laboratory report on practical work that they did with enjoyment (with a complete information sheet and criteria for marking) was assigned to them. Students were expected to work independently and submit the assignment on a given date. A reminder note with the submission date highlighted was hung at the eye level of students in the classroom. Of the five students, only three submitted their assignments on time. As two students in the selected group could not reach the expected level, a better way of giving assignments was required.

As the second action, the students in the classroom were grouped randomly and a group assignment was given to make a booklet on simple machines using the given information, textbooks and other resources. This was expected to be completed in the classroom within the double periods of the lesson. Each group member was expected to do a specified portion of work. While students were engaged in doing the assignment, observations were conducted on how groups divided the task to complete the assignment on time. One did the cover page and another did the tables, and so on. While recording student behavior, feed back was given on identified weaknesses in order to encourage them. Students were able to complete the assignment on time. When engaging in group work, students were able to discuss with others and to recognize their own problems, different ways were adopted to complete the assignment and students also helped each other. At a subsequent discussion, students stated that they prefer to work in groups rather than on their own at home. They appreciated the opportunity to assess their strengths and weaknesses when they work as a group and to receive instant feedback to complete the assignment successfully. Creating challenging assignments to work in group environments make students more interested in working on assignments with sharing of ideas and which enables them to submit their assignments on time.

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Self-assessment: What do chemistry teachers think?

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This research study was designed to reveal chemistry teachers' notions of self-assessment, and the ways these are translated into their classroom practices. There were two main areas of exploration: teacher beliefs, and self-assessment strategies. Two methods were used to collect data; focus group interviews and classroom observations. The sample included 10 schools from Kandy and Matale districts in Advanced Level classes. In the first step, two chemistry teachers from each school were selected and in-depth individual interviews were conducted. Interviews were tape-recorded and transcripts were made. The teachers' responses were analyzed by grouping them under emergent themes. This initial analysis revealed patterns of responses from teachers. In the second step, one of the classrooms of two teachers from each school was observed for a two-week period, paying attention to practice of self-assessments in learning chemistry. Then descriptive field notes were made. Data gathered from interviews and classroom observations were triangulated in the analysis. The results of this study show that chemistry teachers did not include a variety of self-assessment strategies as part of their classroom assessment practices. The teachers seemed to be slower at implementing student self-assessment than other assessments for learning strategies. They tended to have a narrow view of what constitutes a self-assessment. The results also show that teachers were not aware of self-assessment techniques and had reasons why they did not use them in their classrooms. The teachers seemed ambivalent about the value or appropriate use of self-assessment strategies. They expressed doubts about students being able to carry out self-assessment, saying that they were unrealistic about their achievements. They also found self-assessment challenging to implement in classrooms due to the difficulties with getting students engaged in it. These teachers expressed a transmissive view of learning where learning is seen as the transmission of knowledge or skills from the teacher to the student. Before self-assessment can be an effective part of students' learning, teachers have to develop a classroom culture where students are active rather than passive learners, believe that they can learn, are motivated to want to learn, and are given choices about their learning. Continuous and planned professional development is a necessary component of developing a classroom environment for self-assessment practice.

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The use of quality assurance assessment grading for performance evaluation of public universities in Sri Lanka

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Quality assurance rating systems can help parents and students to make informed choices regarding university selection. The existing evaluation procedure for academic programmes in Sri Lanka is based on peer reviewers' judgments on eight selected aspects and the outcome is revealed based on a three level ordinal scale, as Unsatisfactory (C), Satisfactory (B) and Good (A). However, there is no formal method for calculating an overall programme performance indicator within the quality assurance (QA) process in Sri Lanka. The purpose of this study is to assess the applicability and use of quality assurance grading for performance ranking of public universities in Sri Lanka.

Secondary data for programme grading in ten selected universities were obtained from the Sri Lankan Quality Assurance and Accreditation Council. Data for faculties of science, agriculture, humanities, social science and management were available. Twenty four total credit values were assigned to eight aspects that are currently used in programme evaluation depending on the relevance of the given evaluation aspects in monitoring programme performance. Three values were assigned for the grading and a formula was developed to calculate the final programme score as the Average Program Performance Index (APPI). Descriptive, regression analysis and ANOVA were used to compare and identify the performance score and the deviation across faculties and universities.

Findings revealed that APPI ranges between 2.7 and 3.8. Similar results are observed when considering the specific quality aspects of the programme. This indicates that the performance scores are different within the faculties in the sample selected. However, this GPA difference varied among faculties. While significant deviations in programme performance exist in the faculties of science and management, such deviations are not observed in faculties of agriculture and arts. Results from the regression analysis proved that performance among universities are also different.

The study concluded that the reviewers judgmental grading can be used as identifying the performance differences and the best performer among faculties in the public funded universities using the proposed model for programme performance calculation. Findings of this study can be used to identify the highest performer and that can be used as the baseline to compare the performance between universities.

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A preliminary exploration of medical students' time spent on online social networking activities

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Online social networking sites such as Facebook are extremely popular as indicated by the numbers of members and visits to these sites. They allow students to connect with users with similar interests, build and maintain relationships with friends, and feel more connected to their university life. The criticisms of online social networking are that students spend far too much time on these activities and also open themselves to public scrutiny and risk safety by revealing excessive personal information. Though some research on the use of online social networking has been done in other countries, little is known about the dynamics of its use among Sri Lankan students. This study sought to determine how 459 medical students from 1st to 4th year (47% male; mean age 21 years) at a medical faculty in Colombo are using online social networking sites, namely Facebook, online games and public chat rooms. The students completed a questionnaire (with an array of questions on their online social networking use) at the end of a lecture in their regular timetable. It took approximately 15 minutes to complete this questionnaire. Results revealed that 72% of students have an account in the social networking site, Facebook, and on average, they spend 1.4 hours on it during the working week (Monday to Friday), and 1.6 and 1.5 hours on Saturday and Sunday, respectively. Results also revealed that 21 % of the medical students do online social networking games like Farmsville and these students spend, on average, 1 hour during the working week, and 1 hour each on Saturday and Sunday. With respect to public chat rooms, results showed that 19 % of students chat on online public chat rooms, and on average they do so 1 hour on weekdays and 1.2 hours each on Saturday and Sunday, respectively. Hence, it appears that the majority of students are on Facebook while a smaller number participate in online games and public chat rooms. In this age of online communication, there is a blurring of the interface between work and personal lives. Social networking websites are popular among young pre-professionals, and allow medical students to communicate and share information with peers via personalized profiles. These self-created profiles contain personal information such as address, phone numbers, and photos, and include information such as relationship status and political views. Unfortunately, medical students, with their sense of medical professionalism just beginning to develop, may not understand that their publicly available content directly reflects their professionalism. Unknowingly, medical educators, future employers, and even patients may have access to their content online, not without consequences.

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School improvement: theory vs. practice

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The demand for better schools has been increasing in Sri Lanka. Therefore successive governments have made an effort to fulfill this demand by introducing new programmes. The main areas addressed in these programmes are school administration, curriculum management, student development, teacher development, financial management and school community relations, even though the specific names of the programmes were different and changed from time to time. The present paper attempts to discuss the reality of the "school improvement programmes (PSI)" introduced in 2006 at the school level. The main objective of PSI was for schools to become increasingly empowered through strong community involvement in school management. The expected outcomes of PSI show that this programme also addressed the same 06 areas mentioned above. The study was conducted in three phases (2006-2009) (baseline survey, case studies in seven selected schools, impact study) using a sample of 35 schools selected from seven of the eight zones in which PSI was initially introduced. Three types of instruments were used to collect data: a questionnaire, interviews and survey of school documents. Data gathered for the impact evaluation was compared with the baseline information to identify the change in the selected management areas after introducing PSI.

Findings show that by the end of 3 years of implementation of PSI, principals were of the view that they were aware of PSI objectives, but that they ask for support and supervision from other external sources for the sustainability of the programme. The ideas of students on school vision differed from those of the principals and were more related to the current needs of the society. The principals have admitted that they need to focus more on the curriculum implementation process and on teacher development. The main focus of the principals, teachers and parents was to make the students secure a pass at pubic examinations. Inadequate emphasis is given to co-curricular activities which could help development of skills and attitudes. PSI has helped in identifying different avenues for generating funds for school related activities rather than depending on parents alone. School community relationships have been strengthened but the involvement of the community in curricular activities is not so prominent. Their participation is evident in improving the physical infrastructure of the school. There is no evidence of schools addressing and understanding community needs. Lack of awareness of the programme's objectives has been the main limitation in achieving the desired outcomes of the programme.

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From a formal government school to Madrasa: a longitudinal case study

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The randomly selected Muslim student chosen for the present longitudinal case study was selected from a school located close to a vegetable and poultry farm in an environment full of flora that can withstand vagaries of weather in the area. The climate of the area is very cold and misty for a greater part of the day. To study the impact of the school, class, teacher, home and inherent characteristics of the student on participation to school education and competency development, data were collected by 16 instruments in grade 1, 2 and 5 along with researcher's observations in his home. Data were gathered through teacher perceptions, interviews, and document analysis and activities assigned to the student. Data were triangulated and analyzed to identify developmental patterns. The student had his schooling for four terms from grade one which was situated close to a railway station. The transport facilities in the area were minimal. The school had five acres of land, but only two acres had been utilized for students' use. The school had three single storey buildings and 204 students from different cultural backgrounds. Sinhala was the medium of instruction and only Buddhism was taught as a religion. A dearth of physical and human resources affected the student's competency development. The play yard for the primary children was neglected. The lack of success of the teacher who taught the student in grades 1 and 2 and the lack of opportunity to learn Islam made the student leave the school and seek admission to a Tamil medium Muslim school. This gave him the opportunity to learn in his mother tongue and his own religion. The new school was in a semi- modern area and had three buildings, a science laboratory, a play ground and a play yard. When the student was in grades 2, 3 and 4, there was no shortage of teachers. However, as a result of a dispute between the principal and the community, the teachers kept off teaching for five months when the student was in grade five. This had a detrimental impact on the student's competency development. The student participated more frequently in both curricular and co-curricular activities than in the previous school. The student did not pay attention and thus lacked understanding in grades 1 and 2, but he improved his listening skills when in grade 3, 4 and 5. Though, he couldn't write a simple Sinhala word correctly in grade 1, the child wrote Tamil letters, words and sentences when he was in grade 2, 3, 4 and 5. Being an ardent believer of Islam the student showed a great attraction to and faith in Islam. At the end of grade 5, the student left the formal government school and entered a Madrasa school with the intention of becoming a member of the Islam clergy.

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Valuing wildlife benefits of irrigation reservoirs: a case study of Veheragala

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Economic development in the dry zone of Sri Lanka was based on external land augmentation through development of irrigation infrastructure. Irrigation reservoirs generate multiple benefits but information on values of all uses is not available to guide policy makers. The Veheragala Diversion Project of the Menik Ganga Basin of southeastern dry zone of Sri Lanka expects to augment water of the Kirindi Oya Irrigation and Settlement Project and alters the natural flow regime of the Yala Protected Area Complex (YPC). Objectives of this research were to a) develop a theoretical framework to determine the economic value of a quantity of water flowing through a national park, and b) to empirically value the water flow to YPC, and c) to compare these values with those generated by the agricultural sector through diversions to the Kirindi Oya Basin.

Details of rice production costs and benefits for two consecutive seasons were collected through a farm household survey of 180 randomly selected households in Kirindi Oya. Production function for rice with water quantity as an input was estimated and was used in predicting rice yields and allocating optimum quantities of water to maximize total incremental system net benefits. A contingent valuation study was conducted using Single bounded dichotomous choice methods in ten districts of Sri Lanka in the last quarter of 2008. Due to the national importance of the YPC, the general public of Sri Lanka was considered as participants in the hypothetical market. Mean willingness to pay (WTP) was estimated using the non-parametric survivor function approach.

Results indicate that net annual benefits generated by augmented water by farmers as SLR 137 million. General public is willing to pay towards enhancement of YPC through downstream releases of water. Present value of expected net benefits that would be realized by the general population of Sri Lanka is SLR 11.8 billion. This is several times of the net present value of SLR 0.8 billion realized by farmers. The study shows that benefits of irrigation reservoir are realized by general population of the country. Thus irrigation benefits extend beyond the conventional beneficiary population for irrigation reservoirs. Values placed by the general public can be considered as the value of water allocated for wildlife purposes. This information can be used by policy makers in allocating water among different uses.

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Environmental impacts of gem mining in Sri Lanka

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The sustainability of the gem mining industry for over past thousands of years rested on the unique traditional mining methods and scale. At present with the increase in production scale, mining is becoming a hazard to the environment. The main purpose of this study is to investigate the current status of gem mining industry and to identify significant environmental damages caused by gem mining. Primary data was gathered from a questionnaire survey of 378 mines of the six gem mining regions and household questionnaire survey of 100 households in adjacent areas to the mining regions. Additional data were collected from the Gem and Jewellery Authority regional officers, and from other secondary sources. The collected data were analyzed to identify the major environmental impacts.

Results revealed three main environmental impacts due to gem mining including, the spread of diseases (especially malaria), potential loss of agricultural lands (especially paddy lands), and sedimentation and siltation of surface water bodies. Around 29 % of the mines are scattered in paddy lands destroying 30 % of productive paddy fields. The calculated average loss of paddy yield equals to 1271.9 metric tons per year. Land loss is cumulative and when paddy production is lost for a long period of time it could significantly affect national production. Around 75 % of the villagers use mosquito-bite prevention mechanisms such as nets or coils indicating the high abundance of malarial and other vectors. 23 % of people have lost their source of water due to siltation of surface water bodies due to dredging and discharging of used water from mining activities. Miners destroy 1800-2000 rubber trees and 150 - 200 arecanut trees per annum. Natural soil erosion, removal of vegetation cover, flooding, landslides, ground water depletion, risk and/or damage to wildlife, reduction of irrigation efficiency, and other damage including cracking of walls of houses and other manmade structures are among the other significant environmental impacts of gem mining. The results highlight the importance of adopting appropriate mitigatory measures in the short term and the necessity of adopting proper policy measures in the long term to reduce negative environmental impacts.

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Pushing "non-adopters" towards environmental compliance: case of solid waste management in agri-food processing sector in Sri Lanka

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The impact of private and public incentives for a firm to adopt enhanced environmental controls was examined empirically using the case of the Ministry of Environment of Sri Lanka's recommendation of certain solid waste management practices (SWMPs) [3R system, Composting unit, Biogas unit, Good Manufacturing Practices] for agri-food processing sector in Sri Lanka. We hypothesized that: (1) cost and financial implications; (2) increased internal efficiency; (3) market-forces (e.g. sales, commercial pressure and reputation), and (4) government regulation and judiciary have a significant impact on those firms that do not possess any of these SWMPs in place (i.e. "non-adopters") to become "adopters" by the end of 2011. The data collected from 153 firms operate in the Western, North-Western, Central and Southern provinces by means of a face-to-face interview with the owner/top executive of firm supported by a structured questionnaire were subject to Kruskal-Wallis Test for analysis. The results show that existing government regulation and liability laws on solid waste management did not trigger firms to comply with it and their private action on SWMPs is constrained by costs/financial implications faced by the firm. Interestingly, internal efficiency criteria and market-forces did not play a significant role in this respect. Yet, the relative impact of these incentives varied significantly between firms with different characteristics (e.g. types and size). This highlights the importance of bringing strict regulations into the industry to ensure that it is in compliance with the recommendations. However, care must be taken beforehand, to strengthen the base of positive private/market incentives faced by firms so that these would not lead to full- or partial-exit of firms in the short-run, especially those non-adopting small firms, due to financial constraints.

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Price behavior, consumer preference and factors determining methods of preserving arecanut (*Areca catechu*)

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Chewing of betel along with arecanut (*Areca catechu*) kernel is a habit among the working-class and the peasants of our country. Arecanut is a seasonal crop but its consumption is continuous. The objectives of this study were to examine changes of arecanut prices, consumer preference for arecanut products such as ripened fruits, water-preserved fruits (*madapuwak*) and dried fruits (*karunka*) and factors determining the production of the different products. The study was carried out in the Dambulla village in the Rambukkana Divisional Secretariat division. Thirty arecanut growers were interviewed in the Dambulle village to study consumer preference and factors determining the production of different arecanut products. Ten arecanut dealers (five from Rambukkana and five from Alawwa) were interviewed in order to examine price behavior and the distribution of different products from August 2009 to July 2010.

The harvesting season of arecanuts commences in October where the average price of a fruit was in the range of 70 - 80 cents. The peak season of arecanuts is from December and February when prices fall to an average of 40 - 50 cents per fruit. During the declining phase between March and April the arecanut prices remained high at Rs. 1.50-1.60 per fruit. Almost all the arecanut consumers preferred to chew fresh kernels of ripened fruits. Estate workers preferred semi-mature fruits. The arecanut dealers in Rambukkana and Alawwa carried out sorting activities and sent 40 % of their collection as semi-mature fruits to the up country and mid country regions for estate workers. Water-preserved arecanut was preferred by consumers in the northern and north western regions and 70 % of this product was sent to those areas. In the absence of fresh ripened fruits, consumers in other regions were also compelled to consume water-preserved products. Almost all the consumers preferred karunka during off-season of fresh ripened fruits. Water preservation commenced when the arecanut prices became lower during the peak season. When the prices of arecanuts were still low and the fruits were sufficiently preserved in water, farmers sought alternative methods of preservation *viz.* drying. The different products of arecanut were made depending on the availability of the raw material, prevailing price and the prevalence of rainy or sunny weather.

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Terms of trade in the paddy production sector in Sri Lanka

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'Terms of trade' is a common measure used to understand the performance of international trade. It is also used as a proxy for comparing relative prices of various goods. In this study, the performance of input prices as well as prices of paddy for the period between 1990 and 2009 are examined in detail with a view to ascertaining the extent of the terms of trade/price parity ratio of the paddy farmers.

The study shows that the producer price index had increased only by four fold. However, as in real price, producer prices of paddy have been sluggish and have shown an irregular pattern. The analysis indicates that the labour index had increased by seven fold while the fertilizer price index at the farm level had significantly declined (Rs.7/kg) to that of the base year, 1990. This is due to heavy subsidization of fertilizer. Moreover, both the agrochemical cost index and machinery cost index had increased by six-fold compared to the base year value. It was found that terms of trade in the Maha harvesting season is slightly lower than in the Yala harvesting season. Terms of trade in 2008 reached 0.79 in the Maha season (69 % increase) and 0.72 in the Yala season (37 % increase) which were the highest recorded terms of trade values after 1992 and 1993 respectively. But this deteriorated again in 2009. The annual average value of terms of trade shows an irregular movement which declined from 1 (1990) to 0.62 in 2009.

Both producer prices as well as input prices are significantly important in determining the terms of trade in paddy. Anyhow, producer prices of paddy had not increased commensurate with the level of rise in the prices of inputs. This had resulted in a down turn in profitability and terms of trade in the paddy sub sector during the period under consideration. Because of the increase in input costs and as the profit margins are not commensurate with the increase of total production costs, returns from paddy farming had declined over the last several years. This trend will have adverse implications on farmers who continue to farm paddy.

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Awareness and adoption of 'Golden Rules' in agrochemical usage: a case of the paddy farmers in the Buttala area

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Safety measures need to be adopted while using agro chemicals because of its hazardous nature. WHO has introduced five 'Golden Rules' (GR) viz., always read and understand the label information, handling chemicals carefully, maintain sprayers, practice good personal hygiene and always use appropriate protective clothes when buying, transporting, storing , applying and disposing of chemical wastes of agro-chemicals. Paddy cultivation is commonly recognized as a cultivation where there is intensive use of agro-chemicals. Therefore, this study attempted to ascertain the farmers' awareness, adoption and attitude toward 'GR' when using agrochemicals. Data were collected from the Buttala area in the Monaragala District. Ninety four respondents were selected randomly for a questionnaire survey. Awareness, adoption and attitudes on GR were measured by employing the indices. The data were collected with the help of an interview schedule. The descriptive statistics and correlation test were employed to analyze the data. The majority of the farmers fell into the moderate awareness group in respect to the buying (53 %), transporting (45 %), storing (57%), and applying (53%). In respect to adoption for each activity, the majority were in the moderate category on buying (55%), transporting (46%), storing (57%), and applying (60%). However, the majority of farmers were in the very low level on awareness (64%) and adoption (55%) with regard to the disposal of agrochemical wastes. Farmers' attitude towards the safe usage of chemical was not favourable because the direct impacts of safe usage of agrochemicals were not visible. Majority (76%) have neutral attitudes while 13% and 11% had poor and favorable attitudes. Those in the poor attitude group indicated that the special care of agrochemicals was additional work and cost for them. The group with attitudes indicate that safe usage of agro-chemicals at each step helps safeguard the health of both humans and the environment. Awareness and adoption were significantly correlated ($r = 0.87$, $p = 0.001$). Further, the farmers' attitudes towards safe usage of agrochemicals has also shown a positive correlation ($r = 0.41$, $p = 0.001$) with adoption to GR. Farmers' education and farming experience showed a positive correlation with the awareness and adoption attitudes. These findings clearly imply that paddy farmers are still not following accurate guidelines for agrochemical usage. It is therefore, necessary to take appropriate steps *viz.*, conduction awareness and training program etc to increase the farmers' awareness on the safe use of agrochemicals.

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Output instability of rice production: a Sri Lankan experience

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Since independence, Sri Lankan paddy production has achieved a significant average growth of 4.4 % per year. Despite the substantial improvement, instability of the paddy output has attracted the attention of successive governments in the post independence era. Therefore, this study was designed to reveal the actual nature of paddy output fluctuations, characterize the sources and to identify the factors that have led to output fluctuations. The investigation was conducted using macro level paddy related data from 1952 to 2009. Yield per unit area and the area under cultivation were considered to be major sources of paddy output fluctuations and national average paddy yield accounted for 1.9% of the annual growth while the area cultivated showed 2.2 % average annual growth. On a seasonal basis the Maha season provided 67 % of the national paddy output, whereas 33% come from *Yala* season. Variability in the Yala season (Coefficient of Variation - 51%) was higher than that of Maha (CV- 47%). Higher variation seen in the Yala season is due to variation in the area cultivated during the season. However, no significant difference in average yield levels of the two seasons was observed. Further, 60 % major irrigation, 21% rain fed and 19% minor irrigation schemes contributed to the total national paddy output, respectively. According to the availability of water, variation was higher in rain fed areas due to changes in the area under cultivation. The average yield changes are comparatively marginal in major irrigation schemes. Though paddy production occurs in all the districts of the country, about 50% of total national production comes from the four major paddy producing districts: Ampara (16 %), Polonnaruwa (14 %), Kurunegala (11%) and Anuradhapura (9 %). Among these districts the paddy output variation was low in the Ampara and Polonnaruwa districts (CV-13%). However, the two other districts were also in a highly vulnerable position as Kurunegala (CV-30%) and Anuradhapura (CV-40%). This was mainly because rain fed and minor regimes are dominant in these two districts than major regimes. The study suggests that the areas under cultivation during the Yala season should expand, and stabilize via assured water supply through new technology and suitable varieties. Immediate attention is needed to stabilize paddy production in the Kurunegala and Anuradhapura districts. Conventional yield and area expansion are not adequate to tackle the problem of output instability, and further sustainable long term policies focusing on output instability needs to be formulated and implemented.

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Poster Presentations

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Fourteen years experience in conducting the National External Quality Assessment [NEQAS] programme for Bacteriology in Sri Lanka

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The National External Quality Assessment [NEQAS] programme for Bacteriology in Sri Lanka was started in 1997 at the Quality Control section of the Department of Bacteriology, Medical Research Institute, Colombo. The objectives of this programme are to evaluate, compare and improve the quality of diagnostic microbiology, stimulate the use of Internal Quality Control (IQC), propagate standardized techniques with particular reference to a uniform disc susceptibility testing method, select a uniform and restricted list of culture media and reagents, and to identify the competent laboratories in the state and private sectors.

In our NEQAS programme, three pure bacterial cultures stabbed in Tryptic Soy Agar [TSA] are sent quarterly in small screw-capped bottles. The bottles are securely packed and sent by post along with the report form and the instruction sheet. For each culture, the source of the specimen is mentioned and participants are instructed to identify the culture and perform the Antibiotic Sensitivity Testing (ABST). The results should be sent back within two weeks and are analysed and scored. The correct answers of the previous survey are sent to participants along with the next QC package.

Since the beginning of the programme in 1997 up to date (2011), the number of participants have increased from 13 to 54, mostly due to the voluntary participation of laboratories interested in joining a recognized NEQAS programme to upgrade their laboratory test quality. The participation of government hospitals increased by 70% and of private hospitals by 73%. Performance of participants in terms of correct identification of cultures has increased from 63% to 85% while accurate ABST results improved from 45% to 74%. A marked increase in both parameters (8% and 7% for identification and ABST, respectively) was seen after 2009. Reasons for this could include the appointment of medical microbiologists to peripheral hospitals, four workshops and three hospital visits by NEQAS and adoption of the ABST method described by the Clinical and Laboratory Standards Institute (CLSI) by many laboratories. It is observed that participation of government hospitals in the North and East of Sri Lanka has increased by 80%. This is probably due to the alleviation of the crisis situation prevailing in the country after the end of the civil war in May 2009.

The results reveal that the monitoring and guidance given by the NEQAS programme have led to a greater motivation and improved diagnostic skills and is appreciated by the participating laboratories.

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Use of physical and chemical properties as a tool in standardizing *Maha Varthikava Watee:* an effective Sri Lankan poly herbal formulation

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Maha Varthikava watee is an effective poly herbal drug, recorded in the ancient text *Watika Prakaranaya.* It contains 29 herbals and is a very effective drug for digestive tract disorders. Commercially available indigenous preparations that are not prepared according to the original recipes may not be effective as they should be. Therefore, standardization of such poly herbal formulations which synergistically cure diseases has become an essential part in assuring the quality and thereby the actual efficacy of the drugs. A study was carried out to investigate whether physico-chemical properties can be used as measuring tools in assessing *Maha Varthikava watee* for its conformity. In this study all herbals were purified and finely powdered and mixed thoroughly and pulverized together with juices extracted from leaves of Indian pivot, neem and betel and bees honey. The pills were made to the size of a grain of green gram and were dried under shade. Likewise, three batches were prepared to avoid errors due to deviations associated with seasonal changes and their average was used to assess five commercial samples available at the market. Physical properties namely weight, specific gravity, loss on drying, ash content, acid insoluble ash content and chemical properties viz pH value, extractability to hexane, dichloromethane (DCM), ethyl acetate (EA) and methanol were considered as tools for the standardization. One way ANOVA followed by the Dunnett t test was used in the analysis of data at 0.05 significance levels. The SPSS statistical package was used for the data analysis. No significant differences were found in all commercial samples with regards to fiber content (8.42±1.8), acid insoluble ash (0.088±0.07), DSM extract percentages (1.17±0.19), EA extract percentages (2.13±0.52) and methanol extract percentages (15.29±4.36) (P=0.59, 0.55, 0.8, 0.3, 0.43) while the weight of pills (1.18±0.062) was significantly different from that of the control at 0.05 level. The pH values (4.57±0.07) were significantly different in 1st, 2nd and 3rd commercial samples (P=0.08, 0.92, 0.32) while there were no significant differences in 4th and 5th commercial samples. Loss on drying (12.3±0.48) was significantly different in 1st and 2nd samples (p=0.08, 0.91, 0.32), but that of other 3 samples was the same. Specific gravity (1.24±.035) was found different only in the 2nd sample while other 4 samples were the same (P=0.09, 0.49, 0.19, 0.16). Ash value (6.87±0.17) was significantly different only in the 4th commercial sample while other 4 samples were the same (P=0.93, 0.88, 0.64, 0.24). Hexane extract value (6.12±0.84) was same for all samples (P=1, 0.04, 0.87, 1, 0.1) except in 2nd one. Hence, *Maha Varthikava Watee* can be standardized using the above mentioned physical and chemical measurements.

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803/A

Use of synthetic insecticides in the control of dengue vector mosquitoes *Aedes aegypti* and *Aedes albopictus*

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The susceptibility of *Aedes aegypti* and *albopictus* to the discriminating dosages of DDT (an organochlorine) (4%), malathion (an organophosphate) (0.8%), propoxur (a carbamate) (0.1%), permethrin (0.25%) and deltamethrin (0.025%) (pyrethroids) were monitored by exposing mosquitoes to insecticide impregnated papers using World Health Organization (WHO) standard bio-assay test kit and technique. Both species gave 30% and 28% mortalities, respectively against DDT. Mortality against permethrin was 54% for *Aedes aegypti* and 45% for *Ae. albopictus*. Both species were susceptible (100% mortality) to malathion, propoxur and deltamethrin. Efficacy of the technical grade malathion, Pesguard FG161 and Deltacide in thermal fogging, and temephos (an organophosphate) as a larvicide was also monitored according to WHO testing procedures. When the adult mosquitoes were exposed to thermal fogging, both species gave 100% mortalities for all three insecticides at 10 m distance in all three habitat types used i.e. open area, habitat with little vegetation and habitat with dense vegetation. For malathion, 50% - 68% mortality was observed at 50 m distance. Pesguard and Deltacide gave 100% mortality up to 50 m in open area and in habitat with little vegetation. Both species showed >30% mortalities against Deltacide even at 75 m distance. The effect was negligible beyond 75 m. Efficacy of Deltacide was relatively high even with dense vegetation. Results showed that Deltacide had the highest efficacy followed by Pesguard and malathion. Presence of the monooxygenate inhibitor PB in Deltacide may act as an added advantage in knocking down resistant individuals by inhibiting monooxygenases which provide metabolic resistance. Under laboratory conditions, larvicide temephos (1 ppm) in water filled cement tanks (20 x 20 cm) was fully effective against the larvae of both species (100% mortality) for ten months and in the middle of the eleventh month, no larvicidal effect was observed (100% survivals). Under field conditions, 1 ppm temephos was fully effective (100% mortality) against larvae only for the first four months. More than 50% reduction of the efficacy was observed after six months. Results clearly showed that larvicidal effect of temephos is long lasting. Since it is a cheap insecticide, 1 ppm temephos can be highly recommended to use as a larvicide in dengue vector control programmes.

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804/A

Prevalence of refractive errors in children of Bope-Poddala Health Unit area in the district of Galle

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The normal refractive state of the eye is called emmetropia, in which the parallel rays of light entering the eye are focused on to the retina whilst the accommodation is suspended. Deviation from emmetropia is called refractive error or ammetropia. Refractive errors lead to poor vision and in children, it may cause a permanent visual defect called amblyopia. The objective of this study was to assess the magnitude of the problem of refractive errors among children

Visual acuity screening was done in all children of 3-14 years of age in the Bope – Poddala Health Unit area in Galle district of Southern Sri Lanka. Refractive errors were diagnosed after subjecting the positive cases to refraction test.

Visual screening was done on 5649 pre-school and school children (87.8% and 12.2%) aged 3 – 14 years in two stages. Of them, 52.1% were males. Majority were Sinhala (86.4%) while 13.3% were Muslims. Visual defects were found in 9.7% (including refractive errors and other diseases). The detected cases were subjected to confirmation by proper refraction test. Failure rate for referral was 1.9%. Refractive errors were found in 6.2% (5.8% males; 6.6% females).

Table 1 shows the age specific prevalence of refractive errors.

Age group (years)	Number examined	Prevalence of refractive errors
3 – 4	220	2.3%
4 – 5	364	5.5%
5 – 6	620	7.6%
6 – 7	634	7.7%
7 – 8	555	8.6%
8 – 9	611	4.3%
9 – 10	564	5.3%
10 – 11	561	6.8%
11 – 12	565	6.7%
12 – 13	545	5.0%
13 – 14	410	5.6%
Total	**5,649**	**6.2%**

It is concluded that a fairly high prevalence of refractive errors in Sri Lankan children indicate the need of proper visual screening at early ages to prevent further visual damage due to non correction.

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805/A

The depth of visual acuity failure and level of correction in refractive errors among children

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Visual acuity (VA) can be measured using Snellen's chart or Log mar chart in school children. This needs comprehension, concentration educational development, and verbal skills. Vision of pre-school children can be tested using symbols that are based on the principles of Snellens chart. Depth of VA failure may be different from person to person and depending on the type of error. The objective of this study was to assess the degree of VA failure and amount of correction among children with refractive errors. All school children (aged 3-14 years) of Bope-Poddala Health Unit area of Galle were screened for VA defects and subjected to refraction test to confirm the errors in positive cases. Their uncorrected VA levels were compared according to Snellen's test levels. Out of 128 unilateral and 223 bilateral refractive errors (total 574 eyes), VA levels were as shown in Table 1. Table 2 shows corrected VA after refraction, according to WHO VA categories.

Table 1. Visual Acuity (VA) levels in refractive errors

VA Levels	Unilateral refractive errors				Bilateral refractive Errors			
	Right	Left	Total	%	Right	Left	Total	%
<3/60	3	3	6	**4.7**	1	3	4	**0.9**
4/60	1	0	1	**0.8**	2	2	4	**0.9**
5/60	3	5	8	**6.2**	5	8	13	**2.9**
6/60	0	5	5	**3.9**	31	24	55	**12.3**
6/36	3	4	7	**5.5**	18	23	41	**9.2**
6/24	11	5	16	**12.5**	41	40	81	**18.2**
6/18	8	20	28	**21.9**	32	33	65	**14.6**
6/12	6	26	32	**25.0**	48	52	100	**22.4**
6/9	4	21	25	**19.5**	45	38	83	**18.6**
Total	**39**	**89**	**128**	**100**	**223**	**223**	**446**	**100**

Table 2.

Visual acuity	WHO category	Better eye				Worse eye			
		Before refraction		After refraction		Before refraction		After refraction	
		No	%	No	%	No	%	No	%
6/6	0	128	36.5	273	77.8	-	-	206	58.6
6/9	0	57	16.2	41	11.7	50	14.2	29	8.3
6/12	0	55	15.7	16	4.5	79	22.5	38	10.8
6/18	0	31	8.8	14	4.0	63	17.9	35	10.0
6/24 6/60	1	73	20.8	7	2.0	130	37.0	37	10.5
3/60	2	7	2.0	-	-	25	7.1	3	0.9
<3/60 NP	3	-	-	-	-	4	1.1	3	0.9
Total		**351**	**100**	**351**	**100**	**351**	**100**	**351**	**100**

Refraction makes the VA normal in a majority but about 2.0% of better eyes and 12.3% of worst eyes remain in severe visual impairment categories which need close observation and follow up.

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806/A

Knowledge and attitudes regarding dysmenorrhoea among adolescent girls in an urban school

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Dysmenorrhoea or painful menstruation is a very common complaint among women of reproductive age which affects with mental, social and physical activities of adolescents. Attitudes may affect their healthcare seeking behaviour. A descriptive study was conducted among 200 adolescent girls in Grade 12 classes (all students attending Commerce, Arts, Combined Mathematics and Bio Science classes) in a school in Nugegoda educational division in Colombo district to assess the knowledge and attitudes regarding dysmenorrhoea. The students were given a self administered questionnaire following ethical clearance and parental consent. The results indicated that 84% of the study population had dysmenorrhoea. A similar percentage had physical discomfort. When considering the localization of pain, most of students' (85%) pain was localized in the abdomen. Resting was the main pain relieving method (63%). Paracetamol was the drug of choice for pain relief (87%). Ayurvedic pain killers like Siddalepa was used by 4% and coriander water was used by 6% of the students. 85% of students used it mainly as a preventive remedy before the onset of menstrual pain as a preventive remedy. There was a statistically significant ($p< 0.05$) association between pain and poor mental health status (increased anger, less concentration, impaired decision making) (66%) of the adolescents, but there was no significant association between the pain and poor physical health status ($p=0.887$) and poor social health status ($p=0.395$) of the girls. Our findings indicate that 44% of students are absent from school at least one day a month due to the menstrual pain. There was no significant association between the pain and school absenteeism ($p= 0.805$). Almost all students (93%) of this study have stated that they seek answers for their menstrual problems from their mothers and 84% of students said that pain was a natural thing for them. Only a small proportion (6%) of adolescents stated that pain is a symptom of disease in the reproductive tract. Bathing is perceived to be affecting pain as reported by 95% of the students. In conclusion, dysmenorrhoea was common among adolescent girls in an urban school and was associated with their mental status. Most of the students did not seek medical advice for dysmenorrhoea. As health care providers, arranging health education sessions is therefore important to raise their awareness.

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807/A

Determination of Ash content in *Varatika* and *Abhraka* used in Ayurveda Rasa pharmaceuticals

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Varatika is the shell of *Cyprea moneta* (shell of cowry) and chemically it is identified as a carbonate of calcium ($CaCO_3$). This is used in *Rasa Shatra* as a key ingredient. Among *Abhraka* varieties *Krishna vajra abhraka* (Biotite Mica) is the finest variety used for therapeutic purposes. Mineral compounds that are prepared through *Shodhana* (purification), *Bhavana* (trituration) and *Marana* (incineration) are considered pharmaceutically as the most suitable forms as they are superior, non-toxic and highly potent for therapeutic point of view. Owing to the superiority of mineral drugs in the place of herbal drugs it has been described that the supremacy might be due to their fast action in smaller dose with good palatability. Hence determination of the total ash content and the acid soluble ash content of *Varatika* and *Abhraka bhashma* are important, as it could be helpful to understand the effectiveness of those Ayurveda medicines in the human body.

Purification of *Varatika* and *Krishna vajra abhraka* (six samples each) and preparation of *Dhanyabhraka* and *Dhanyabhraka chakrika* were carried out using traditional methods described in authentic Ayurveda texts. Samples were ashed using Muffel furnace and total ash content and acid soluble ash content were determined.

Ash content of unpurified and purified *Varatika* was 55.64% and 57%, respectively. When compared with the traditionally incinerated sample it is lower (8.50%) than the sample incinerated in a Muffle furnace (14%). These results revealed the importance of improving traditional methods using modern techniques for the manufacture of quality Ayurvedic medicines and this result could be useful to interpret the therapeutic effect of *Varatika Bhashma* used in hyper acidity.

The ash content of unpurified *Abhraka* was 0.94g (±0.00) in 1g of sample and it was 0.95g (±0.01) in 1g of purified sample. Acid soluble ash content has increased during the purification from 5% to 7.8%. Total ash content and acid soluble ash content of *Dhanyabhraka* was 0.92g (±0.01) and 10% respectively, and 0.66g (±0.01) ash amount was determined in *Abhraka chakrika*. Acid soluble ash content in *Abhraka chakrika* was 5.8%. These results highlight the significance of purification process in Ayurveda pharmaceutical preparation.

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808/A

Assessment of nutritional status of adolescent school girls in Panala sub zonal educational division by means of anthropometric assessments

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Adolescence is a unique crucial period in the life cycle. Adolescents are defined as persons aged 10-19 years. Adolescence can be the second opportunity for catch-up growth if environmental conditions, especially nutrient intake are favorable. Growth is faster than at any other time in life except the first year. Adolescents gain up to 50% weight of their adult weight, more than 20% of their adult height and 50% of their skeletal mass. Adolescent girls commonly experience psychological and emotional problems that exert a significant influence on their nutritional status when compared with boys. In Sri Lanka, few studies have been carried out to assess the nutrition status of adolescent school girls. The objective of this study was to assess the nutritional status of adolescent school girls in Pannala sub zonal educational division by using anthropometric measurements.

Three schools in Pannala sub zonal educational division were randomly selected and a cross-sectional study was carried out. A total of 110 subjects, aged 13 – 15 years were randomly enrolled to this study. A pre-tested, self administered questionnaire was distributed among the subjects and their weight, height, waist and hip circumference, were measured by using standard techniques. Epi Info version 3.4 was used to generate Z scores and percentiles for weight for age, height for age and BMI for age. Subjects were categorized as underweight, stunted, overweight and obese using WHO cut-offs. Overall mean weight, height, and BMI of the study group were recorded as 43.46 (8.32) kg, 151.37 (10.36) cm and 18.69 (3.20) kg m^{-2} respectively. In the study population 20.7%, 19.8% 19.1%, 9.1%, 0.9% and 52.7% were of underweight, stunted, wasted, overweight, obese and normal nutritional status, respectively.

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809/B

Efficacy of selected plant extracts in the control of *Fusarium oxysporum* f. sp. *capsici* inciting chilli wilt

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Chilli (*Capsicum annuum* L.) is one of the most important cash crops of Sri Lanka. It is mainly affected by Fusarium wilt caused by *Fusarium oxysporum* f. sp. *capsici*. In this context, an eco-friendly approach that uses plant extracts to control the pathogen is being explored. The antifungal effects of the aqueous extracts of five plant species *viz. Azadirachta indica*, *Ocimum sanctum*, *Zingiber officinale*, *Allium sativam* and *Allium cepa* were tested *in vitro* against *Fusarium oxysporum* f. sp. *capsici* by the poisoned food technique. The results revealed that all plant extracts showed significant ($P<0.05$) reductions in the growth of the pathogen. Plant extracts at 10 % concentration were significantly higher in inhibitory effects than those at 5 % concentration. Among the different extracts at 10 % concentration, *Allium sativam* was found to be the most effective (53 %) in inhibiting mycelial growth of the fungus followed by *Azadirachta indica* (47.7%) and *Ocimum sanctum* (36.3%). The lowest inhibitory effect was in the crude extract of *Zingiber officinale*. Based on the above results, it could be stated that *Allium sativam* and *Azadirachta indica* extracts which are cheap and environmentally safe, exhibited considerable *in vitro* control of *Fusarium oxysporum* f. sp. *capsici* and may be considered a promising remedy for the protection of chilli plants against wilt pathogen which may result in the improvement of this economic crop.

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810/B

Production of set yoghurt incorporating cassava flour (*Manihot esculenta* Crantz) and the evaluation of its shelf-life and quality parameters

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Cassava (*Manihot esculenta* Crantz), which is a popular tuber crop in Sri Lanka, can be used to manufacture yoghurt while minimizing the nutritive deficiencies whenit is consumed alone. The objectives of the present study were to develop a set-yoghurt with cassava flour to achieve a low production cost and to evaluate its physicochemical, sensory and microbiological properties. Experiments were carried out to determine the best cassava flour (3.25, 4 & 4.5 w/w) and gelatin (0.3, 0.35& 0.4 w/w) percentages in yoghurt. Nine different yoghurt types were prepared with the addition of standardized cow milk (fat 2.5%), cassava flour (3.25, 4 & 4.5% w/w), milk powder (2.8% w/w), sugar (9.7% w/w), gelatin (0.3, 0.35 & 0.4% w/w), egg yellow colouring (0.1% v/v), vanilla flavour (0.1% v/v) and yoghurt culture (2.6% v/v). Physico-chemical properties such as titratable acidity, pH and proximate composition were determined during storage at 4 °C. Furthermore, microbiological (yeast, moulds and *E. coli*) and sensory properties (appearance, taste, aroma, texture, mouth feel and overall acceptability) were also determined. Out of nine yoghurt types, the one with cow milk (83.03% w/w), milk powder (2.8% w/w), cassava (4% w/w), sugar (9.69% w/w) and gelatin (0.35% w/w) was selected as the best product because of its significantly ($P<0.05$) higher sensory properties according to the statistical method ofKruskal Wallis non-parametric one way ANOVA using STATISTIX Computer software (Version 2.0 for Windows). *E. coli* was not detected in the yoghurts tion andat the time of producduring storage, thus, showing hygienic production procedure. Shelf-life of the product was 15 days considering the changes in titratable acidity and microbiological and sensory properties. Moreover, the percentages of moisture, total solid, protein, fat, ash and crude fiber of the final product were 74.32, 25.68, 3.33, 2.82, 0.76 and 0.063% , respectively. The raw material cost of the final yoghurt was Rs. 8.55 and the cost reduction was approximately 16% compared to normal yoghurts. Addition of cassava flour appears to improve mouth feel, and reduce whey separation in the product. Therefore, it can be concluded that cassava flour can be successfully incorporated into yoghurts to produce value-added cassava flour incorporated set yoghurt with higher nutritional and sensory properties and reduced production cost.

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811/B

In vitro protein and dry matter digestibility of some varieties of *Pisum sativum* and *Glycine max* after germinating

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Though many studies have been carried out on germinated legumes, there is a lack of information on digestibility of cotyledons and radicles in *Pisum sativum* (peas) after germination. Radicles can be eaten fresh in the form of a salad. Digestibility of protein is a good indicator of the quality of protein. The main objective of this study was to investigate the *in vitro* digestibility of raw legumes and compare it with germinated cotyledon and radicles and to explore the possibility of using *Pisum sativum* as an alternative to *Glycine max* (soya bean) for both humans and as a feed for farm animals.

Four varieties of *Pisum sativum* (Terno, Xantos, Svit, Achat) and *Glycine max* seeds were germinated for 48 hours. Seeds, cotyledons and radicles of each legume were analysed separately for their chemical characteristic including crude proteins, dry matter, *in vitro* protein digestibility (IVPD) and *in vitro* dry matter digestibility (IVDDM). The *in vitro* digestibility of legumes was determined using pepsin (3 g/1.5l of 0.1M HCl in to one jar; pepsin EC 3.4.23.1. from porcine gastric mucosa, Merck, Darmstadt, Germany) and the Daisy^{II} Incubator. Data were evaluated by producing summary statistics and analyzing the variance using an ANOVA. The mean values were separated using the Duncan's multiple range test and cluster analysis.

Although the protein content was higher in the raw seeds of *Glycine max* when compared with all *Pisum sativum* varieties, the IVPD in the raw seeds of all *Pisum sativum* was not significantly different ($P \geq 0.05$) to the raw seeds of *Glycine max*. IVPD of cotyledons and radicles increased significantly ($P < 0.05$) after germination for 48 hours in comparison with the results of IVPD values of respective raw seeds of all the legumes investigated in this study. The IVPD values of radicles of all legumes studied ranged from 88.2 to 93.4 %, in cotyledons of legumes it ranged from 79.1 to 86.4 %.and in raw seeds it ranged from 62.6-75.0 %. Values for IVPD was higher when compared to the dry matter digestibility in all legumes tested. There was no significant difference ($P \geq 0.05$) in IVDP values of raw seeds, cotyledons and radicles of *Pisum sativum* when compared with *Glycine max*. Therefore, varieties of *P. sativum* tested can be given as alternative sources of protein after germination without any further processing to farm animals. The quality of proteins in all legumes improves significantly after germination for 48 hours in their cotyledons and radicles when compared to raw seeds of the respective legumes.

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812/B

Rooting of orthotropic, plagiotropic and single nodal cuttings of black pepper (*Piper nigrum* L.)

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Possibility of an alternate plant production system using plagiotropic and orthotropic cuttings from 8-year-old field grown plants of two high yielding local selections of pepper (GK-49 and MB-12) were compared with currently available systems for rooting of single nodal cuttings. Rooting of cuttings using three cutting types i.e., orthotropic terminal cuttings with 6-7 nodes, plagiotropic cuttings with 2-3 nodes and single nodal cuttings from Bamboo Rapid Multiplication System of two local selections (GK-49 and MB-12) were taken for the study. All cuttings were established in polythene bags filled with normal potting mixture (equal parts of top soil, sand, cowdung and coir dust) and kept in a polythene humid chamber for 4 weeks and then allowed to harden for 10 weeks. Thirty cuttings were used per treatment and replicated three times. After 14 weeks data were collected on cutting success, shoot and root growth parameters.

High cutting success was observed in the three cutting types (orthotropic 85.7%, plagiotropic 78.9%, single nodal 87.8%). Significantly higher shoot growth was observed in single nodal (17.5 cm) than orthotropic (3.9 cm) or plagiotropic (1.6 cm) cuttings whereas new shoot production was higher in orthotropic (2.1) than plagiotropic (1.3) or single nodal (1.0). A higher number of new leaves was observed in plants produced in single nodal cuttings (4 leaves) and orthotropic (2.9 leaves) than plagiotropic cuttings (1.1 leaves).

A higher number of roots were observed in plants produced from orthotropic (13.3) cuttings than single nodal cuttings (8.8) plagiotropic (4.6). Higher root volume was given in plants produced from orthotropic (4.4 ml) and single nodal (3.2 ml) than plagiotropic cuttings (1.7 ml). Similarly higher root length was given in plants produced from orthotropic (25.2 cm) and single nodal (22.3 cm) than plagiotropic cuttings (15.7 cm). Root dry weight was higher in orthotropic (0.18 g) and single nodal cuttings (0.2 g) than in plagiotropic cuttings (0.06 g). Differences were not significant between the two local selections used. However, field establishment, life span and yield performance of the three types of plants should be evaluated in a field trial before arriving at the final conclusion.

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813/B

Comparison of different training systems and effects of foliar fertilizer on growth and yield of vanilla (*Vanilla fragrans*).

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The major problem in vanilla cultivation is low yield due to the unavailability of flower clusters for pollination, even after adopting recommended cultural practices. Therefore this study was undertaken to compare the different training systems and effects of foliar fertilizer on the growth and yield of vanilla. The experiment was conducted at the Export Agriculture Research Station, Matale. Gliricidia shade trees were established at 8' x 5' spacing in early 2004 and vanilla cuttings were planted. Two different training systems were adopted i.e., single (individual) system and trellis system. A trellis was made by tying up two adjoining gliricidia branches. All management practices were adopted according to the recommendations. When the vines reached a height of 5-6 ft they were allowed to droop on individual trees as well as on the trellis. Shade was reduced by pruning of gliricidia branches to receive 70-80 % sunlight and vines were pruned by removing 4-5 nodes in January for induction of flowering. Two different foliar fertilizers (each at two levels) were applied to the vines i.e., Maxi-crop (0 g/l and 2 g/l) and foliar fertilizer with N:P:K 13:27:27 (0 g/l and 2 g/l). These two foliar applications were sprayed rotationally at two week intervals after six months of establishment of the vines.

Seven vines were used per plot and a total of 84 vines were used for the experiment. All treatments were replicated three times. The experimental design used was the Randomized Complete Block Design (RCBD). The number of flower clusters, number of flowers pollinated, number of pods developed and final yield with fresh weight and length of a pod were recorded. First flowering was observed in 2006 after 2 years of establishment. The number of flowering seasons varied from 1-3 per year i.e., one flowering season in 2006, 2009 and 2010, two flowering seasons in 2007, three flowering seasons in 2008. The highest flowering and yield within the period of 2006-2010 was obtained in 2009 with a single flowering season. The five year cumulative yield (fresh weight) from 2006–2010 were 2,672.4 kg/ha single vines system with fertilizer, 3,387.4 kg/ha single vine system without fertilizer, 3,300.0 kg/ha trellis system with fertilizer and 2,643.2 kg/ha trellis system without fertilizer. Significant differences were not found among the treatments. A distinct drought period of two months from February to March is required for flower initiation in vanilla. The increased concentration of peroxidase within the vine is believed to be the factor for induction of flowering in vanilla.

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814/B

Pest complex of ginger (*Zigiber officinale* L.) in Sri Lanka

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Ginger has been cultivated in Sri Lanka for a long time. Even though, several insect pests cause damage to the crop, only few species have been documented. The main objective of this study was to record the pest complex of ginger in Sri Lanka. The study was conducted at the Export Agriculture Research Station, Matale during the period March to November 2009. Ten experimental plots (3 m x1.2 m) from two different experimental sites were selected to observe pest occurrence. The spacing was 30cm x 30cm and the cultivar was Chinese ginger. Observations were carried out every two weeks and pest samples were collected when ever pests were available in the field. Those samples were reared in the laboratory and identified using reference samples and taxonomic keys. This experiment was also repeated in 2010. The pest species recorded were leaf eating caterpillars, *Udaspes folus* Godfrey (Lepidoptera: Limacoidae), *Leucoma salicis* L. (Lepidoptera: Limacoidae), *Spodoptera liturali,* (Hubnur) (Lepidoptera: Noctuidae), leaf eating beetles, *Lasioderma serricorne,* (Fabricius) (Coleoptera: Anobiidae), aphids, *Pentalonia nigronervosa* Cockerell (Hemiptera: Aphididae), locust sp. thrips, *Panchaetothrips indicus (Bagnall)* (Thysanoptera: Thripidae), shoot borer, *Dichocrocis punctiferalis* (Guen.) (Lepidoptera: Pyralidae), rhizome scale, *Aspidiella hartii* (Cockerell) (Hemiptera: Diaspididae) and ginger maggots *Eumerus figurans* Walker (Diptera: Syripidae).

None of the recorded pests caused economically important damage to the crop except the shoot borer and the rhizome scale. Shoot borer, *D. punctiferalis* is the most important pest in ginger and damage to shoots are caused by larvae feeding on the internal tissues of the pseudostems. Rhizome scales infest rhizomes in the field. The adult female scale is about 1mm in diameter and is circular in shape. It is light brown or grey in colour and appears as encrustations on the rhizome. Scales feed on sap and when the rhizomes are severely infested, they become shrivelled and desiccated affecting germination.

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815/B

Nutritional status of lactating dairy cows under small holder dairy farming system in the Polgahawela veterinary range

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The present study was conducted to investigate the nutritional status of lactating dairy cows under small holder dairy farming systems in the Polgahawela veterinary surgeon's range. A preliminary survey was conducted to collect data on small scale dairy farming, feeding practices and milk production of lactating dairy cows using a structured questionnaire. Data were collected from 30 dairy farmers having 68 dairy cows. Based on the results of the survey 30 lactating dairy cows were selected for further study and they were categorized into 3 groups based on the level of production (Low<2.5L, Medium 2.5-7.5L, High 7.5-14L). Amounts offered and refused were recorded for 3 consecutive days while milk yields were recorded for 2 consecutive days in all 30 cows. Body weights were determined using a weigh band. Representative samples of roughages and concentrates were analyzed for proximate composition. Pooled milk samples were analyzed for Milk Urea Nitrogen (MUN) using the spectrophotometer method and protein, lactose, salt, and fat were analyzed using the lactoscan tester. Specific gravity, total solid and SNF were calculated using lactometer readings.

Dry matter intake of High, Medium and Low milk producing animals was 14.34, 14.77 and 12.22 kg respectively. Digestible energy (DE) and crude protein (CP) content of supplied feed samples were not different ($p>0.05$) among high and medium production levels, but was significantly lower with the low production level. There was a significant difference ($p<0.01$) between required and supplied and farmer information based DE and CP amounts. There was no difference between supplied and farmer information based DE and CP amounts. However, required DE and CP levels were significantly lower than supplied amounts in all animals. It was observed that, the crude fiber was high while crude fat was low in offered roughage feed samples collected from the low production category. No difference was observed in CP %, CF % and fat % with respect to offered rice bran and dairy meal in high and medium levels of production. But low producing animals fed with dairy meal consisted of high fiber levels. MUN level was significantly lower in low milk production level (9.2 mg/ 100 ml) as compared with medium (10.67 mg/ 100 ml) and high (13.8 mg/ 100 ml) production levels. However milk protein, milk lactose and milk salt were different ($p<0.05$). High milk producing animals had high milk protein % (3.248) than the other two levels of milk production. There is no correlation between MUN and the total crude protein intake. Therefore, it can be concluded that the nutritional status of lactating dairy cows of all production levels are in good condition.

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816/B

Use of *Cyclea burmanni* (Kahipittan) leaves for the production of herbal yoghurt

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The aim of the study was to produce a value added herbal yoghurt incorporating *Cyclea burmanni* (Kahipittan) leaf juice which is already used as a medicine in Ayurvedic treatments. The recipe was developed to produce low fat yoghurt containing 1.5 % fat and preliminary trials were conducted to select the best level of sugar (8, 9 and 10 %), best level of gelatin strength (0.4,0.5 and 0.6 %) and the best level of leaf extraction (8, 9 and10 %). A sensory evaluation was performed in order to select the best level of sugar (8 %) and gelatin strength (0.5 %). Finally a sensory evaluation was conducted to select the best level of *Cyclea burmanni* leaf extract incorporation (8, 9 and 10 %) and 9 % was selected in wet basis as the best leaf extract incorporated level. Set yoghurt was developed after the preliminary trials. Vanilla flavour and apple green coloring were used in order to give the normal taste and color of yoghurt. Sensory best product contained of 8 % sugar, 9 % leaf juice, 1.47 % fat, 2.5 % culture and 0.5 % gelatin. Physiochemical properties of the final product were determined and it comprised 5.93 % crude protein, 11.43 % carbohydrates, 0.32 % crude fiber and 1.95 % ash. The average pH and acidity of the final product were 4.71 % and 0.92 % respectively. Microbiological analysis of the final product demonstrated the absence of *E. coli*, a yeast count <1000 per gram, and a mould count <1 per gram up to the 7th day of storage. The shelf life of the final product is 7 days. The keeping quality, proximate analysis and microbiological results show that the final product is safe for human consumption. Therefore *Cyclea burmanni* can be introduced to yoghurt in order to produce value added low fat yoghurt with high herbal and nutritional properties. Further studies will need to improve microbial quality of yoghurt in order to obtain longer storage time.

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817/B

Effect of four different soil media on okra (*Abelmoschus esculentus* (L.) Moench) cultivation in Ampara

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The climatic conditions in the Ampara district are suitable for the cultivation of okra but the soil factors adversely affect plant growth. Therefore an experiment was conducted with four soil media to find a suitable soil mixture for okra cultivation. The location of the experiment was the Hardy Advanced Technological Institute, Ampara. The mean annual rainfall of the area is 1250mm - 1500mm and temperature is 25 - 27 ^{0}C.The soil type of the area is low humic gley. The four soil media tested were top soil (T1), compost +top soil + sand (1:1:1) (T2), cattle manure + top soil + sand (1:1:1) (T3) and poultry manure + top soil + sand (1:1:1) (T4). Humic top soil, well decomposed cattle manure and poultry manure were used to prepare mixtures. The experimental design was RCBD with three replicates. Twenty plants were maintained in one plot with the spacing of 90 cm x 60 cm. The size of the hole was 30 cm x 30 cm x 30 cm to facilitate the growth of the root system. Two seeds were planted in each hole and all the cultural practices and fertilizer applications were practiced according to the recommendations of the Department of Agriculture. The number of leaves, leaf length and width, height of plants, weight of pods and length of pods were counted. The leaf length, leaf width and plant height were measured at four day intervals from 45 days after planting. The pod weight was measured at 03 day intervals from 45 to 60 days after planting. The data were subject to ANOVA and the means were compared in DNMRT.

The treatment effect was significant at $\alpha = 0.05$. T3 had the highest mean values for all the measured parameters. The difference of T3 is significant in all measured parameters when compared with the other treatments. The treatment T3 (cattle manure + top soil + sand, 1:1:1) provides significantly higher yield compared with the other treatments when it is used as a medium for okra cultivation.

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818/B

Effect of picking time and storage conditions on the germination and seedling growth of chilli (*Capsicum annuum*)

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Crop production depends on usage of quality seeds for planting. In agricultural production, seeds are required to be stored for a period of time. Environmental factors during storage influence seed deterioration and it leads to loss of viability and vigour of seeds. The present study was aimed at investigating the effect of picking time and storage conditions on germination and seedling growth of chilli. The experiment was conducted in a complete randomized design with three replications. The chilli pods were picked once in 7 days and stored for 6 months. The first factor was picking time and the second factor was storage conditions viz; ambient and cold storage condition. The chilli variety PC 1 was used in this study. The present study revealed that there was no interaction between storage conditions and picking time of chilli pods on germination and growth of seedling. Germination percentage was significantly different ($P<0.05$) between seeds stored in cold and at ambient temperatures. At the 12th day after sowing, the mean % germination and seedling height were 82.66 % and 3.93 cm respectively, in cold storage, while in ambient temperatures the values were 73.33 % and 3.66 cm. Among the picking periods, there was a significant difference ($P <0.01$) in % germination with seeds obtained from 2nd picking having 84 % and those of the 3rd picking having 79.5 %. The seeds from the 2nd picking produced taller seedlings (4.1 cm) followed by the 3rd picking (3.95 cm). The fresh weight of seedlings was significantly ($P<0.05$) different among the pickings and no significant difference was observed between seeds from 2nd (1.15g) and 3rd (1.03g) pickings. However, there was no remarkable variation between seedlings raised from different storage periods. The dry weight of seedling was not significantly different in seeds stored in different storages. The seeds obtained from the 2nd picking and stored in cold conditions would be suitable for successful chilli crop production in the eastern region.

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819/B

A study of the effect of different shade levels on the growth and development of threadstem carpet weed (*Mollugo cerviana*)

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Light regulates plant growth and the development and weed/crop interactions. Effect of different shade levels on the growth and development of the threadstem carpet weed (*Mollugo cerviana*) was studied to identify the level of shade tolerance of this weed. This study was conducted at the crop farm of the Faculty of Agriculture, Eastern University, Sri Lanka during February to April 2011. The soil was sandy regosol and the average temperature was around 31 ± 2 °C during the experimental period. The experiment was arranged in a completely randomized design. The treatments were as follows: Treatment-1 (T_1) open field (0% light reduction), T_2 - 50% shade level, T_3 – 70% shade level and T_4 – 80% shade level. The threadstem carpet weed was established via seeds and grown on soil under four different shade levels. Measurements viz. plant height and biomass were taken three months after planting. The data were analyzed statistically using analysis of variance (ANOVA). Mean separation was done by Duncan's Multiple Range Test (DMRT).

Significant differences ($p<0.05$) were observed between the treatments tested. Plant height and biomass decreased with increasing shade levels. The Threadstem carpet weed has a C_3 - C_4 intermediate photosynthetic machinery. It requires a high intensity of solar radiation for maximum photosynthesis. Reduction in light levels decreases the rate of photosynthesis and dry matter accumulation. Hence, increasing shade levels suppresses the growth and development of the threadstem carpet weed. From this study it could be concluded that the level of shade tolerance of threadstem carpet weed is low. Hence, interference of this weed in agricultural fields can be minimized by reducing the amount of solar radiation which reaches the soil. This is possible through crop management practices such as close spacing, use of varieties with a large leaf area and early establishment and intercropping. Further, these practices could save money, time and the environment.

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820/B

Plant performance of groundnut (*Arachis hypogaea* L) seeds harvested from plants grown in different levels of cattle manure

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A field trial was carried out in the Eastern region of Sri Lanka in 2010 - 2011 to study the plant performance of groundnut (*Arachis hypogaea* L) seeds harvested from the organic cultivation with different levels of cattle manure viz. 0, 5, 10, 15 and 20 tons/ha and also from inorganic cultivation followed by the Department of Agriculture. This experiment was laid out in a randomized complete block design with three replications. All other agronomic practices were according to the recommendations of the Department of Agriculture, except for fertilizer application which was not applied to all experimental plots. The results showed that differences in treatments significantly influenced performance of groundnut plants such as the leaf area, number of nodules and dry weight of roots and pods. Among the treatments, plants developed from groundnut seeds collected from 15 tons/ha cattle manure exhibited the highest numbers of leaves, nodules and mature pods and also leaf area. Dry weight of pods recorded at different growing periods (6 -14 weeks after planting) was not statistically different among the treatments except in unfertilized treatment. However, the progeny of groundnut plants from 15 tons/ha cattle manure ranked first in dry weights of root, leaf, stem, nodules and pods. The demand for organically grown products is increasing in the global market. In the present study, the results showed that progeny from organic origin performed better than those with inorganic origins. Cattle manure is locally available in the eastern region and could be used by farmers for better crop production in sandy regosol.

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821/D

Analysis of antigenic salivary gland proteins of the *Armigeres subalbatus* mosquito and detection of antibodies against them in the rabbit and human

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Mosquito-borne infectious diseases are life-threatening to humans and animals. Mosquitoes play a major role in the transmission of many deadly diseases such as malaria, dengue hemorrhagic fever, Japanese encephalitis, yellow fever and filariasis. *Armigeres subalbatus* mosquitoes used in this experiment are the most common mosquito species throughout the country and a major vector of canine dirofilariasis caused by *Dirofilaria repens*. The objectives of this study were the isolation of the salivary gland proteins and characterization by SDS-PAGE and Western blotting using experimentally exposed rabbit serum and naturally exposed human serum samples collected from different localities according to the mosquito density in order to identify the specific protein fractions of *Ar. subalbatus* and to study the presence of antibodies against salivary proteins. The collection, identification and maintenance of *Ar.subalbatus* mosquito colonies in experimental cages were performed. Antibodies were raised in the rabbit against salivary proteins by experimental exposure to mosquitoes. Dissection of salivary glands of mosquitoes and extraction of proteins were carried out and protein fractions were identified using SDS-PAGE. Further antigenic protein fractions were identified by Western blotting using experimentally exposed rabbit serum. SDS-PAGE analysis of salivary gland proteins of female *Ar. subalbatus* mosquitoes revealed the presence of minimum of 10 major protein bands with the molecular masses of 241, 79, 56, 35, 22, 19, 17, 15, 10, 8, kDa. Further, Western blotting with rabbit serum showed antibodies against 79, 56, 35, 22 kDa salivary protein fractions suggesting that antibody development occurs during mosquito bites in experimentally exposed rabbits. Similary, antibody level of human serum samples received from mosquito high density areas showed high antibody levels compared with the other. Therefore it is suggested that mosquito salivary gland antibody levels can be used to monitor mosquito density as well as to assess the risk factors for vector borne infectious diseases.

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822/D

Molecular identification of an efficient phosphate solubilizing fungus

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Plants take up phosphorus (P) as phosphate anions. Although P is abundant in soil, the majority remains as insoluble forms. This is because P anions are extremely reactive with some cations in soil in alkaline and acidic pH. In the environment, these immobilized P is converted to mobilized forms by soil microorganisms. Soil fungi play an important role in converting highly insoluble mineral phosphates in the environment into plant accessible forms. Utilization of such organisms in agriculture has a considerable economic importance in developing countries as an alternative, low cost, eco-friendly natural phosphate bio-fertilizer. In previous studies, 11 phosphate solubilizing fungi (PSF) have been isolated from bulk and rhizosphere soils from different agro-ecological zones in Sri Lanka and KBF4 fungus has been identified as the most efficient phosphate solubilizer among them.

The present study focused on identifying KBF4 fungal isolate. According to the morphological and reproductive characteristics obtained in slide cultures, isolate KBF4 was identified as an *Aspergillus* species. Further identification was carried out using molecular techniques.

For DNA extraction, the Promega Wizard ® DNA extraction kit was employed. PCR was carried out for the extracted KBF4 fungal DNA using ITS1 and ITS4 primers which are forward and reverse primers, respectively. Amplified products gave DNA bands of approximately 500 bp. These gel bands were excised, purified and directed for sequencing. The sequence results were analyzed using BLASTn program. The results indicated that KBF4 fungus showed 97 % similarity to *Aspergillus aculeatus*. This identification would help in future research work, aimed at mass production and commercialization of an efficient phosphate soubilizer.

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823/D

Identification of suitable landfill sites for solid waste disposal in the Matara District using Geographical Information Systems and the Analytic Hierarchy Process

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Improperly placed solid waste dumping sites have created numerous environmental and social problems in the society. Such impacts could be minimized by implementing proper landfills in suitable locations. Even though Matara is a highly populated district, it lacks properly planned landfills. The objective of this study was to select suitable sites for solid waste landfills in the Matara District using the Geographic Information System and the Analytical Hierarchy Process. Existing national and international landfill site selection regulations and guidelines were reviewed to prepare eleven landfill site criteria namely; surface water body, forest reserve, wetland, coastal zone, rainfall, town centre, residential area, important building, major road and railway, slope and soil. These criteria were divided into two parts, constraint criteria and factor criteria. Constraint criteria divide the district into suitable and unsuitable areas for landfill site placement. Factor criteria classify the suitable areas for landfill placement into high, medium and low suitable areas. Each constraint criterion was mapped using GIS. All eleven constraint criteria maps were overlaid to prepare the final constraint map. From the total area of Matara district, 1100.16 km^2 (85.7%) is unsuitable for landfill placement. The remaining 182.34 km^2 (14.2 %) land area of the district was further evaluated using factor criteria and was classified into three groups of high, medium and low suitability. When determining the relative importance of each factor criterion Analytic Hierarchy Process was utilized. The resulting final factor map revealed that 112.4 km^2 (8.8%) of land in the Matara District is highly suitable for placing landfills. Field investigations within the Matara Divisional Secretary Division were carried out to validate the data obtained from the final factor map. It was found out that one site at Thalpawila, one site at Parawahera and two sites at Kekanadura were suitable for landfills in Matara Divisional Secretary Division. The final decision for landfill site selection will require more detailed field studies.

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824/D

Effect of heat treatment and microwave treatment on β-Carotene content and their *In vitro* bioaccessibility in Betti amba variety (*Mangifera indica* L.)

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Vitamin A deficiency is one of the major health problems prevailing in Sri Lanka, irrespective of the fact that many common fruits are good sources of provitamin A. Mango (*Mangifera indica* L.) is one such fruit, which suffers a large scale loss due to lack of post harvest technology practices and the lack of processing and preservation techniques. Processing methods may, however, alter the nutritional composition including the provitamin A content. The objective of the present study was to determine the effect of heat treatment and microwave treatment on the content of β-carotene and *in-vitro* bioaccessibility in the mango variety Betti amba as it has the highest amount of provitamin A carotenoids and β-carotene as predominant provitamin A carotenoid, among local mango varieties.

The effects of different heat treatment [80 ℃, 50 ℃, freezing (-10 ℃) and refrigeration (5 ℃)] for 20 minutes and microwave treatment (for 2 minutes) were determined in Betti amba at the fully ripened stage. Carotenoids were extracted and identified with open column chromatography (OCC), followed by ultra violet visible absorption spectra (λ_{max} and spectral fine structure). Identification and quantification was also carried out using Reversed phase High Performance Liquid Chromatography with photo diode array detection (C_{18} column Spherisorb ODS2; gradient elution of mobile phase of Methanol, Acetonitrile and 0.05% Triethylamine in Ethylacetate). *In-vitro* bioaccessiblity was also assessed analyzed using Gastro Intestinal Tract simulation method.

The study revealed that microwave treatment (2.49 ± 0.93 μg g^{-1}) and heat treatment at 80 ℃ (2.24 ± 0.50 μg g^{-1}) were significantly ($p<0.05$) more effective methods of increasing the bioavailability of β-carotene content among other treatments. It was followed by freezing (0.94 ± 0.24 μg g^{-1}) and heat treatment at 50 ℃ (0.84 ± 0.10 μg g^{-1}). Refrigeration (0.41 ± 0.084 μg g^{-1}) found to be significantly least effective. In *in-vitro* bioaccessibility, β-carotene content was significantly higher in microwave treatment (2.76 ± 0.80 μg g^{-1}) and freezing (2.37 ± 0.96 μg g^{-1}). Heat treatment at 80 ℃ (0.141 ± 0.045 μg g^{-1}) and heat treatment at 50 ℃ (0.11 ± 0.00 μg g^{-1}) were found to be significantly lower values. The samples of Betti amba subject to different treatment, showed a considerable variation in β-carotene content revealing that the type of treatment affects the β-carotene content.

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825/D

Acclimative responses of shoots in some lowland rice (*Oryza sativa* L.) varieties to complete submergence

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Flooding is a serious naturally occurring disaster for rice in many regions of the world. Tolerance to submergence stress is an important breeding objective in areas where rice cultivars are subject to complete inundation for a week or more. Submergence tolerance is controlled by a single major quantitative trait locus (QTL) named submergence-1 (*Sub1*) locus, on chromosome 9. The present study was conducted to determine acclimative shoot responses to complete submergence, in *Sub1* containing mega varieties, and few local varieties, under greenhouse conditions. Completely randomized design was followed as the experimental design. Fourteen days old seedlings of Swarna-*Sub1*, IR64-*Sub1*, IRRI 119, and Samba Mashuri-*Sub1* which are submergence tolerant enhanced mega varieties, a known tolerant traditional local variety (Goda Heenati) and intolerant local varieties (Bg 360, Bg 94-1 and Bw 363) with 15 replicates were submerged for 14 days in 60 cm deep tank. De-submerged plants were then allowed to recover for 14 days. Complete length of the longest leaf was recorded and survivability, in terms of development of new leaves was scored during submergence and de-submergence. During submergence the longest leaf length increased at a rate of 0.7-1.0 cm day^{-1} in intolerant varieties and leaves became chlorotic whereas in submergence tolerant varieties and Goda Heenati showed an elongation rate of 0.02 - 0.09 cm day^{-1} with green leaves. Thus, susceptible genotypes displayed significantly greater elongation of leaves than Swarna-*Sub1*, IR64-*Sub1*, IRRI 119, Samba Mashuri-*Sub1 and* Goda Heenati during submergence. There were no significant differences ($p>0.05$) of the leaf length of the tolerant varieties between submergence and normal conditions whereas susceptible plants indicated a significant difference. During 14 day de-submergence (recovery) period all submergence susceptible genotypes had turned brown and died while all submergence tolerant varieties including Goda Heenati showed 100 % survivability with new shoot development & elongation of existing shoots. According to the results obtained, submergence tolerant and intolerant varieties can be clearly distinguished by using shoot related responses following submergence and de-submergence.

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826/D

Antioxidant activity of aqueous and solvent leaf extracts of *Ixora coccinea* and *Vitex negundo*

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Neutrophils, the first cell type to be activated during an inflammatory response, migrate to sites of injury and release reactive oxygen species (ROS) which kill pathogens. Excessive neutrophil activation leads to inflammatory disorders. *Ixora coccinea* and *Vitex negundo* are two medicinal plants that have been scientifically proven to have anti-inflammatory effects *in vivo*. The objective of this study was to assess and quantify the antioxidant effects of aqueous and solvent leaf extracts of *I. coccinea* and *V. negundo* to determine their capacity to scavenge free radicals and to determine their inhibitory activity on ROS production by human neutrophils using 2,2-Diphenyl-1-picrylhydrazyl and quantitative nitro blue tetrazolium assays respectively. Different leaf extracts were used to identify which fractions contained the anti-inflammatory active components – aqueous (ALE), methanol (MLE), ethyl acetate (ELE), chloroform (CLE) and hexane (HLE).

In antioxidant activity investigations, the order of potency of the *I. coccinea* extracts based on EC_{50} values (µg/ml) were as follows: ALE (7) > MLE (65) > CLE (127) > ELE (252) > HLE (329). The antioxidant activity of *V. negundo* was as follows: MLE (66) > ALE (127) > ELE (247). No significant activity was noted for CLE and ELE of *V. negundo*. Vitamin C used as the positive control showed antioxidant activity of 6 µg/ml. For *I. coccinea* inhibition of ROS production at 500 µg/ml, the order of potency of the extracts was as follows: MLE (56%) > ALE (51%) > CLE (48%) > ELE (46%) > HLE (32%). In the case of *V. negundo* extracts, inhibition of ROS production was as follows: ALE (55%) > MLE (52%) > CLE (44%) > ELE (41%) > HLE (22%). Diphenyleneiodonium chloride used as the positive control showed a higher inhibition of ROS production (70%). For all extracts for both plants, the activity was found to be dose-dependent in both assays ($r = 0.737 – 0.970$; $p < 0.001$). In conclusion, the results from this study suggest that antioxidant activity and inhibition of ROS production contribute significantly to the underlying anti-inflammatory mechanisms of *I. coccinea* and *V. negundo*, and that the polar extracts (ALE and MLE) had more activity than the non polar extracts (ELE, CLE and HLE).

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827/D

Effective biocide options for eliminating *Ceratocystis* spp associated with coir products

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This study describes the determination of suitable methods for eliminating the fungus *Ceratocystis* associated with coir products. *Ceratocystis* spp is a pathogen causing diseases in several plants including coconut. The occurrence of this organism in coconut cultivations in Sri Lanka has been reported since 1906. Sri Lanka has extensive coconut cultivation and many coir products are exported. It is a quarantine requirement that the coir products are free from this organism. Currently, methyl bromide is used as a fumigant to eliminate the organism, but the use of this chemical is restricted due to its high toxicity and because it affects the ozone layer.

In this study the organism was isolated from the coir dust samples collected from the areas of Lunuwila and Kurunegala. The morphological characters of spores were similar in the isolates obtained from these two different locations. However, the color of the chlamydospores was darker in the isolates obtained from Kurunegala than in the samples collected from Lunuwila. The effectiveness of the fumigant formaldehyde (37% formaldehyde 120 ml with 60 g potassium permanganate for 2.83 m^3 or 100 ft^3 air space) was tested in fumigation chambers parallel with methyl bromide (48 g/m^3) on a Potato Dextrose Agar culture and in inoculated coir dust. The formaldehyde was effective for inoculated coir dust but not for the fungus grown on culture plates, while methyl bromide was effective for both. As an alternative method, water vapor heat treatment was applied at different time temperature combinations on coir dust inoculated with fungal spores. At 55 °C for 5 min., the vapor heat treatment destroyed the viable spores in it. For the elimination of *Ceratocystis* associated with coir dust, formaldehyde can be used in place of the currently used methyl bromide. Formaldehyde is less effective when the organism is grown on culture media due to the different conditions prevalent in culture media and coir dust. Besides the chemical formaldehyde, heat treatment can be applied for eliminating the organism. A temperature of 55 °C generated from water vapor for 5 minutes is sufficient for eliminating the fungal spores.

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828/D

Evaluation and assessment of the distribution and utilization of groundwater in the Siyabalakote Village, Hambantota District in Sri Lanka

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In some parts of the world, groundwater is the only source of potable water available for human consumption. Even in Sri Lanka, people in the dry zone predominantly depend on groundwater, during the dry periods of the year. The low water table, mainly due to the poor rainfall reception in many parts of the country, especially in the dry zone, enhances the eminent necessity of proper groundwater analyses. Hence this research study focuses on the evaluation of the spatial distribution and assessment of the utilization patterns of the existing groundwater resources, in the dry zone of Sri Lanka for continuous supply of drinking water to the locals. Siyabalakote, a remote village in Barawakuguka GN Division, which falls under the Ambalantota DS Division in the Hambantota District, was selected for the current hydro-geological investigation. The groundwater of the area originates from both weathered formations, as well as from top soil deposits. The study area lies in the Low Country Dry Zone (DL5) where the terrain is generally flat, but has an undulating relief pattern. The elevation varies from 30 to 150 m and significant morphological features cannot be identified in the study area.

The samples were randomly drawn from 40 selected dug wells and the irrigation canal of the village. A Geo-Plotting exercise was carried out in order to map the spatial variation of the electrical conductivity (EC) and pH values of the groundwater, using a hand-held GPS (Global Positioning System) machine. Socio-economic causes which enhance the utilization of groundwater were also recognized by interviewing well-owners and through field observations.

The study revealed that dug wells which are constructed in the study area in the alluvium sandy to clay sandy unconfined aquifers are permeable. Maps have been generated using the GIS software to evaluate the spatial distribution of groundwater, in accordance with the identification of the spatial variation in EC and pH values. The EC and pH of the groundwater resources were identified as being static and below WHO and Sri Lankan standards for drinking water. As such it is a reliable source that could be used to meet the demands of the local population.

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829/E1

Review of the citations of the research paper "A variant of Newton's method with accelerated third-order convergence"

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An unprecedented number of research papers cited the article: "A variant of Newton's Method with Accelerated Third-Order Convergence" published by S Weerakoon and T G I Fernando in the Elsevier journal "Applied Mathematics Letters" in 2000. At the moment it records over 240 citations. The curiosity to know what triggered seemingly overwhelming interest encouraged this review.

Weerakoon-Fernando Method (WFM), as some citations called it, introduced in the above paper suggested an improvement to the Newton's iterative method. The iterative scheme of WFM can be described as follows:

$$x_{n+1} = x_n - \frac{2f(x_n)}{[f'(x_n) + f'(x^*_{n+1})]}\ ,\ n = 0\ ,\ 1\ ,\ 2\ ,\ \ldots\ldots \text{ where } x^*_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$$

A rigorous proof of the third order convergence of WFM which was supported by computational results by applying the method to a representative cross section of the nonlinear equations was given in the above paper.
This review identifies

(i) what is being cited
(ii) whether there are direct applications of the algorithm given in the WFM
(iii) the improvements proposed to the WFM and
(iv) the similarities and the differences

in the citations of aforementioned, by examining about 50% of them obtained by internet searching and emailing authors directly.

Subsequently, we categorized the articles and compared a selected few using the mathematical program we developed. This review validates the assertion by some of the cited authors that WFM is perfect because of its simplicity and the high order of convergence.

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830/E1

Plane symmetry groups and their applications

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Group theory, which is considered to be one of abstract concepts of Mathematics, has many applications in various fields, especially in Art and Architecture where the theory of plane symmetry groups plays a major role. This paper discusses plane symmetry groups, also known as planar crystallographic groups or wallpaper groups. The seventeen unique plane symmetry groups describe the symmetries found in two-dimensional patterns such as those found on weaving patterns, the work of the artist M.C. Escher, and in wallpapers. We discuss the fundamental components and properties of plane symmetry groups and how group theoretical concepts are used to create new wallpaper patterns.

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831/E1

Invertibility of Modified Buffon Transformation matrices

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The Buffon transformation deals with polygons. It generates an infinite polygon sequence by connecting the midpoints of edges of each subsequent polygon. Hence it generates polygonal designs by repeating this transformation. Buffon transformation on an n-gon can be represented by a $n*n$ matrix and when we consider the modified Buffon transformation obtained by choosing a point which divides each edge of the polygon into $a : 1-a ; a < 1$, we get the following matrix as the corresponding transformation matrix T_n^a.

$$T_n{}^a = \begin{bmatrix} 1 & a & a & 0 & 0 & \cdots & 0 & 0 \\ 0 & 1-a & a & 0 & & \cdots & 0 & 0 \\ 0 & 0 & 1-a & a & 0 & & 0 & 0 \\ \vdots & \vdots & & & & & \vdots & \vdots \\ & & & & & & 0 \; 1-a & a \\ a & 0 & 0 & 0 & & \cdots 0 & 0 & 1-a \end{bmatrix}_{n*n}$$

Here we prove by induction that T_n^a is invertible in all other cases except when the order of T_n^a is even and $a = 1/2$. Subsequently we prove that the set of modified Buffon transformation matrices form a group when n is odd.

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832/E1

Ranking candidates at G.C.E A/L examinations

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The Z-score method is being used as a tool for ranking students at G.C.E. (A/L) examinations. The Z-score method is a better ranking method for comparison than the previous aggregated marks method. The Z-score is calculated using the formula

$$Z = \frac{(raw\ marks - mean\ marks)}{Standard\ Deviation\ of\ the\ marks}$$

Z-score method works well under the Normality assumption. Even though the Z-score method has been in use for several years, detailed research is needed on the appropriateness of the Z-score method. In our initial investigations, we identified two-drawbacks of the Z-score method. For skewed non-Normal distributions, the parameters mean and Standard Deviation (SD) are sensitive to extreme values. In most of the real world cases, the marks would not follow the Normal distribution and hence the distribution of the marks would be skewed or bimodal. For non-Normal data the SD would be unnecessarily large which affects the ranking system. We propose a Median Centered Score (MCS) method which is robust for non-Normal distributions. Since median and Inter Quartile Deviation (IQD) are less sensitive to extreme values we replace the mean and SD by median and IQD respectively for the calculation of the MCS. Thus,

$$MSC = \frac{(raw\ marks - median\ marks)}{IQD\ of\ the\ marks}$$

Using simulated data we show that our proposed MCS works better than the existing Z-score method. The other drawback of the existing Z-score method is that it is not easy for a non-mathematics person to understand the idea, as the range of the average Z-score is between -3 to +3 while the range of the raw mark is between 0 and 100. In order that the final values of student ranks are easily understood by persons particularly from a non-mathematical background, we propose the following user friendly equation,

$$MCS(UFMCS) = \frac{MCS}{MAMCS - MIMCS} \times 100$$

where MAMCS and MIMCS are respectively the maximum and minimum value of the MCS for a particular subject and MIMCS <0, MAMCS>0.

Thus, the average Z-score values which were in the range of -3 to +3 have been transformed to the range of 0 to 100.

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833/E2

Efficacy and dose response of glucose tolerance of *Gmelina arborea* in alloxan induced diabetic rats

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An aqueous extract of *Gmelina arborea* (Sinh. Et-Demata) is documented in Aurvedic Medicine for its hypoglycaemic activity. The present study was conducted to investigate the efficacy and dose response on glucose tolerance of the aqueous extract of *G. arborea* in healthy and alloxan induced diabetic rats.

The effect of different doses of the bark extract of *G. arborea* on oral glucose tolerance test (OGTT) was evaluated. A single dose of the aqueous extract at 0.25 g kg^{-1} - 1.25 g kg^{-1} doses including the therapeutic dose (1g kg^{-1}) was administered orally to normoglycaemic (healthy) and to alloxan induced (150 mg kg^{-1} body wt, ip) diabetic rats before 30 min of glucose administration. Glibenclamide was used as the standard drug at a dose of 0.5 mg kg^{-1}. The acute effect was evaluated over a four hour period. The efficacy of hypoglycemic activity was evaluated using the area under OGTT curve. The results of test groups and glibenclamide treated rats were compared with the respective control group. The results indicate that the hypoglycaemic effect was dose dependent. No statistically significant change was shown with the control and test groups at doses of 0.25 g $kg^{-1}$and 0.5 g kg^{-1}. The area under the curve significantly decreased ($p<0.05$) at a dose of 0.5 g kg^{-1} in diabetic rats but not in healthy rats. At the therapeutic dose, the aqueous extract improves the glucose tolerance by 26 % ($p<0.05$) and 30 % ($p<0.05$) in normal and diabetic test groups respectively. Healthy and diabetic rats show higher ($p<0.05$) glucose tolerance with the plant extract at a dose of 1.25 g kg^{-1}. The experimental results revealed that the aqueous extract of *G. arborea* possesses a statistically significant hypoglycaemic activity and the therapeutic dose was found to be the most effective dose on glucose tolerance in alloxan induced diabetic rats.

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834/E2

Amino acid and peptide profile in Sri Lankan samples of milk, whey, digested milk and curd using paper chromatography

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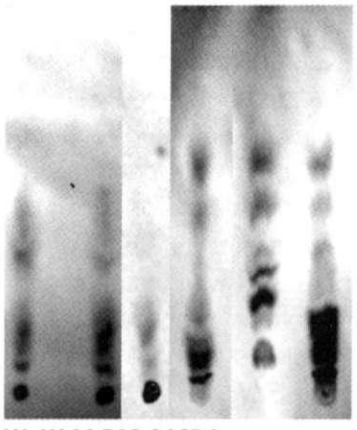
The type and concentration of amino acids and peptides liberated during fermentation of milk varies depending on the bacterial strain and the type of milk. These have many biological activities such as anti-hypertensive and anti-oxidant activities. This study was carried out to compare the differences in amino acids and peptides of milk, whey, digested milk and curd of Sri Lankan samples.

Two different brand curd samples were centrifuged and whey fractions (W_1&W_2) were obtained. 2 g of milk and curd samples from Brand 1 were digested with pepsin (pH=1.5) followed by pancreatin (pH=7.8). On chromatography paper milk (M_1), W_1 & W_2, digested milk (DM_1) and curd (DC_1) were spotted and separated using n-butanol:ethanol:ammonia (7:3:4) solvent system. Spots were visualized after treating with ninhydrin.

Samples were matched with the nine spots obtained for the standard amino acid. Sample W_1, W_2, DM_1 and DC_1 showed eight spots with varying intensity where the upper six spots matched with the standard amino acids and an additional two spots were observed below the standard amino acid indicating smaller peptides (Fig.1). All samples had intense yellowish purple spots indicating smaller peptides with proline. W_2 gave a more intense yellowish purple spot compared to W_1. Three spots, most likely to be smaller peptides, were seen in M_1. Broader spots were observed in DM_1 and DC_1 compared to whey. Most intense and broadest spots were observed in DC_1. All samples showed purple at the spotting position indicating larger peptides and proteins. This indicates that even though both whey fractions consist of similar amino acids, the quantity of the active peptides might differ in concentration. The digested samples had a high amount of amino acids and small peptides compared to the fresh milk and whey fractions, but the peptides and amino acid concentration in digested curd was very high compared to the digested milk indicating that fermentation leads to a different amino acid and peptide profile.



W_1 $W_2$$M_1$$DM_1AASDC_1$

Fig. 1: Paper chromatogram ofW_1, W_2, M_1, DM_1 and DC_1 in comparison with the amino acid standard (AAS).

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835/E2

Effect of ethylene diamine tetra-acetic acid (EDTA) and citric acid on the uptake of nickel from serpentine soil by *Fimbristyllis ovata*

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Serpentine soils are derived from the weathering of serpentinite and ultramafic rocks that are rich in metals such as iron, nickel and chromium. Plants growing on serpentine soils tolerate heavy metals in their tissues and are potential species for phytoremediation. Bioavailability of metals in the soil and the translocation of metals from root to shoot are important requirements for metal phytoextraction. Synthetic chelates enhance the accumulation and translocation of heavy metals in plants.

We determined the effect of EDTA and citric acid on the uptake of Ni by *Fimbristyllis ovata* growing on the Ussangoda serpentine soil, and its translocation from roots to shoots. Morphologically similar *F. ovata* plants were grown on sieved (2.0 mm sieve) serpentine soil in pots of pH = 5.6, treated with different concentrations of the disodium salt of EDTA and citric acid (2 mmol/kg, 5 mmol/kg, 7 mmol/kg) in the root zone. Each pot was treated with the same volume of deionized water every day. Each pot contained one plant and each treatment was replicated five times. After the treatment period, plants were harvested and thoroughly washed in running water, followed by 10 mM disodium salt of EDTA solution and deionized water. Shoots and roots of each plant were digested separately and analysed by atomic absorption spectrophotometer, using air-acetylene flame at the wavelength of 232.0 nm, with the background correction to determine the Ni content. The total amount of Ni in the serpentine soil was 1800.0 µg/g of which 0.008% was available. The accumulation of nickel in shoots increased with increasing concentration of EDTA. In the presence of EDTA in the soil, the percentage of absorbed Ni translocated from root to shoot was 55 % whereas that of the control plants (without chelate) was 30 %. Nickel uptake was not affected by the citric acid treatment. However, the presence of other ions in the soil can also affect Ni uptake, but this was not included in this study. EDTA enhanced the uptake and translocation of nickel from roots to shoots in *F. ovata*.

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836/E2

Study of chemical composition of atmospheric bulk deposition in an industrialized area in the Western Province

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The chemical composition of the atmospheric bulk deposition was studied at three monitoring stations in the Western province. Dalugama, Thambiligasmulla and Sedawatta were chosen as the monitoring stations which are considered to be highly polluted areas in Sri Lanka, influenced by heavy road traffic on the A1 road, the Sapugaskanda oil refinery and the Kelanithissa power plant. The samples were collected weekly from February to June 2010. Conductivity, pH, and concentrations of NH_4^+, NO_3^-, SO_4^{2-}, Na, Mg, Ca and Pb were determined for each bulk sample. The concentrations of NH_4^+, NO_3^- and SO_4^{2-} were determined colorimetrically, while the concentrations of metals Na, Mg, Ca and Pb were determined using Atomic Absorption Spectroscopy (AAS). Meteorological data, i.e., wind direction, rain fall, air temperature and atmospheric pressure were also collected during the study period in order to determine any influence on bulk deposition. Pearson's correlations were determined using the statistical package (SPSS 16.0 for windows).

The study indicated that the acidity of rain water varied from low pH (5.41) to high pH (9.56). One incident of an acid rain condition has been reported at each sampling site during the study period indicating a rare occurrence of pH of the bulk sample below 5.60. As expected, both sulphate and nitrate concentrations were negatively correlated with pH at each site. Both calcium and magnesium concentrations showed positive correlations with pH at each site. Strong positive correlations were observed between ammonium, nitrate, sulphate, magnesium, calcium and sodium concentrations with concentration of lead, at each site. Although the nitrate and sulphate concentrations show high values in rain water, the pH was balanced by the buffering action of ammonium, calcium and magnesium. This buffering action was frequently seen in all sampling sites throughout the study period.

Both the rainfall and the wind direction influenced the dispersing and scavenging of air pollutants. Vehicular emissions, the influence of Kelanithissa power plant and the Sapugaskanda oil refinery could have been the major sources for the reported composition. But, for precise identification of the source and to design an atmospheric model, continuous investigation for a prolonged period is essential.

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837/E2

Use of moss (*Barbula* sp.) as a bioindicator to monitor atmospheric deposition of polycyclic aromatic hydrocarbons (PAHs): identification and quantification

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The atmospheric deposition of PAHs was investigated qualitatively and quantitatively by analyzing moss (*Barbula* sp.) used as a bioindicator in this study. *Barbula* sp. has only been identified to the generic level. In June 2010, moss samples were collected from five different sampling sites (i.e. Fort, Sedawatta, Dalugama, Sapugaskanda, and Biyagama) in the Western Province. The background level was monitored using moss (*Barbula* sp.) collected from Kosmulla, a village bordering the Sinharaja forest where anthropogenic influence is low.

Analysis of PAHs was carried out using high performance liquid chromatography (HPLC, Agilent 1100 series) with a UV detector (Agilent 1200 series) after extracting the moss samples separately by the Soxhlet extractor and cleaning using a silica gel column. A C18 column (VYDAC PAH column) was used as the stationary phase and methanol: water (93:7 v/v) was used as the mobile phase. Statistical analysis was carried out using MINITAB 14 software (Minitab Inc., Pennsylvania, USA).

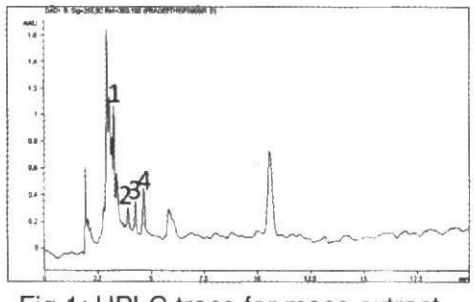

Fig.1: HPLC trace for moss extract

Four low molecular weight PAHs namely naphthalene (1), phenanthrene (2), anthracene (3) and fluoranthene (4) were identified by comparing with retention times and spiking with standards (Supelco USA) and were quantified using an external calibration method. The concentrations of total detectable PAH at sampling sites ranged from 2703 – 45197 μg kg^{-1} dry weight of moss (*Barbula* sp.) with a mean value of 1.678 X 10^4 μg kg^{-1}. One way ANOVA showed that there was a significant difference of total PAHs at the Fort site compared to the other sites at 95 % confidence level. The total detectable PAH concentration was compared with the PAH levels in vegetation samples collected from different regions around the world obtained from the literature. The highest PAH accumulated concentrations were found in *Barbula* sp. when compared with other plant species used as bioindicators. Further studies need to be carried out using HPLC-MS to confirm the identification of the above PAHs.

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838/E2

Analysis of chlorpyrifos and dimethoate pesticide residue levels in bottled drinking water

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Pesticide misuse is of great concern, due to its adverse effects on the environment, such as contamination of ground water resources. This could be a major problem for the bottled drinking water industry, as ground water would be the water sources for most of its products. Pesticide residue levels in bottled drinking water is one of the parameters tested in the Sri Lanka Standard (SLS) 894 certification scheme. This scheme ensures that, the pesticide residue levels in these products are lower than the Maximum Residue Levels (MRLs) of pesticides in drinking water established by the World Health Organization (WHO). Therefore, consumers prefer SLS certified bottled drinking water, considering the detrimental effects of pesticide residues on human health. The objective of this study was to determine the residue levels of chlorpyrifos and dimethoate in the SLS uncertified brands of bottled drinking water available in the local market.

Although, a majority of the bottled drinking water in the market have the SLS certification, four SLS uncertified brands of bottled drinking water were found from different areas in the Colombo District. Chlorpyrifos and dimethoate are two of the most widely used organophosphorus pesticides in Sri Lanka and hence, were selected for this study. Liquid-liquid extraction has been applied successfully in the analysis of pesticides in drinking water and this technique was used in our study. Water samples were extracted with dichloromethane, the extracts were dried, evaporated to near dryness and the residues were dissolved in acetone. The acetone extracts were analyzed by GC/MS.

Recovery studies were carried out by spiking sample blanks (double distilled water samples) with chlorpyrifos and dimethoate standards to obtain concentrations of 0.001, 0.005, 0.01 ppm. Excellent average recoveries of 93 -100 % were obtained for all spiked concentrations. The Limit of Detection (LOD) with respect to chlorpyrifos and dimethoate was 0.07 ppb and 0.30 ppb while, the Limit of Quantification (LOQ) was 0.20 ppb and 1.00 ppb respectively. This method enables quantitative determination of both organophosphorous pesticides in water samples at concentration levels lower than the MRLs specified by the WHO for drinking water. Chlorpyrifos and dimethoate pesticides were not detected in any of the SLS uncertified bottled drinking water samples. Since the LOD values of the two pesticides are lower than the WHO guideline values of 30 ppb for chlorpyrifos and 6 ppb for dimethoate in drinking water, the samples are safe for consumption.

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839/E2

The antifungal activity of surface modified Mn doped ZnO nanoparticles

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A great amount of research has been done on the physicochemical properties of Mn doped ZnO (Mn-ZnO) nanoparticles such as ferromagnetism and photoluminescence. However less research has been conducted on its biochemical properties. This research focused on investigating one of its biochemical properties, namely antifungal activity, which is significant in the field of nanobiotechnology. Frescos are considered to be a world heritage and the frescos at Sigiriya, Dambulla and in other sacred places symbolize the pride of Sri Lankan culture. The fungi taken from the frescos of the Dambulla viharaya were chosen for the investigation. Although some methods have been identified as being able to destroy fungi, these methods cause also harm the paint of the frescos. This method could be considered as a safe method. Since it has been found that ZnO nanoparticles have antifungal activity, it was thought that an enhancement could be achieved via doping ZnO nanoparticles with Mn^{2+}. The nanoparticles were synthesized in the presence of surface passivating agent in order to control the particle size and Polyethylene glycol (PEG) was selected as the coating material as PEG is a biocompatible material which prevents the nonspecific absorption of nanoparticles to the cell membrane. The desired Mn-ZnO nanoparticles coated with PEG were synthesized by a modified version of an existing procedure which can be categorized as a method of co-precipitation. The presence of Mn^{2+} and Zn^{2+} was qualified and quantified by atomic absorption spectroscopy. The nanoparticles were characterized by FT-IR spectroscopy. The X ray diffraction data and scanning electron microscopic images were taken. Qualitative determination of antifungal activity of Mn-ZnO nanoparticles was carried out using the plate method. Further improvement of qualitative analysis and the quantitative determination were conducted by the flask method. The qualitative and quantitative determinations were done in the presence of potato dextrose agar as the negative control and silver nanoparticles as the positive control. Among the eleven genera of fungi, the Mn-ZnO nanoparticles coated with PEG exhibited fungicidal activity with four genera, and fungistatic activity for one genus. There was significant inhibition action with the other genera, and it is expected that increased concentration may result in complete inhibition of growth. The nanoparticle concentration which is required for hundred percent inhibition was determined on *Penicillium* sp.

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840/E2

Development of simple procedures to synthesize different colored silver nanoparticles

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A great wealth of research continues to be focused on nanomaterials due to their unusual mechanical and physical properties than on the corresponding bulk materials. Silver nanoparticles (AgNps) ,in particular, have been the subject of many reviews due to its tremendous applications in many industries such as medical, textile, food water purification, personal care products, sensors, coatings and paints. Unlike gold colloidal nanoparticles (NPs), silver colloidal solutions of different colors are not common. The distinctive colors of colloidal silver are due to a phenomenon known as surface plasmon resonance. Although, a great wealth of research has been available in the literature about synthesizing and characterizing, effort aimed at synthesizing one pot, simple, cost effective and time saving procedures to develop AgNps of different colors have been limited. At the same time, the reported methods used to prepare AgNps are not straight forward and most of the available methods involve the seed method, which is a multi step procedure. As the properties of NPs strongly depend on the size, size distribution, shape, crystal structure and surface chemistry, the careful control over these factors are essential to obtain the desired product. In this study our main focus is to investigate simple one pot reactions to synthesize a stable spherical shape AgNps with different sizes which in turn shows different colors using metal salt reduction method. In this investigation five different colors of AgNps have been synthesized using silver nitrate as the metal precursor. Sodium borohydride was used as the main reducing agent and tri sodium citrate was used as the stabilizing and auxiliary reducing agent. Characterization of synthesized AgNps was carried out using UV-Visible spectrometry and the size of the AgNps was investigated using Transmission Electron Microscopy (TEM). The sizes of synthesized AgNps were found to be with an average size of 10 nm, 14 nm, 15 nm, 19 nm and 33 nm for orange, red, greenish yellow, blue, greenish blue respectively.

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841/E2

Ornithine decarboxylase from *Colletotrichum gloeosporioides*: its purification, properties and inhibitors

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Fungal polyamines play an indispensable role in controlling the growth and development of fungal cells. High levels of polyamines enhance cell growth where as low levels retard growth. Therefore, depleting polyamine levels by selective inhibition of polyamine biosynthesis by specific inhibitors will provide a key to controlling a variety of fungal diseases in plants. With this aim, Ornithine decarboxylase, a rate limiting enzyme of fungal polyamine biosynthesis, was isolated from the fungus *Colletotrichum gloeosporioides*, and purified by ammonium sulphate fractionation followed by DEAE cellulose and sepharose 4B gel filtration chromatography. The enzyme was purified 11.56 fold with 58 % recovery. The purity of the enzyme fraction was screened by SDS-PAGE. Two bands were seen at ~65kDa and ~ 25 kDa. The native molecular mass of the enzyme as determined by sepharose 4B gel filtration chromatography was ~ 130KDa. Kinetic studies of the enzyme reaction showed that enzyme exhibited higher activity in the range of 35-45 ℃ with a maximum at 40 ℃. Effect of pH on enzyme activity showed that the enzyme possesses high activity in the range of 4.8-5.4 with an optimum at pH 5.2. Inhibition studies with the enzyme showed that eugenol, linalool, α-pinene, geraniol , citral were not inhibitors. Cyclohexylamine, methyl isoleucine, methyl isothiourea and methyl hydrazine carboxylate act as inhibitors for the enzyme.

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842/E2

Chemical composition of three varieties of banana pseudo stem (*Musa spp.*) and the use of cellulose in the preparation of carboxymethylcellulose

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Banana pseudo stem is a potential commercial raw material for the production of cellulose based food additives. A study was conducted to compare the chemical composition of three varieties of banana (*Musa* spp.) pseudo stem namely, Ambul, Ambun and Kolikuttu. The possibility of the preparation carboxymethylcellulose (CMC) was investigated using cellulose obtained from pseudo stem of Ambul variety of banana.

Three varieties of pseudo stem harvested from a banana plantation in Embilipitiya, Sri Lanka, were used in the study. The stem was cut in to small pieces of 2 cm cubes and air dried for 2 days. Dried material was milled and its chemical composition was determined. For determination of the percentage extractives and lignin, material that passed through a particle size of 60 to 80 mesh size was used. The extractive percentage was determined as % loss in weight, after soxhlet extraction with ethyl alcohol- benzene mixture (1:2 V/V). The residue was hydrolysed with 72 % Sulphuric acid and the insoluble fraction, was washed with distilled water, until neutralization and dried at 105 ^{0} C for 4 h., and acid-insoluble lignin content was quantified. Pectin content in the dried material was determined by extracting in 0.1 M HCl for 2 hr. The soluble fraction was recovered by precipitation with 96 % ethyl alcohol. Cellulose was extracted sequentially in 1 M and 4 M KOH. The insoluble material was washed in acidified ethyl alcohol and air –dried. All experiments were carried out in triplicate. In the preparation of CMC, cellulose prepared previously from banana stem *Ambul* variety, was bleached and left to react with 1 % sodium monochloroacetate for 12 h. The CMC obtained was confirmed by FTIR spectra and compared with commercial CMC. The length and colour was determined using SEM and a chromatometer, respectively.

The results show that the moisture content of the pseudo stem ranged between 92 - 95 %. The chemical composition was as follows (% range): Extractives: 4.3-6.7, pectin: 1.8-3.3, cellulose: 21.5-32.5, lignin: 11.4 -13.0. The chemical composition of the three banana pseudo-stems, were significantly different ($p<0.01$) among the three varieties of banana as determined by paired T-test. An 87 % yield of CMC was obtained from cellulose. The product was similar in length (70 - 80 µm) and colour (L value- 63.41 and 63.92) when compared with the commercial product.

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843/E2

Spatial variation of metal ion concentrations in water bodies of the Bundala National Park, Sri Lanka

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There is growing concern about increased urban and agricultural runoff, salt production and other human activities that disturb the ecosystem balance in water bodies within the Bundala National Park (BNP). In this work, the concentrations of selected metal ions of three lagoons namely, Malala, Embilikala, and Bundala within BNP, were determined monthly for a period of 18 months, to monitor water quality.

Iron (Fe^{3+}) content of the samples was measured using a UV/Visible spectrophotometer. The atomic absorption spectrophotometer was used for the determination of Na^{+}, K^{+}, Ca^{2+}, Mg^{2+} and Mn^{2+} ion concentrations in water samples. The highest average concentration of sodium (2800 ppm), potassium (893 ppm), magnesium (2138 ppm), calcium (420 ppm), iron (Bundala south 0.5 ppm and Bundala north 1.0 ppm) and manganese (86 ppb) concentrations were recorded from the Bundala lagoon largely due to sea water intrusion as well as due to the discharge of effluents from the saltern (Bundala Lewaya). The lowest concentrations of sodium (52 ppm) and iron (0.1 ppm) were recorded at the northern part of the Embilikala lagoon probably due to the dilution effect with large volumes of fresh water received from the irrigation canals. The possible reason for the relatively high mean concentrations of Ca and Mg from the Embilikala lagoon is the leaching of ions from the soil. Overall results suggest that dilution due to freshwater in Embilikala and Malala lagoons and the addition of effluents from the saltern into Bundala lagoon have contributed to the observed changes of the natural metal ion levels.

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844/E2

Antioxidant potential and total phenolic content of nutmeg (*Myristica fragrans*)

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Antioxidants, especially polyphenols help protect the body against oxidative stress by neutralizing free radicals, reactive oxygen species (ROS) and reactive nitrogen species (RNS). The present study was carried out to determine the antioxidant potential and total phenolic content of methanolic extracts of the pericarp, seed and mace of nutmeg (*Myristica fragrans*) fruit. The total phenolic content was estimated using the Folin-Ciocalteu colorimetric method and expressed as gallic acid equivalents (GAE). The radical scavenging potential of the fruit components was estimated using a stable radical, 1,1-diphenyl-2-picrylhydrazyl (DPPH). The highest phenolic content was found in nutmeg seed extracts (50 ± 0.3 GAE/g) followed by mace (44 ± 0.1 GAE/g). When the fruit extracts were subject to DPPH radical scavenging assay, nutmeg seed extract exhibited highest free radical scavenging capacity (92 ± 0.5%) while pericarp recorded the lowest (11 ± 0.4%). Both phenolic content and antioxidant potential are highest in nutmeg seed. It can be observed that the phenolic content in the extracts correlates well with the radical scavenging activity (R^2=0.90), confirming that phenolic compounds contribute to the radical scavenging activity of these plant extracts.

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845/E2

Value addition to shrimp waste by developing silage

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Shrimp farming is identified as one of the growing agricultural industries in Sri Lanka. Annual shrimp production is approximately 16,684 tonnes and the estimated waste accumulation is about 8,342 tonnes per annum, which is usually discharged into lagoons or abandoned land without prior treatment and so causes serious environmental problems. Therefore value addition and utilization of shrimp waste is both necessary and urgent. Objectives of the study were, to add value to the shrimp waste generated from the processing industry by developing an acid digested shrimp silage, to evaluate the quality of shrimp waste, and to determine the composition, quality and storage stability of the developed product with the intension of producing an animal feed ingredient.

Quality of the shrimp waste was evaluated by analyzing proximate composition and freshness parameters including Total Volatile nitrogen (TVN), Tri Methyl Amine (TMA) and Tri Methyl Ammonium Oxide (TMAO) content. Optimum concentration, acid type and ratio needed to produce silage were selected after monitoring the pH changes of silage produced by mixing 50 g of waste with different concentrations of formic acid (45 %, 65 % and 85 %) and acetic acid (50 %, 75 % and 99 %) at different acid to waste ratios (10 %, 25 %, 35 % and 50 %). 65% formic acid at 10 % of acid to waste ratio was selected as the optimum condition. A batch of silage was produced following the selected optimum conditions. Proximate composition of the developed product was analyzed. In order to evaluate the storage stability, the degree of hydrolysis, TVN, TMA, TMAO, and pH of the developed product was analyzed at weekly intervals for a period of six weeks.

Proximate composition of shrimp waste was as follows: moisture 76.66 %, crude protein 11.49%, ash 5.13 % and crude fat 4.30 % whereas TVN, TMO TMAO values were 15.35, 10.23, 5.12 mg N/100 g respectively. A significant decline ($P < 0.05$) in protein (10.21 %) ash (4.93 %) and fat (2.70 %) in silage was observed, due to addition of water through acid. During the storage, TVN (23.99 - 45.50 mg N/100g) content of the product continuously increased up to six weeks while TMA (10.41 mg N/100g) and TMAO (3.53 mg N/100g) content were stable throughout the period. pH of the silage was changed from 3.72 to 3.85 showing a similar pattern as TVN. The degree of hydrolysis of the product increased with time. Moisture content of the silage (78.03 %) was stable during the storage period. According to the above findings, freshness of shrimp waste generated from the processing industry complies with the requirements of an animal feed ingredient. A concentration of 65 % of formic acid at acid to waste ratio of 10 % can be used to produce stable shrimp silage.

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846/F

A study on primary grade students' errors on column graphs

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Interpreting and drawing column graphs is essential to the students and the general public as it is a popular format for presenting information related to social issues. The Sri Lankan Primary Mathematics syllabi consist of six main topics: numbers, mathematical operations, measurement, money, space and shapes, and data handling. Of these topics handling data consists of the sub topics: (i) collect data and represent in a graph and (ii) read time tables and graphs logically. In Sri Lanka, the concept of column graphs is introduced to children in Grade 3 (8 years of age) and expanded gradually until Grade 5. The column graphs could be defined as a 'type of graphical presentation, in which numerical values are represented by vertical columns'. The Grade 5 Scholarship Examiners' reports highlighted that the students' performance in column graphs is poor. The objective of this study is to identify the errors in representing data on column graphs.

The sample for the study consisted of 117 boys and 108 girls of Grade 5 from four 1 AB type Tamil medium schools in the Colombo Educational Zone. A question paper with 5 problems on data handling was designed. Only 124 students got all answers correct for these graphs. The students were subsequently interviewed to identify the reasons for the errors. The data collected from the interviews were further analysed to categorise the errors.

The following types of errors were identified (i) scale used on vertical axis does not begin at zero (Students have labelled the vertical axis starting at one) (ii) number track used on vertical axis (Students have numbered the spaces on vertical axis of a column chart) (iii) incorrect labelling of horizontal axes (Students have labelled the items represented on the horizontal axis) (iv) inconsistent scale used on vertical axis (students have labelled the vertical axis using an inconsistent scale) (v) inconsistent scale used on horizontal axis (students have used different widths for their column). Knowledge of these errors is useful to primary mathematics curriculum developers, educators, teacher trainers and teachers to minimise the errors made by the students, in understanding column graphs.

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847/F

Development of art competencies during the primary stage of schooling

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The objective of this longitudinal research was to study the developmental patterns of creativity in art work in relation to concepts, shapes and colouring of primary school children across grade 1 to 5. A sample of children was selected from 43 Grade 1 classes from 41 schools (including two bilingual schools) to represent different socio-economic backgrounds of the Sri Lankan school system. The sample was gradually reduced from 1141 (Grade 1) students to 973 students in grade 5 (i.e., Grade 1 = 1141; Grade 2=1071; Grade 3=1019; Grade 4=983; Grade 5=973). Topics were decided based on grade level and the suitability of the developmental stage of the child. At grade 1 the children were directed to draw anything they liked, and at grade 2, an incident / rainy day, they experienced. At grade 3 they were instructed to draw a flower vase, a market and a playing event, and in grade 4 to draw on the topic "I am happy about flowers in the garden" and in grade 5 a "religious place". The instruments were administered by class teachers. In analyzing the data, a nine point rating scale was used, with "1" representing the lowest and "9" the highest. Weighted means of each grade level were calculated and were compared across grade levels. The main findings were that the mean values relating to "concept" and "shape" increased significantly from grade 1 to grade 2. However, a decreasing trend was observed from grade 3, with regard to colouring. The same trend was observed in grade 1 and grade 2, but again in grade 4 had an increasing trend as it was compared with grade 3, but again in grade 5 the mean value dropped significantly. The overall competency level with regard to concept and shape of drawing in grade 2 shows a significant increase when compared with grade 1 figures. However, from grade 3 to 5, a decreasing trend of the concept and shape was observed. With regard to the theme-colouring, a mixed pattern was observed between grade 1 and grade 2, an increment and a decrease again in grade 3. However, an increment in grade 4 and again a decline in grade 5 were evident. Further research is necessary to identify underlying reasons for the decreasing pattern in art development in second and third key stages of primary education.

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848/F

"I won a gold medal for running. But I got only 5 marks for the Scholarship exam"

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Low achievement at the Grade 5 Scholarship Examination is a neglected phenomenon as a research issue. The present study was one of the 19 case studies conducted in 2010 to identify causal factors for gaining less than 5 marks at the Scholarship Exam conducted in 2009. The child, the subject of the study, attended a 1C school, which was selected from the list of schools having students who obtained low marks. This information was obtained from the education office of the Western Province. Data collection techniques were directed to understand the underlying factors for the student's low achievement. The history of the child in Grade 5 was studied retrospectively and the present patterns of learning were studied at Grade 6 using survey techniques. A question paper was prepared to assess mathematics and language competency levels of the child at Grade 6. The interviews were conducted with teachers who taught the child from Grade 1 to Grade 6, parents, family members, Grama Niladari, and neighbours. Classroom observations were conducted to identify how the child was participating in teaching learning situations and also to understand behavioural patterns of the child. In addition, students' progress records and writing books were observed. Data analysis revealed that the common denominator of the child's very low achievement can be attributed to the low socio economic status of the family, and broken family status. In addition, extra marital affairs of the father of the child and conflicts between mother and father, father getting married to step mother, father's illegal drug business, and his imprisonment from time to time have badly affected the child's natural growth as a school child and as a result the educational attainment of the child. His mental state was not balanced during the lessons. Teachers were aware about his family background but did not apply specific remedial measures due to their routine teaching career. Although the child is academically backward, his inherent and inborn physical talents were displayed in sports events of the school. Although the school has ample resources, the child had not benefitted from the said resources.

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849/F

In-service advisors as action researchers

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To build the capacity of In Service Advisors (ISA), the link agent between the Ministry of Education and the National Institute of Education (NIE) at the center, and the teacher at school, through action research (AR), a project was started in 2007. Twenty five ISA's from different subject areas were selected from a group of 100 applicants for a newspaper advertisement. The layout and the strength of the content of the bio data sent by applicants and marks gained for an assignment completed by applicants were used as the selection criteria. ISA's visited the NIE on three occasions to gain theoretical knowledge on AR and to refine their AR reports. They sensed the problems for AR and found facts about the identified problems at their Zonal or Divisional education level work places. They reflected on the selected problems to develop action plans that can be implemented flexibly in their working environments. In the process, the practitioner-based problem identification techniques, their competencies in interpreting their own professional roles and contextual influence on ISA on the process of AR could be identified. The impact of implemented action plans was assessed using qualitative criteria. The capacity of ISAs in identifying problems and preparation of plans as remedial measures was depicted by interventions of AR, ranging from 'zonal level general intervention plans' to 'teacher focused specific remedial measures'. Necessity of a zonal and school specific diversified and creative role, free from existing monotonous office work was felt by the ISAs. They were able to explore hidden patterns of their own professional practice and could unblock the areas of their capacity in their respective subject areas. AR programmes revealed the need for ISAs to be innovative practitioners rather than merely acting as a link agent to transmit centralized curriculum content piecemeal from center to periphery. AR suggests the need for identifying new techniques and strategies in implementing curriculum at zonal / school level using AR process, rather than conveying the content directly to the teachers. The necessity of being a researcher and a reflective practitioner to identify specific problems based on data and generic to schools was confirmed by the research series. The importance of grass root level modifications in implementing the centralized curriculum to achieve the national goals and objectives too was confirmed.

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850/F

The teacher as a policy implementation and policy generating figure

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In 2007, 25 teachers conducted Action Research (AR) in collaboration with the Department of Research and Development of the National Institute of Education (NIE). They were required to observe and reflect on their classroom role to identify problems that need remedial measures for better classroom practices. Teachers were also guided to develop action plans to suit their perspectives and school environments. The impact of implemented action plans were assessed against qualitative criteria. Later they inductively identified theoretical underpinnings on five themes (Peace and value, Risk and disaster, Second language, Psycho-social care and Remedial teaching) based on which GTZ planned educational activities. Resource persons from the NIE guided the teachers on the conduct of action research and experts on five themes attached to GTZ provided content advice. Teachers visited the NIE on three occasions to get ideas on AR and the five themes and resource persons visited schools to break the ice in the minds of the teachers in conducting AR. During the research process, teachers displayed different types of innovations in teaching (Eg: planning lessons in modified ways, seeing performance of students with different perspectives, taking help from parents to upgrade learning of the child, developing innovative teaching aids). Further empirical data were collected to prove their innovations and as a result, in the process of AR, data based judgmental classroom practices were improved (e.g., using student diary notes to prove their feeling and self understanding of lessons). Multifaceted initiatives of interventions (e.g., guiding mothers to improve the quality of writing of primary school children; using first five minutes of a lesson creatively) based on data collected for AR as well as teachers' thought processes (e.g., moral principles for teachers) independent of the existing curriculum framework of textbook and TIM were identified. These innovations were used to develop classroom / school based policy papers by teachers themselves. As a result culture friendly classroom practices, curriculum innovations and modifications were suggested to the national level centralized curriculum as policy options. Due to AR reporting, the research writing skills of teachers were developed and oral presentation skills too were upgraded. Teachers confirmed the importance of action research cum reflection in self-development and in implementing centralized curriculum creatively at the grassroot level.

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851/F

A longitudinal study on the development of listening skills

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A cohort of 1021 children was studied between 2002 and 2006 to identify their development in listening competency during the primary cycle of schooling. Seven aspects of listening (namely Listening alone, Listening in a group, Listening comprehensively, Listening thoughtfully, Listening for appreciation, Listening for learning, Listening politely) delineated by the National Education Commission under "Literacy Competency", were used as fields of study. Data collection instruments were developed across the five year period and measured the nature of development of competency in listening. Data collection instruments were developed using examples from the environment of the child and considering the developmental stage of the child. The curriculum materials were studied to check the content validity of the instruments. The number of words in the question or activity too was decided based on the developmental stage of the child. Data were collected by class teachers who were guided for the purpose. A researcher was appointed to guide the teachers. Percentages were calculated to identify developmental patterns of competency. According to the findings, the percentage of children who responded after listening alone was lower than the percentage of children who responded in a group. More students achieved the competency in listening in groups than the other competencies in listening. Grade wise analysis of data showed that responding after listening was highest in Grade 2. Listening for appreciation and listening for learning show the highest levels compared to the other fields in Grade 2. Grade 5 showed the lowest percentage (other than the field of listening in groups) in listening competency. The fluctuation pattern in grades, specially the decreasing trend towards key stages 2 and 3 should be studied further to understand underlying factors for the situation. Further in the preparation of the curriculum with regard to listening in primary grades, the pattern needs to be studied to change the focus on different aspects of listening. As an example the decreasing trend in listening at grade 4 (65%) within a group when compared with other grades can be studied in depth to identify remedial measures.

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Development of personality traits in primary school children

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As one aspect of a longitudinal study, the developmental patterns of personality traits and underlying variables of personality traits in the primary grades were studied. The sample consisted of 1021 students who entered Grade 1 classes in 41 selected schools that represented diverse educational backgrounds of the country in 2002. Four data collection instruments were developed using components related to personality traits in the five sets of competencies delineated by the National Education Commission. The instruments were prepared to find out changes in personal traits after the student had entered the school, to identify personal traits when the children are engaged in the four main subject areas in the classroom, to identify personal traits related to the essential learning competencies, and to find out the personal traits in the classroom and out of the classroom. The instrument was prepared to measure changes in 16 personal traits on four occasions in grade one. In grade two, personal traits through subject matter were measured. In grade four and five, personal traits related to linguistics, rhythmic, mathematical, spatial, motivational, inter personal and nature fields were measured. Each criterion was marked on a five point scale. Due to dropouts, deaths, absenteeism, transfers of the teachers, and changing of schools, after purification of data, the sample decreased from 1,171 to 673. Percentages were calculated on the exhibited personal traits for each grade and to understand the distribution of personal traits related to each grade, mean, standard deviation, histogram and kurtosis were calculated.

In grade one, the development of personal traits increased more than the average level. But the stability of personal traits decreased according to the dispersion of the standard deviation. Intellectual, creative, social and leadership personal traits developed systematically, but slowly, in grade two. The stability of mathematical traits was lower than the other traits. Linguistic traits in grade five were higher than the average level. The development of rhythmic traits in grade five was equal to that at grade four. The stability and the development of mathematical traits were lower in grade five than in grade four. The development of whole traits in grade five had a slight positive change compared to grade four. Issues with regard to the development of personal traits were at a minimum during the primary stage of education.

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Development of habits in primary school children

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A longitudinal study (2002-2006) was conducted to investigate the development of habits of the students in primary grades. Habits related to the competencies of communication, environment, value and religion, sports and learning to learn were addressed in the study. Four sub instruments were developed for grade one, two, four and five. Objectives of instrument were to identify relationships of the students to ethical and religious practices, identify the development of competencies related to health, food, and things related to human life, identify relationships with people and their immediate environment of the student, identify the development of leadership, identify the ways of resolving problems and identify the ways of engaging in work. The habits were categorized into nine groups. 27, 25, 33 and 37 criteria were included in the instruments for grade one, two, four and five respectively. The instruments for each grade were developed to measure a higher competency level than in the previous grade. The social relationship, responsibilities and human rights of the students were expected to be measured in grade four and five. The data were collected once in every school term. The valid student sample was 869. Students' development of habits was ranked as none, occasionally and always and numbered as 1, 2, 3. The data were analyzed by calculation of the percentage of each habit exhibited in each grade, calculation of mean and standard deviation and Histogram & Kurtosis. Analyzed data were first interpreted by student's habits in each term and during the whole year in each grade during the primary stage. Secondly, the distribution of groups of habits was discussed. Thirdly exhibition of separate habits was explained. Finally the distribution of habits according to media, gender, ethnicity, school type, school environment, religion and geographical factors was discussed. According to the findings, learning habits were exhibited less than other groups of habits, Social habits were exhibited more in grade one, grade four and grade five. Food habits were the weakest habits in grade one. The habits were stable in grade one. The habits were stable in Sinhala medium students and fluctuated in Tamil medium students. Girls exhibited better habits than boys. Students in 1AB and type 3 schools exhibited good habits more than students in 1C and 2 schools. Highly developed good habits were identified in rural schools. The slowest development of good habits was seen in plantation schools. The slow development of good habits was shown in upcountry schools relative to those in other geographical zones. The focal issue of habits was the poor exhibition of learning habits relative to other habits.

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Development of mathematics competency in primary school children in Sri Lanka

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Development of mathematics competencies in primary school children was measured longitudinally in a sample of 1021 students (girls = 45.6%; boys= 54.4%) (Sinhala = 68.8%; Tamil = 17.96%; Moor = 7.7%; Indian Tamil= 5.5%) from 43 classes from 41 government schools (Type 1AB=4; 1C=11; 2=14; 3=12). Competencies were measured continuously between 2002 and 2006, based on activities designed on the themes of identifying numbers, counting, arithmetic, money and transactions, shapes and space, measurements, directions, time and data handling. Class teachers collected data with the help of a researcher. Means and percentages were calculated for each activity to display the patterns of development. Influence of independent variables was calculated using a regression model. There was an increase in competency from grade 1 to grade 2 as students become familiar with numbers and counting. Thereafter there was a decline until grade four as the topics that the students were taught became more complex. From grade 4 to grade 5 there was a significant increase. This is possibly because of the extra preparation the students get for the Grade 5 Scholarship examination. Gender was not a significant differential in mathematics competency. In some years boys scored more, in other years girls scored more. It was only in grade 2 that there were significant differences, specifically in three themes, where girls did significantly better than boys. There were significant differences in the mean scores of urban, semi-urban and rural sectors. The rural sector showed a poor performance in general while the urban sector was generally the best. Performance of the semi-urban sector fluctuated. While the differences between gender and medium were either not there or had disappeared by grade 4, the differences by school type emerged strongest in grade 4. Type 1AB generally had the best results, type 2 generally the worst. Type 1C was normally the closest to the national average. It was only in grade 2 (when there were significant differences by medium and by gender) that there was no significant difference between the school types. Grade 2 was also the year when overall performances were best. Difference between Sinhala and Tamil medium declined as the students grew older.

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Sources for development of a small school in Sri Lanka: A case study

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A case study on a Tamil Medium Type 3 mixed school was conducted to identify features related to a small school (SS) and suggest a developmental model. The objectives were to study the historical development of the SS, to identify current educational, socio-economic, cultural and political contribution of the SS to the development of the village, to investigate the nature and factors for the present status of the SS with regard to its development, to analyze the strengths and weaknesses in its present societal role, to suggest a model with policy options and innovative activities for transforming the SS into a catalyst of rural development. The SS was situated 72 km from the town and public transport was not available. The school caters to the children in a tea estate. Two teachers were 'primary trained' and one teacher had a postgraduate diploma. The tea estate and tea factory buildings were used as school premises, and in 2007, the SS got a new building. Data were collected using two methods i.e. data from outside the SS (Unstructured interviews with education officials, data from Grama Niladhari, Samurdhi Niladhari, Health Officials, Past Pupils and Community Members) and data from the SS (Documentary data on historical development, unstructured interviews with principals and teachers, unstructured observation at school and classroom, student competencies test to Grade 4, 5 students). Data analysis focused on backward village environment, possibilities for growing as a SS that can be developed and converted into a SS which serves the community, philosophy of the principal on SS and rural community, role of teachers as partners in community development, and ways of developing the teacher skills to increase the standards of SS. The identified issues were that the SS was situated in a remote area, difficulties for teachers to access the SS, lack of infrastructure and health facilities, uneducated people, and malnutrition. Suggested remedial measures were to guarantee a safe and protective environment for children, developing infrastructure to be useful for teachers; raise teacher's level of motivation and success, develop SS using school mapping, mobilize the parental and community support for SS, implement non formal education programmes, encourage optimal enrolment and completion of school education, enhance children's health and well-being, and ensure children's optimal academic achievement. A model with specific suggestions and intervention strategies applicable to the SS environment were developed.

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Burden on the substitute-carers of left-behind children of migrant women

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Objective of this qualitative and descriptive cross-sectional study was to describe the perceived burden among substitute-carers of children of migrant women of Sri Lanka (employed overseas) resulting from childcare responsibility. Forty semi-structured interviews were conducted among substitute-carers of children of migrant women, in Colombo, Gampaha, and Kurunegala districts. They included grandmothers, fathers, grandfathers, aunts, siblings, and other relatives who have taken over responsibility of childcare. Data analysis was done using qualitative content analysis.

Most female carers were unemployed and some male carers did not have regular employment. Current work of male carers but not of female carers was affected by childcare responsibility. However, some carers had given up their employment in order to care for children, and some others had forgone new employment opportunities. Education (school and higher) of elder children who looked after younger siblings as well as of young relatives in the same capacity has been adversely affected. Unmarried carers of left-behind children have forgone marriage opportunities due to responsibility of childcare, and love affairs of some unmarried carers have got adversely affected. Despite appreciation by others, most fathers did not receive any help from other relatives for childcare, compared to other carers. The strain of childcare affected many carers psychologically, due to their inability to help children in school and other work, fear that they may fail as mother substitutes, and fear that their work may get adversely affected. Physical health of some elderly carers was adversely affected, and some failed to seek health care due childcare responsibility. Disruption of interpersonal relationships with family members, relatives, and friends adversely affected substitute-carers. Most substitute-carers of left-behind children were adversely affected due to responsibility for childcare. Many health and social problems arising from such burdens could be prevented or addressed by providing suitable support services to families of migrant women.

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857/F

Unscalable barriers? Factors associated with initiation and continuation of street-life among street children in Colombo City

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The objective of this qualitative and descriptive cross-sectional study was to describe factors associated with initiation of street children in Colombo City to street life and to describe factors associated with the continuation of their present lifestyle. Twenty semi-structured interviews with key informants and 10 focus group discussions and 25 semi-structured interviews with street children were conducted to collect data, which were analysed using qualitative content analysis.

Participants were from Fort, Pettah, Slave Island and Maradana areas of Colombo City. All major ethnic and religious groups were represented in this sample of street children. Children who participated were aged 8 -18 years and most were boys. Initiation of street life for most of children was due to the influence of the family and aided by a close family member (one or both parents, siblings or a close family relative) or peers. The commonest factors reported as reasons for initiation of street life were death/illness/imprisonment of one or both parent/s, extreme poverty, alcohol/substance abuse by fathers, and being born in the street. The majority lived with their mothers, while some lived with their fathers, siblings, and uncles / aunts / grandparents. Many other children lived on their own, without an adult guardian. The level of education of these children is very low and none has employable technical skills.

For many children, street life has become the norm in their lives, in which they feel comfortable and do not want to get away from. Although many others prefer to escape from street life to an attractive alternative, given their educational and social background, they may be unable to obtain alternative employment/income sources. Poverty, low educational level, lack of employable skills, and lack of identification documents are factors barring them from pursuing an alternative, socially acceptable lifestyle. Reducing the vulnerability of children due to key factors associated with the initiation of street life will reduce the incidences of children coming to the streets. Policy and attitudinal changes may be required to address the factors that bar the street children from pursuing alternative (and more socially acceptable) lifestyles.

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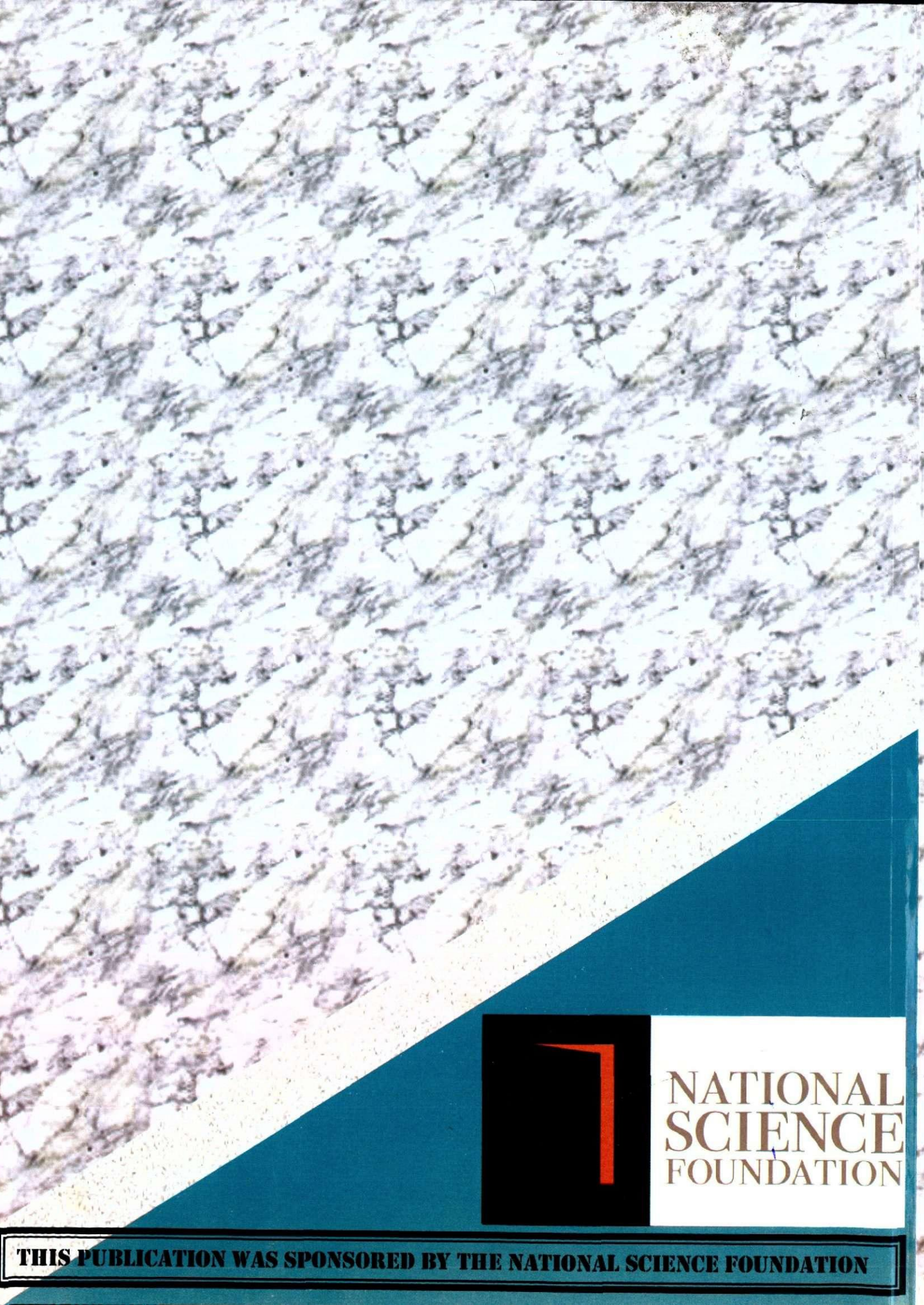

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