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SECTION A

001/A

Rapid differential diagnosis of dengue and chikungunya infections by multiplex RT-PCR and impact of chikungunya infection on liver biochemical tests

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Outbreaks of chikungunya infections on a background of sporadic cases of dengue have become a major public health concern in Sri Lanka. In such situations, rapid and differential diagnosis is considered extremely important to deliver appropriate therapeutic intervention and patient management. Not many studies to date have documented hepatic involvement in chikungunya infection. The development of a rapid, multiplex reverse transcription polymerase chain reaction (M-RT-PCR) for differential diagnosis of dengue and chikungunya infections and analysis of liver enzyme profiles of chikungunya patients, to evaluate the impact of infection on liver biochemical tests. All specimens (EDTA blood) from patients with suspected clinical diagnosis of dengue (n=186) and chikungunya (n=145) referred to the Molecular Diagnostic Laboratory at the Durdans hospital from June 2007 to May 2008 were tested by dengue specific and chikungunya specific RT-PCR for dengue and chikungunya viral RNA respectively (Rs. 2950.00 per one assay). A cost effective M-RT-PCR test (Rs. 2480.00) was also developed and evaluated (n=50) for rapid differentiation of the two viral infections. Of the 186 suspected dengue patients tested, 28 (15%) were positive for dengue viral RNA. Of the 145 suspected chikungunya patients tested, 64 (44%) were positive for chikungunya RNA. The test results of 50 samples analyzed with M-RT-PCR (sensitivity 100 copies/ml) and dengue and chikungunya specific individual RT-PCR assays were in 100% agreement (all samples that became positive with respective individual RT-PCR assays also yielded positive results with M-RT-PCR assay). M-RT-PCR also revealed that 5 patients referred for dengue specific RT-PCR testing were negative for dengue RNA but positive for chikungunya RNA, highlighting the importance of differential diagnosis. An elevation in the level of the liver enzymes SGPT and SGOT was observed in 12 and 19 chikungunya RNA positive patients respectively. Eight patients had both enzymes elevated and the 10 patients had normal levels of both enzymes (<35 for SGPT; <34 for SGOT). The level of SGOT (40-100 U/L) was higher than that of SGPT (35-82 U/L) and the elevation of enzymes was mild in most cases (< 3-fold greater than the normal upper limit). M-RT-PCR is a cost effective rapid method for differential diagnosis of dengue and chikungunya infections. A significant proportion of chikungunya infected patients had evidence of mild to moderate liver damage.

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A microbiological study of an Ayurvedic compound preparation Dasamoola Arista with a view to defining an acceptable microbial quality standard

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The Indigenous system of medicine has been practiced successfully over several thousand years. The basic ingredients of indigenous medicine are plant materials. These materials contain natural inherent microbial flora and also may become contaminate during processing. Considering these facts the World Health Assembly in its resolutions WHA-31:33, 40:33, and 42:43 has emphasized the need for the microbial quality standard of medicinal plant products. Dasamoola Arista, has been used in therapeutics for several centuries. The objectives of this study were to enumerate the total viable count of bacteria, fungi and specific microorganisms such as Coliforms and Salmonella in the market samples of this drug. Fourteen different market samples were subjected to this study. Nutrient agar and Potato Dextrose agar were used as culture media. Pour plate and Spread plate techniques were used to study the microbial load in dilution series up to 10⁻³. Microbial counts on Nutrient agar and Potato dextrose agar were taken after 24 hours and 72 hours. Tests for Coliforms and Salmonella were done according to International standards. Coliform test was performed by MPN method using single strength MacConkey broth. Salmonella was tested after an enrichment process in buffered peptone. 0.1ml of this peptone was transferred to test tubes of Tetrathionate and Selenite broth separately and incubated at 37 °C for 48 hours. These broths were streaked on Bismuthsulphiteagar (B/S.Agar) and Brilliantgreenbile agar(BGB) Black colonies on B/S-Agar and Pink colonies on BGB Agar were considered as positive for Salmonella. These colonies were biochemically tested for salmonella. All tests were repeated thrice and results were confirmed. The microbial load observed in this study was within the limits of the WHA. The Colony count for Bacteria was in between 10x10 to 10x68. Fungi Colony count was in between 1x10 to 36x 10. The biochemical tests revealed that the Bacteria present in this preparation was Bacillus firmus. None of the drug samples were positive for Coliforms or Salmonella. These results revealed that these tested samples were microbiologically safe and up to the microbial quality standard.

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Clinical utility of PCR and Real Time PCR assays for Cytomegalovirus, Hepatitis B and Hepatitis C infections

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Reactivation of cytomegalovirus (CMV), Hepatitis B (HBV) and C (HCV) viruses from the status of latency is seen in immunocompromised individuals and such reactivation is often associated with morbidity and mortality in such individuals. The prevalence of these viral infections in a selected population of patients referred to the Molecular Diagnostic Laboratory at the Durdan’s Hospital, Colombo, during the period from August 2007 to May 2008 were studied using qualitative PCR assays. All specimens from patients with suspected clinical diagnoses of either CMV or HBV or HCV infections were analyzed. Of 176 samples analyzed for CMV 78 were positive (37 males, 29 females) and majority of them are patients from a nephrology unit. Out of 40 and 10 samples analyzed from males and females, respectively, 22 and 4 were positive for HBV. Twenty six samples were analyzed for HCV and only 6 were found to be infected with viruses and all of them were from males. Although PCR detection of these viral DNA/RNA is a sensitive method to detect infection, it lacks specificity for the detection of active viral disease and for monitoring the efficacy of antiviral therapy. Therefore, Real-time PCR (RT-PCR) assays for the detection and quantification of CMV-DNA, HBV-DNA and HCV-RNA were developed using SYBRgreen1 chemistry. The assays developed are capable of detecting viral particles in blood samples and quantifying viral DNA accurately over a broad range of input target copies ($10^2$ – $10^8$ copies/ml) and therefore, can be used to predict the reactivation of viruses by comparing with published kinetic criteria in clinical guidelines. Post PCR analyses of Real-time PCR products by agarose gel electrophoresis revealed bands having the same intensity for a wide range of target copies ($10^3$ - $10^8$ copies/ml). In contrast, RT-PCR elicited higher cycle threshold for the descending order of concentration of target copies. Therefore, based on these results, it is evident that the intensity of conventional PCR bands should not be used for the assessment of viral reactivation or for monitoring therapeutic intervention and for this purpose RT-PCR is the method of choice

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Evaluation of an IS 6110–based PCR assay for laboratory detection of *M. tuberculosis* complex DNA in clinical samples

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Due to the slow growth rate of the causative agent, the diagnosis of Tuberculosis (TB) takes considerable time period leading to the complication and spread of the disease. Towards this end, use of Polymerase Chain Reaction (PCR) technology, has revolutionized diagnosis of TB by reducing the diagnostic time. The aim of the present study was to compare two primer pairs and DNA extraction methods for the PCR based detection of *M. tuberculosis* complex (MTB) DNA in clinical samples for the routine laboratory diagnosis of TB. Two DNA extraction methods (Modified Boom’s method and Roche commercial kit) and two IS 6110-based primer pairs were compared with respect to the sensitivity, time and quality/quantity of DNA. Extra pulmonary and pulmonary specimens from 45 TB suspected patients referred to the Molecular Medicine Unit, University of Kelaniya from February 2007 to April 2008 were analyzed. Results indicated 50% and 70% of the samples extracted from modified Boom’s method and commercial kit, respectively, had high quality DNA, while 17% and 67% of the specimens extracted by the Boom’s method and commercial kit, respectively, had over 200 µg/ml DNA. Both primer pairs exhibited similar level of sensitivity (200 fg of MTB DNA). In comparison to the time consuming culture, which takes 4 to 6 weeks, the modified Boom’s method and commercial kit combined with PCR takes only 48 and 24 hrs, respectively. Of the 19 positives (42.22%) 11 were males while 17 and 02 were extra-pulmonary and pulmonary TB, respectively. The commonest clinical indication for sending samples was suspected disseminated TB. Presence or absence of fever or presence or absence of very high ESR (>100 mm) did not have a significant positive or negative predictive value for PCR. Moderately high ESR (>50 mm) had a negative predictive value of 0.8 and Mantoux test had a positive predictive value of 0.8. According to the time required for completion, labour, quality/quantity of DNA (statistically significant at p=0.05) and reproducibility the commercial kit proved to be an efficient DNA extraction procedure. Both sets of primers elicited similar discriminating power. There was not a single clinical indicator with satisfactory predictive values, which is useful in clinical decision making regarding the need for PCR diagnosis in individual patients. We report a simple, rapid and reproducible PCR assay for routine laboratory diagnosis of MTB DNA from both pulmonary and extra-pulmonary specimens.

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Introduction of numerical scores for the evaluation of diarrhoea

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Diarrhoea is defined as an abnormal increase in the frequency, of passing watery stools for a minimum of two consecutive days. Generally, diarrhoea has been evaluated clinically as moderate or severe diarrhoea, diarrhoea associated with blood. The evaluation of diarrhoea is important in studies associated with occurrence and the treatment of diarrhoea. For research purposes, it is essential to have clear guide lines to evaluate the severity of diarrhoea by giving some numerical values, which can be repeatable. Healthy 30 dogs were used to establish the grading of stools by this method. Body weight of the subjects between 1 to 5 years (mean age 17.16±3.14 months) of both sexes (12 males and 18 females) and in a study associated with doxycycline induced diarrhoea and the effect of fermented milk products as a preventive measure The score was given to the stools as follows. The stools with normal tubular shape, solid nature with normal frequency (0 grade), with unclear tubular shape, in between solid and liquid (with a stick can draw a line), slight increased in frequency per day by 1 or 2 (1 grade), appearing stools as a mass/ but cannot draw a line/ increase in frequency by 2 per day (grade1.5), watery stools which does not appear as a mass, increased in frequency by 3 (grade 2) and finally stool draining along the floor, increased in frequency by 3 as grade 2.5.

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Occurrence of *Aedes* (Finlaya) *gilli* Barraud in Sri Lanka: A new record

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The occurrence of *Aedes* (Finlaya) *gilli* in Sri Lanka is reported by the collection of 08 larval and 01 female specimens in January 2008 at Semenariyawatta, Ampitiya in the Kandy district of Sri Lanka. In an *Aedes* mosquito systematics study, mosquito larval collections were carried out in potential breeding habitats of *Aedes* mosquitoes in Sri Lanka. The larvae and the emerged adults were identified using *Aedes* larval and adult identification keys by Barraud (1934). During this study, 08 larvae and 01 adult female specimen of *Aedes* (Finlaya) *gilli* was identified. Nomenclature and chaetotaxy used for adult and larvae follow Huang (1972), and Knight and Laffoon (1971). Characters of larvae: (1) 5C and 6C are long and single, about 2 ½ times length of head, (2) 7C is 2 branched, (3) mouth brush hairs are simple, (4) antennae are about 12 times length of width, (5) antennal shaft is with few fine specules, (6) 1A is single and attached between 1/2 - 2/3 of length from base, (7) comb is with 26 fringed teeth in a patch, (8) siphon is 4 - 5 times length of diameter at base, (9) 1S is with 6 fine branches attached some distance beyond pecten, (10) pecten is with 24 - 28 teeth with basal lateral denticles, (11) 1X is with 3 fine short branches, (12) 2X is with 6 branches (13) 3X is single and long (14) 4X is with 10 hairs, each divided into a number of branches (15) 3 pairs of pre cratal hairs are present (16) dorsal and ventral anal papillae are long and pointed and the ventral pair is about ½ the length of dorsal pair. Adult characters: (1) anterior half of mesonotum is entirely covered with pale golden scales, (2) wings are dark scaled, (3) tibiae of legs are dark brown, pale at base and streaked with pale scales posteriorly (4) tarsal segments 1 and 2 of the fore and mid legs are with basal pale rings while the first 3 tarsal segments of hind legs are with wider pale rings, (5) abdominal segments 2 - 6 are with narrow basal pale bands and basal lateral silvery patches and (6) sternites are pale with apical dark bands. These characters agree with the key larval and adult characters of *Aedes* (Finlaya) *gilli* by Barraud (1934). Since *Aedes* (Finlaya) *gilli* has not been reported previously in Sri Lanka, it is a new record. *Aedes* (Finlaya) *gilli* is not a known vector of human diseases. However, identification of this species is necessary as this species shares the habitats (tree holes) with *Ae.* *albopictus* (an important vector of dengue and dengue haemorrhagic fever in Sri Lanka), *Ae.* *krombinii* and *Ae.* *novalbopictus*.

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Comparison of five DNA extraction methods from human blood for the detection of *Wuchereria bancrofti* by polymerase chain reaction assays

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**Introduction:** Lymphatic filariasis (Lf) is the second most common vector-borne disease globally. Approximately 90% of global burden of Lf is caused by *Wuchereria bancrofti*. *W. bancrofti* is routinely diagnosed by morphological identification of microfilariae (Mf) by microscopy which is a labour intense, low sensitive and time consuming method. Detection of *W. bancrofti* Deoxyribonucleic acid (DNA) using polymerase chain reaction (PCR) technique has become popular today, because of its high sensitivity and specificity. The overall success of the PCR strategy in detecting a filarial parasite in human blood varies between sample preparation methods. The objective of this study was to compare five DNA extraction methods (Lysis + centrifugation, Chelex method, Mf pellet method, QIAamp DNA Mini Kit commercial system, and Phenol-chloroform) with regard to duration of completion, labor involvement and PCR analytical sensitivity in-relation to DNA quality and quantity for the detection of *W. bancrofti* in human blood. Five blood samples positive for mf of *W. bancrofti* were tested for each DNA extraction method and were compared with respect to the sensitivity, time and quality/quantity of DNA and also by PCR analysis. Of the 5 methods tested, Mf pellet method was found to be the most simple and effective technique for the isolation of *W. bancrofti* Mf in human blood. This method was quick (15 min to complete), simple (5 min of manual labor), and very economical. It does not require any organic solvents, and the entire extraction procedure uses only two steps requiring supernatant transfer between tubes, hence minimizing the possibility of cross-contamination. Moreover, the PCR analytical sensitivity of the Mf pellet method was comparable to that of the commercial kit used. No PCR inhibitors were detected, independently of Mf count in the blood. Same method (optimal DNA extraction method) can be also used for the detection of parasite DNA from the field collected Mf positive mosquitoes using a PCR. Therefore, we recommend the Mf pellet method for processing large numbers of blood samples in community surveys aimed at determining the prevalence of *W. bancrofti* infection.

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Most important breeding habitats of potential vectors of malaria in Sri Lanka

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Anopheline larval surveys were carried out from March 2007 – May 2008 at 24 localities in 11 districts to study the breeding habitats of potential malaria vectors in Sri Lanka. Larval collections were made in all potential anopheline breeding habitats at 6 dips per m² surface area of water. Larvae were staged and identified at the 3rd and 4th stages and the larval density of each species in each habitat was given as the percentage of collection and (number per 100 dips). Habitats that had larval density > 5 were considered as “most important habitats”. Larval densities of most important habitats were: An. aconitus: wells, 55.71% (2.98), river beds, 22.86% (0.19), ground pools 12.86% (0.54), rice fields 5.71% (0.27); An. annularis: quarry pits 77.27% (8.67), tanks 22.73% (0.35). An. barbirostris: river beds 49.46% (3.44), wells 16.96% (7.25), burrow pits 13.21% (6.93), ground pools 10.18% (3.40); An. culicifacies: river beds 95.02% (13.26), quarry pits 1.07% (6.12), hoof prints 0.36% (6.06); An. jamesii: burrow pits 26.76% (11.05), tanks 17.69% (5.40), river beds 16.10% (0.88), ground pools 12.02% (3.16), rice fields 8.84% (2.62), irrigation canals 5.21% (2.39), hoof prints 1.59% (10.61) tyre prints 4.99% (8.87); An. nigerrimus: river beds 21.17% (1.17), tanks 18.92% (5.82), rice fields 13.29% (3.97), irrigation canals 12.16% (5.61), burrow pits 11.04% (4.59), ground pools 8.78% (2.33), wells 7.43% (2.52), marshes 6.76% (4.30). An. peditaeniatus: rice fields 34.35% (13.64), river beds 30.29% (2.22), ground pools 10.49% (3.70), burrow pits 8.29% (4.59), marshes 5.08% (4.30) hoof prints 0.68% (6.06). An. subpictus: ground pools 47.37% (11.27), hoof prints 16.04% (96.97), river beds 13.78% (0.68), burrow pits 8.27% (3.09). tyre prints 4.51% (7.26), An. tessellates: wells 47.31% (3.36), river beds 29.03% (0.36), burrow pits 12.91% (1.12), irrigation canals 8.60% (0.83). An. vagus: river beds 25.19% (1.63), rice fields 16.92% (5.91), ground pools 16.54% (5.13), tyre prints 16.54% (34.68) burrow pits 13.08% (6.37) hoof prints 3.65% (28.79). An. varuna: river beds 71.75% (9.58), ground pools 10.22%, (6.56) wells 7.71% (6.34). River beds (45.05%), ground pools (9.37%), rice fields (8.32%), tanks (8.07%) and burrow pits (5.97%) provided 76.78% breeding surface of the anopheline fauna in the study areas. Anopheline vector larval control is an essential element of the malaria control programme in the country. Thus, anopheline larval control in the most important and abundant breeding habitats would be much helpful for effective and efficient malaria control in the country.

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Large-scale entomological assessment of *Wuchereria bancrofti* transmission by dissection and PCR-ELISA in Gampaha district, Sri Lanka

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Entomological surveys are important tools for monitoring progress of lymphatic filariasis (Lf) eradication programs. In this study, dissection of *Culex quinquefasciatus* was compared with a Polymerase Chain Reaction – Enzyme Linked Immunosorbent Assay (PCR-ELISA) for pooled mosquitoes to assess filarial infection levels in the major vector of *Wuchereria bancrofti* in Gampaha district, following mass-treatment programme with diethylcarbamazine (DEC) and albendazole. Mosquitoes were collected in 30 sentinel and 15 non-sentinel sites in 15 Medical Officer of Health (MOH) areas of Gampaha district known for the presence of *W. bancrofti* transmission. Captured mosquitoes were dissected to determine the *W. bancrofti* larvae (L1, L2, L3). PCR was carried out using Deoxyribonucleic acid (DNA) extracted from mosquito pools (15 body parts/pool) utilizing primers specific for the Wb-Sspl repeat. PCR products were analyzed by hybridization ELISA using fluorescein-labeled wild type specific probes. The prevalence of infected/infective mosquitoes in PCR pools (3 pools/site) was estimated using the PoolScreen™ algorithm and a novel probability-based method. The prevalence of infected mosquitoes with L1-L2 larvae of *W. bancrofti* ranged from 0%–8.54% by dissection and point estimates of infection prevalence as assayed by PCR-ELISA, ranged from 0% – 25.4%. Mosquitoes collected from all MOH areas (80%, N = 12), except for Minuwangoda, Dompe and Ragama, were positive for *W. bancrofti* larvae, with a prevalence rate ranging from 0.78% to 16.97% in both methods. Of 30 sentinel sites, 43.3% (N = 13) were positive for *W. bancrofti* transmission whereas it was evident in 40% (N = 6) of non-sentinel sites. The proportion of positive pools detected by the PCR-ELISA assay was higher than that obtained by the dissection indicating that PCR-ELISA assay is more sensitive than the dissection method in detecting infected/infective mosquitoes. Also results of this study showed that autochthonous transmission of *W. bancrofti* continues in the Gampaha district despite completion of the 5 year mass drug administration (MDA) programme. Therefore, we emphasize the use of more sensitive tools such as PCR-ELISA to monitor the impact of the MDA programme on disease transmission. This study also emphasizes that control measures should be further continued until the microfilaremic population is reduced to a level which could interrupt transmission in the area.

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Assessment of microbiological quality of drinking water from water projects in Sri Lanka

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A safe water supply system is a “double – edged sword”. If this system functions well, it can maintain the health of a population. But if not, large public health problems occur. Some people in Sri Lanka fulfill their freshwater needs from small water schemes.

The objective of this study was to assess the microbiological quality of drinking water in small water schemes in selected areas in Sri Lanka. The tanks surveyed were selected randomly. Government officers visited the selected small water schemes (n = 40) to collect water samples. Water samples were collected for analysis and total coliform and Escherichia coli were determined by enumeration of total coliform count and different coliform count method. *E. coli* is a bacterial indicator of faecal contamination.

Results showed that a total of 40 water samples of community water projects, approximately 52.5% of the samples analyzed were contaminated with total coliforms in concentrations exceeding 10 CFU/100 ml, and approximately 47.5% of samples showed contamination with *E. coli*. Highest detected coliform count was 800CFU/100 ml from Kithulgoda Community water project, Kevitiyagala and highest *E. coli* count (800CFU/100) was found in Samurdhi water Project Matugama. More than 90% of coliform contaminated samples were polluted by *E. coli*. Unfortunately, the water quality found in this study was poor.

Poorly managed public water supplies have the potential to make the large number of people ill. Because most of the people ordinarily drank water without treating it. Therefore we have to continue to put efforts in supplying of safe drinking water and to educate the people who use it. As a primary prevention, an immediate improvement of the water purifying environment by using cost effective method like chlorination, as well as the education of the population is needed.

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Analysis of genetic polymorphism of Plasmodium vivax Duffy Binding Protein ligand domain of Sri Lankan isolates

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Interaction of Plasmodium vivax Duffy Binding Protein region II (PvDBPII) critical binding motif (CBM) with its erythrocyte receptor is critical for maintaining blood stage infections, rendering PvDBP a leading vaccine candidate. Since the efficacy of a vaccine based on a polymorphic antigen, such PvDBP, is influenced by the local host immune response, characterization of the GD among local parasite strains is important in specific geographic settings. GD of the PvDBPII-CBM was assessed for the first time among field isolates from Sri Lanka. Forty single clonal P. vivax infections identified from two malaria endemic areas (Anuradhapura and Kataragama) and from a non-endemic area (Colombo), were used to generate nucleotide sequence data of CBM of PvDBPII (aa 285 to 521) by nested PCR amplification followed by direct sequencing.

Twenty dimorphic sites, 20 nucleotide polymorphisms and 15 haplotypes (haplotype diversity = 0.890) were identified at the CBM of PvDBPII compared to Sal-1 sequence. Genetic polymorphism in terms of pair wise diversity (π) and Tamura’s three parameter model (d) were calculated to be 0.00950 (S.D.=0.00072) and 0.00959 (S.D.= 0.00052), respectively, consistent with published data from world wide isolates. Eighteen non-synonymous(NS) and 02 synonymous(S) mutations were identified, and the ratio of NS (0.01086) to S (0.00458) mutation rates was significantly >1, suggesting that positive selection acts on the CBS of PvDBPII. Residues essential for erythrocyte binding on PvDBPII-CBR were conserved in these 40 isolates. Six polymorphic residues recorded in high frequencies in worldwide isolates were also present among Sri Lankan isolates. Polymorphisms occurring at higher frequencies than Papua New Guinea isolates, of three amino acid residues involved in resistance to binding inhibitory antibodies were also detected.

Thus, even under low and unstable transmission conditions prevalent in the island, relatively high allelic diversity and positive selection acting on CBM of PvDBPII, possibly due to immune pressure were detected in Sri Lankan P. vivax field isolates.

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Application of nucleic acid technology (NAT) in the diagnosis of active viral replication in HBV and HCV infections and evidence for HBV surface antigen mutants

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Introduction: The community prevalence of Hepatitis B (HBV) and hepatitis C (HCV) infections, although considered low (< 1%) in Sri Lanka based on serological markers, pose a significant health threat to patients in high risk groups. The early diagnosis of active viral infection is crucial in such situations to prevent further transmission and to enable the clinicians to initiate successful therapeutic interventions. Objective: This study was carried out to investigate the usefulness of polymerase chain reaction (PCR) in the diagnosis of active viral replication in HBV and HCV infections. Methodology: All specimens from patients with serological evidence of hepatitis B (HBV surface antigen and/or antibodies for HBV core protein) or hepatitis C (antibodies for hepatitis C core protein-Anti-HCV) and referred to the Molecular Medicine Unit from May 2005 to May 2008 were analyzed by PCR and reverse-transcription PCR (RT-PCR) for HBV DNA (n=130) and HCV RNA (n=95) respectively. Results: Of the 130 patients tested, 57 (44%) were positive for HBV DNA. The positive group of patients included 10 renal transplant patients, 4 multiply transfused patients, 4 paediatric patients with lymphoma, and 1 patient with cirrhosis. Six HBV DNA positive patients had negative HBsAg serology profiles indicating the possibility of surface antigen mutant strains. The HBV DNA negative patients with positive serology profiles indicate sero-converted/patients with resolved infections or false positive serology results. Of the 95 patients tested, 14 (15%) were positive for HCV RNA and included 3 paediatric patients with thalassaemia. HCV RNA negative, anti-HCV positive profiles reflect either false positive serology results (due to less specific antibody assays) or donors who have been exposed to HCV previously and subsequently resolved their infections. Conclusions: A major proportion of patients with serological markers for HBV have active viral infection whereas only relatively a minor proportion of patients with serological markers for HCV have active viral replication. We have also found the first possible evidence of hepatitis B surface antigen mutant strains. This underlines the importance of the nucleic acid based technology in the diagnosis and assessment of infection with or suspected to have hepatitis B or C infections. We also emphasize the importance of introducing NAT for screening donors for HBV DNA and HCV RNA to substantially lower the risk of acquiring HBV/HCV infection from a transfusion.

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Chikungunya outbreak in 2008 in Ratnapura district, Sri Lanka – clinical and socio-economic analysis

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Since 2006, Sri Lanka has experienced several outbreaks of chikungunya fever (CHIK) affecting several thousands of people. Today, CHIK has become one of the most important vector-borne diseases in the country. The objective of this study was to analyse the clinical manifestations and socio-economic status among CHIK patients reported from Pallebedda and Godakawela areas in Ratnapura district during the outbreak in February and March 2008. After obtaining the informed written consent, venous blood samples were collected from 80 suspected patients. A medical officer carried out clinical examination of each patient. Clinical information along with socio economic data of the patients was recorded in an interviewer-administered questionnaire. Serum samples were tested for CHIK by a Reverse-Transcription Polymerase Chain Reaction (RT-PCR) assay. Of eighty patients tested, 51% (n=42) were positive for CHIK. All positive patients had fever for less than 5 days duration. Majority of them (95%, n=40) had severe arthralgia with arthritis of small joints of hands and feet (81%, n=34). Moreover, a generalized, itchy maculopapular rash was present in 78% (n=33) of them. The appearance of skin rash only after 4-5 days of fever was characteristic in the majority of patients. The mean age of positive patients was 38 years and consisted of 48% (n=20) of males. Many (43%, n=18) of them were farmers having a mean monthly family income of Rs. 4867.00. Analysis of educational status revealed that 60% (n=26) of family members had educated up to G.C.E. O/L whereas only 26% (n=12) had completed G.C.E. A/Ls. Twenty-eight (67%) positive patients had at least one or more CHIK infected family members in addition. Moreover, 95% (n=40) of them were surrounded by infected neighbours indicating active, intense transmission in the area. According to the results, the most predominant clinical features of CHIK were fever either with severe arthralgia or arthritis of small joints of hands and feet. Skin rash, though characteristic, appeared to develop 4-5 days after the infection. CHIK has mainly affected the most productive labour force in these areas with majority belonging to the middle class farming community with a low monthly income. Hence, the sources of income of the affected families were severely hampered by the CHIK outbreak. Therefore, non-fatal, CHIK may have a negative impact on the socio-economic status of the affected communities. “The staff of the Molecular Medicine Unit, Faculty of Medicine, University of Kelaniya, Dr Richard Perera and the staff of Godakawela Hospital and Dr. Susanth Kariyawasam and the staff of Pallebadda Hospital are acknowledged”.

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Knowledge, attitudes and practices (KAP) on dengue control in Gampaha district.

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Dengue/Dengue Hemorrhagic Fever (DHF) has become a major public health problem in many parts of the tropics. In Sri Lanka, it is endemic in some parts of the country with outbreaks of dengue/ DHF. The present study was done to assess 1) knowledge regarding dengue among the general population in the district of Gampaha, 2) whether simple preventive measures are being practiced in the community. A cross-sectional survey was conducted in selected 2000 households in the Gampaha District from June - August, 2007 using a pre-tested structured questionnaire to assess the level of knowledge, attitudes and practices regarding dengue. The majority of the respondents interviewed were females (65.2%). More than 90% have had secondary education (90.2%). The main source of water supply were pipe borne (43.4%) and well water (40.6%). 64.3% households stored water for washing, drinking and cleaning purposes. More than 95% of the respondents had heard about dengue fever and its transmission. 91.3% cited that their main source of information on dengue was from television/radio. 34.3% had either received advice or participated in a training programme on dengue prevention and 7.8% had received support materials. The main preventive measure used to reduce the mosquito nuisance was personal protection with repellents (73.6%). Most of the respondents (56.8%) felt that no action was taken by the government to control mosquitoes. When respondents views were taken, the suggestions made by them to improve dengue control included, fogging (31.8%), educating people (30.5%), treating water (24.3%) and cleaning the environment (19.5%). When questions were directed at possible methods for community participation for dengue control, the majority were in favour of removing solid waste (84.15%), eliminating stagnant water collections (40.7%), removing larvae (8.75%) and covering all the water containers using lids (8.1%). The community had good understanding on dengue and the main source of information was from the electronic media. However it was found that good knowledge itself does not necessarily lead to good practices. The respondents' attitudes were found to be good and most of them were supportive of control measures. Mass media is an important means of conveying health messages to the public, thus research and development of educational strategies designed to improve behaviour and practices of effective control measures through mass media among the community are recommended.

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**Effect of release of glucose from selected food items on their glycaemic indices**

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The glycaemic index (GI) concept categorizes starchy food items according to the blood glucose response following a meal. The *in-vivo* procedure of GI determination is very laborious as it is time consuming and requires the corporation of supportive volunteers. Therefore, the aim of this study was to determine the glycaemic responses using an *in-vitro* method. The procedure used in the present study determined glucose fractions released from food items with timed incubations using digestive enzymes under standard conditions. The released glucose at different time intervals were categorized as rapidly available glucose (RAG), slowly available glucose (SAG), rapidly digestible starch (RDS) and slowly digestible starch (SDS). The fractions mentioned above were correlated to published and unpublished GI values obtained by the *in-vivo* method. The food items analysed were white sliced bread, wholmeal bread, string hopper (wheat), roti (wheat), pittu (wheat), roti (atta), red rice, string hopper (red rice), hoppers (red rice), chick pea, cowpea, mung beans and lentils. Significant positive correlations were observed between RAG contents of the 50 g available starch portions with GI (p = 0.003) and incremental area under curve (IAUC) (p = 0.001). When the RDS contents were correlated with the GI and IAUC significant positive correlations (p =0.01, p=0.005 respectively) were obtained. The SAG/RAG ratio showed a significant negative correlation with GI (p=0.007) and with IAUC (p=0.001). This *in-vitro* method not only showed a relationship between the glycaemic responses of individual items and the glucose fractions but also with the meals (wholemeal bread & lentil curry, red rice with lentil curry) containing different sources of starch. According to GI values determined by the *in-vivo* method, foods are classified as high (>85), medium (85-60) and low (<60). When classifying foods into above 3 categories using RAG this study observed that measuring RAG was more accurate in finding low (RAG<31) and high (RAG>43) GI foods. Medium GI roti preparations (dry heat processing) had high RAG values. This might be because roti preparations were chewed less thoroughly leading to a medium glycaemic response. Thus, *in-vitro* measurement of RAG and SAG can be used as a tool to predict GI values. This method can also be used to estimate the blood glucose responses of meals containing normal serving sizes which may be more or less than the 50 g available starch portion size.

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Recognition of foods responsible for Hypercarotenemia from serum carotenoid metabolic profiles

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Hypercarotenemia is a condition now commonly seen among young infants in Sri Lanka mainly due to the excessive intake of carrot, pumpkin and papaw. Infants and children with Hypercarotenemia have yellow skin (palms and soles) mainly because of the deposition of carotenoids in the fatty tissue. The objective of this study was to determine the food types that the hypercarotenemic infants or children have ingested, from the serum carotenoid profile. A sample of venous blood was collected from the hypercarotenemic infants or children and serum was separated. The carotenoids were extracted into hexane and carotenoid profile determined using Reverse Phase High Performance Liquid Chromatography. (RP-HPLC) (Mobile phase – 58 Acetonitrile: 35 Methanol: 7 THF) The carotenoids in papaw, carrot and pumpkin were also extracted and carotenoid profiles determined as above.

The carotenoid profile of carrot has peaks at Retention Time (RT) 37 and 39 min, which are due to α and β carotene respectively. In pumpkin in addition to the α and β peaks, a luetin peak (RT= 5.5 min) is observed. Prominent peaks at 15 to 15.5 min (β- cryptoxanthin) and at 39 min (β carotene) are observed for papaw. The peaks which correspond to the α- carotene and β- carotene are indicated when carrot and pumpkin are high in the diet. Similarly when papaw consumption is high an additional peak at 15.5 min corresponding to β-cryptoxanthin is observed. This can be taken as a marker for papaw consumption. The polyhydroxy metabolites in the profile indicate that the excess carotenoids are hydroxylated to be removed. Out of the hypercarotenimics (n=15) studied, 67% had high amount of papaw in their diet. As a result of that the β-cryptoxanthin levels were high (mean = 30.9 μg/dL) compared to those who had not consumed papaw as their major carotenoid bearing food. For the other subjects, the major contribution was from the carrot and / or pumpkin as their α –carotene (mean = 36.3 μg/dL) and β-carotene (mean = 31.5 μg/dL) levels were high. If pumpkin contributes a high peak appears in the polyhydroxy region.

Results also indicate that more than in 80% of investigated infants and children α- carotene levels are higher than their β- carotene levels. This may be due to the high affinity of the β-carotene to bioconversion than α- carotene by physiological process.

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Effect of Inter and intra individual variations in determination of glycaemic indices

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Starchy foods differ in the ways by which they elicit blood glucose responses. Thus the concept of Glycaemic index (GI) was introduced to classify starchy foods depending on their rate of digestion and absorption. The GI of a food is measured by giving a standard food containing 50 g available carbohydrate and a test food containing the same amount of available carbohydrate on different days after an overnight fast. The standard food is given twice to the same individual to minimize day to day variations. The GI of foods is influenced by the properties of foods as well as physiological properties of the individuals participating in the study.

Thus the objectives were to analyze the effects of various parameters employed in GI determination on the interpretation of GI values. Following were analysed i) variation in fasting blood glucose values of individuals (n = 24) on the two days when standard was given ii) the effect of the fasting glucose values of the two days on Incremental area under curve (IAUC), iii) type of dinner meals and duration of fasting on IAUC, iv) variations of fasting blood glucose values of the same individual on different days when test foods were given; v) variations in postprandial glycaemic responses (at 2 hours following ingestion) for different foods in the same individual. The standard food (white sliced bread) was given on the first day of the study and midway (5-6 weeks later).

The two groups of values of fasting glycaemic responses and the IAUC of the individuals when standard was given were found to be not significantly different (p = 0.917, and p = 0.788 respectively). The duration of fasting on the two days when the standard was given varied from 9-12 hours. One third (33%) of individuals had fasted for similar periods while 54% had 15-60 min differences on two days and rest of the individuals had 1.30 -2 hour differences. Most of the individuals (71%) had consumed rice and curry for dinner on both days, while the rest of the subjects had taken different dinner meals. When the coefficient of variation (CV) of fasting glucose responses of each individual on different days were analyzed a range of 1.8 – 12.3% were observed with 83% of individuals having a CV less than 10%. The CV of postprandial glycaemic responses (after 2 hours) varied from 2.2 – 16.2%.

Thus the different dinner meals and the duration of fasting (9-12 hours) have had no effect on the IAUC for the standard food. As the IAUC of the standard in each individual was employed to determine the GI value of the test foods the results of the present study confirms the reliability of the results.

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Extra - pancreatic actions of *Trichosanthes cucumerina*

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*Trichosanthes cucumerina* Linn (Family: Cucurbitaceae), locally known as Dummella is commonly found in Asian countries including Sri Lanka. The aerial parts of *T. cucumerina* (T.C) are widely used in combination with other plants in the traditional medicinal systems as a remedy for fever, dropsy, acute bronchitis, boils, inflammation, skin diseases, jaundice, gastric lesions and diabetes. In Sri Lanka, the aerial parts of T.C are used as a remedy for diabetes. In a previous study we demonstrated that hot water extract (HWE) of T.C aerial parts can exert significant hypoglycemic activity in both normaglycemic and streptozotocine (STZ) induced diabetic rats. It was also shown that HWE had no effect on intestinal glucose absorption. A study was therefore, carried out to determine if extra – pancreatic effects were the main mechanisms by which the HWE exerts its hypoglycemic effect in rats. Extra – pancreatic effects were investigated by comparison of (a) Liver glycogen levels and (b)Triglyceride level in adipose tissue in normaglycemic and STZ – induced (by i.v. 50 mg/kg) diabetic rats that were orally treated with the HWE with those that did not receive the extract in the corresponding groups.

Wistar rats (175 – 200 g body weight) were randomly divided in to 4 groups. Rats in Group 1 (n = 12; normal controls) were orally administered distilled water (1.0 ml/Kg), Group 2 (n = 12; normal test) received HWE (750 mg/kg of body weight), Group 3 (n = 7; diabetic control) received distilled water (1.0 ml/Kg) while group 4 (diabetic test) received HWE consecutively for 28 days. The dose of 750 mg/kg T.C was used because it exerted the maximum hypoglycemic effect in the previous study. Rats were kept fasting and, blood samples were collected from their tails at 14 days and 28 days post treatment and serum glucose levels determined. Subsequently, rats were sacrificed, livers and adipose tissues were harvested and subjected for estimation of glycogen levels and triglyceride levels respectively.

In the diabetic rats, compared to the control group HWE significantly reduce the blood glucose levels at the end of 14 days and 28 days. The reduction in blood glucose was comparable to that produced by the antidiabetic drug, glibenclamide (0.6 mg/Kg). In normaglycemic rats HWE reduced the blood glucose levels at the end of 14 and 28 days. At the end of 28 days, it was found that in both normaglycemic and STZ – induced diabetic rats, there was a significant (P≤ 0.05) increase in the levels of liver glycogen (normaglycemic rats by 55.8 %; diabetic rats by 93.6 %) and adipose tissue triglyceride (normaglycemic rats by 14.3 %; diabetic rats by 16.7 %) in comparison with the respective controls that were not treated with HWE.

It may be concluded that hypoglycemic effects demonstrated by T.C are mediated mainly via enhanced up take of blood glucose in to extra – pancreatic tissues.

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A study on cost of caring for patients with dengue fever at Professorial Medical Unit, Colombo North Teaching Hospital

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Dengue fever (DF) and Dengue Hemorrhagic Fever (DHF) may constitute a substantial economic burden on both the healthcare system and individual households in Sri Lanka. The objective of this study was to determine cost of caring for patients with DF and to determine the economic impact of DF on households and healthcare institution. The direct economic impact of the healthcare system and on the households of 31 laboratory confirmed dengue patients who were managed in the professorial medical wards of the North Colombo Teaching Hospital, Ragama was assessed during October, 2006 to March, 2007. The institutional cost was calculated using data obtained from relevant departments of the hospital. The cost for the households of each patient was calculated using an interviewer administrated questionnaire. Of the 31 patients enrolled all had DF and none developed DHF. The median and mode for hospital admission of study sample was third day of fever (range 1-7). The mean Direct Household Cost (DHC) for a single day in hospital of a dengue patient was Rs 820.06. Over 90% of DHC consisted of cost for transportation (33.22%), food (30.44%) and for services obtained from outside hospital sources (30.14%). The mean basic institutional cost for a patient-day in a medical ward of the hospital (excluding the cost for specific management of an illness) was Rs.961.81. Total institutional cost of caring dengue patient per day was Rs. 1142.57 which comprised of cost for basic inpatient care (84.2%) and specific management of dengue fever (15.82%). Further, total cost of hospitalization due to dengue for the study sample comprised of 6.5% for drugs, 17% for investigations and 76.5% for accommodation, staff, transportation, food and other expenses. The study shows a considerable economic burden for both hospital and households due to hospitalization with dengue fever. Although this study focused on some aspects of curative care, primary prevention should be regarded as the basis for minimizing the economic and social burden. The rising demand for the laboratory investigations needs to be addressed by the public sector in a more systematic manner. The substantial burden on the household can be reduced by integration of the private sector in to the system in a rational manner and ensuring a pricing policy.

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Study on 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity in relation to the phenolic and gallic acid content in four medicinal plants used for cancer therapy in Sri Lanka

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Antioxidants have an important role in preventing a variety of diseases including cancer. It has been shown that phenolic substances present in plants have major contribution for their antioxidant activity. The objective of this study was to investigate, the antioxidant activity in relation to the polyphenolic and gallic acid contents in four traditional medicinal plants used by traditional medical practitioners in Sri Lanka for cancer therapy.

The total phenolic content present in water extract of Smilax glabra (Cheena Ala; root), Bombax ceiba (ela imbul; gum), Anacyclus pyrethrum (Akkarapatta; root) and Hemidesmus indicus (Iramusu; root) was determined by Folin-Ciocalteu method. Caffeine and gallic acid were quantified by high performance liquids chromatography (HPLC). Total free radical scavenging activity of each ingredient was investigated by 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging method and the values were compared with phenolic and gallic acid present in each plant.

The polyphenol content of Bombax ceiba, Anacyllus pyrethrum, Hemidesmus indicus and Smilax glabra, were 32.57 ± 5.04 %, 30.98 ± 2.97 14.52 ± 1.13 and 19.43 ± 2.89 % w/w gallic acid equivalents respectively. Detectable levels of gallic acid were present only in Bombax ceiba (1.46 mg g⁻¹) and Smilax glabra, (0.94 mg g⁻¹). The EC₅₀ values for DPPH radical scavenging activity for Bombax ceiba, Anacyllus pyrethrum Hemidesmus indicus and Smilax glabra were 15.47±1.80, 15.01±0.82, 46.78±16.03 and 35.67±0.64 µg cm⁻³. The mean values of EC₅₀ (y) for DPPH radical scavenging activity were correlated with total phenolics (x) present in plant extracts (y = -35.417x + 1428; R² = 0.9887), for all plant ingredients used in this study.

The above findings suggest that phenolic substances present in the four plants, contribute to their free radical scavenging activity in the presence or absence of endogenous gallic acid.

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SECTION B

101/B

Nutritional studies on rice bran incorporated cereal

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Rice bran is a highly nutritious by-product of the rice processing industry. In Sri Lanka it is utilized only as an animal feed. The present study reports the utilization of rice bran to produce a consumer acceptable breakfast cereal and the nutritional properties of the product.

Three cereals were prepared by mixing rice flour (milled by 2 mm diameter die) with 5\%, 10\% and 15\% stabilized rice bran from Madathawalu. The rice bran was stabilized by steaming in a pressure cooker immediately after milling. The mixture was extruded with a 2 mm die at 140 °C using a twin screw extruder. The cereal prepared was dried at 60 °C for 2 hours and sealed in double layered polythene. The sensory evaluation of the product mixed with slightly warmed milk containing sugar was carried out by 12 trained panellists at ITI using seven point hedonic scale for colour, odour, flavour, appearance. The resulting scores were analysed using the Friedman non-parametric statistical test in the SAS package. The results of sensory evaluation suggest that 10\% rice bran incorporated cereal was the best product and the proximate analysis of the product (moisture, protein, fat, ash, fibre and carbohydrates) was also carried out.

It was observed that the percentages of moisture, protein, fat, ash, fibre contents of the particular product (dry weight g/g) were 9.3 ± 0.3, 10.9 ± 0.5, 4.2 ± 0.3, 1.2 ± 0.02, 0.8 ± 0.1 and 82.5 ± 0.9, respectively while those of rice were 14.3 ± 0.3, 8.1 ± 0.5, 0.96 ± 0.13, 0.7 ± 0.1, 0.55 ± 0.04 and 89.4 ± 0.6 and of rice bran was 8.53 ± 0.03, 16.8 ± 0.4, 18.1 ± 0.4, 5.71 ± 0.97, 5.6 ± 0.5 and 53.1 ± 2.5, respectively.

The present study reveals that a consumer acceptable cereal that is more nutritious than rice could be obtained by incorporating 10\% rice bran with rice.

Further, the ash (7 -12\%) and crude fibre (8 -12\%) content in Madathawalu were lower while moisture (8-12\%), protein (12 -16\%) and fat (16 -22\%) were within the range reported elsewhere.

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Trans fatty acid formation in vegetable oils during repeated heating

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Trans fatty acid formation during repeated heating of vegetable oils has become a food safety concern today. Due to the negative impact of trans fatty acids on human health, investigation of trans fatty acid formation during repeated heating of vegetable oils is of great importance. The objective of this study was to assess the effect of repetitive heating of vegetable oils on formation of trans fatty acids. Vegetable oils, namely soy oil, palm olein and virgin coconut oil were heated at different temperatures (180 ºC, 200 ºC, and 220 ºC) for 20 min for five days successively with one heating cycle per day. The heating experiment was repeated without controlling the temperature. Oil samples (60 ml) were withdrawn after each heating cycle and analyzed for the trans fatty acid content by Gas Chromatograph.

The amount of trans fatty acids contained in the original soy oil, palm olein and virgin coconut oil samples were 3.3%, 0.3% and 0% respectively. After five days of continuous heating the trans fatty acid contents was not significantly (p>0.05) different in all three oil samples heated at 180 ºC, 200 ºC and 220 ºC. However the samples heated without controlling the temperature showed a sharp increase in trans fatty acid contents. The trans fatty acid contents of soy oil, palm olein and virgin coconut oil heated without controlling the temperature were 10.7%, 2.2% and 0.3% respectively. The least alterations to the trans fatty acid content was observed in virgin coconut oil sample.

The changes in trans fatty acid formation depended on the temperature used in repeated heating. Repeated heating appear safe under temperature conditions lower than 220 ºC, in relation to trans fatty acid formation. Moreover, minimizing the number of cycles of repeated frying less than five cycles would be a better approach in deep frying irrespective of the oil used.

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Development of pasteurized coconut milk pouches for domestic consumption

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Provision of coconut milk as a stable and in a homogeneous form is a convenient product for the domestic market. Coconut milk is extracted from freshly grated coconut meat, and undergoes progressive deterioration, in a few hours at room temperature (28-30°C). This is due to its high content of fat and moisture which quickly deteriorate upon exposure to microorganisms, light, oxygen and high temperature. Short term preservation is easily effected by pasteurizing the milk, but long term storage can only be achieved by using a heating system that ensures commercial sterility of the product. This research was conducted to develop a coconut milk pouch from mature coconut kernel. Coconut cream was extracted from grated coconut and diluted up to 20% fat content. Stabilizers were added and homogenized. Pasteurized milk was packaged and stored at 4°C. pH, free fatty acid and Brix value were checked at selected storage intervals. Combination of 0.5% Sodium stearoyl lactate and 0.5% Sodium caseinate prevented layer separation. The optimum temperature and time combination observed for pasteurization was 72°C for 20 minutes. Nylon low density polyethylene pouches and Aluminum laminated linear low density polyethylene pouches were identified as suitable packaging materials. pH value decreased gradually from 6.5 to 6 throughout the storage period but it did not reach the unacceptable level (<5.9) at end of four weeks. A Brix value of 10 remained constant throughout the storage period. Free Fatty Acid value reached up to 0.78 which was below the critical level (1%). A consumer preference test on taste, aroma, texture and overall acceptability showed preference (like slightly) to the processed product by the panelists (p>0.05) after two weeks of storage compare to that of fresh milk. After four weeks there was no significant difference (p>0.05) in taste, aroma and overall acceptability but there was a significant difference (p=0.006) observed in texture compared with fresh milk. Storage studies indicate that pasteurized coconut milk pouches could be stored for 14 days at refrigeration condition at 4°C with no change in sensory characters.

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Reducing the use of salt (sodium chloride) in natural gherkin fermentation process and storage

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The current practice of gherkin pickling maintain a fruit to brine ratio of 60/40 and fermenting for 4 to 6 weeks with 5 – 7 % of salt allowing natural micro flora to act. Microorganisms utilize sugars diffused from the gherkins, producing lactic acid and reducing pH to 3.5. This is followed by increasing brine strength gradually up to 13 – 16 % by adding dry salt. The combination of low pH and high salt preserve the product more than one year by suppressing the activity of spoilage microorganisms. This study was conducted to reduce the amount of salt used for storage of fermented gherkins, below the current level. Gherkin fermentations were carried out in brine containing potassium sorbate (0.07 %) and glacial acetic acid (0.05 %) as practiced industrially and with modified new concentrations. Changes in brine pH and acidity (as lactic), reducing sugar, yeast and mold were followed over time. The modified brine containing potassium sorbate (0.1 %) and glacial acetic acid (0.15 %) developed maximum acidity and required minimum pH of <3. The low acidity in industrial brines are caused by yeast fermentation and luxurious scum (surface film) of fungus during fermentation. But, improper pack out ratio (fruit to brine 45/55) in modified brine resulted in a low buffering action that resulted in reaching an inhibitory pH level of 3.15 for lactic acid bacterial fermentation. In modified brine, the yeast fermentation is controlled by high levels of potassium sorbate that results in a lesser brine acid production and incomplete utilization of fermentable sugars. However, industrial brine shows quick completion of fermentation with the involvement of both lactic acid bacteria and yeast. Further studies were carried out with modified brine by adjusting the pH and maintaining anaerobic storage conditions at a salt level of 5 – 7 %. After one month of storage period, there was no significant difference in texture, color and aroma of gherkin fermented by industrial and modified methods. The adjusting pH in modified brine maintained the acidic environment along with the yeast and mold activity, because this pH level did not increase up to undesirable levels that favored growth of spoilage bacteria. The modified brine can used in industrially, with fruit to brine ratio of 60/40 to develop high acidity (>1.0 %) and low PH (3.0 – 3.2). Combination of acidification and anaerobic condition can be used with modified brine to store fermented gherkins at 5- 7 % salt having same color, texture and aroma of the current product.

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Study on the antioxidant activity of mangosteen (*Garcinia mangostana*)

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Water and ethanolic extracts of mangosteen peel and the pulp prepared using different extraction methods were assessed for total phenolic content, flavonoid content, free radical scavenging activity, ferrous ion chelating activity, and ferric ion reducing activity. The phenolic content was significantly (*P* < 0.05) higher in the water brew and lower in the 96% ethanolic extract. The respective values were 304.56 mg GAE/g and 36.07 mg GAE/g. The flavonoid content was significantly (*P* < 0.05) higher in the water brew: 9.0 mg QE/g. DPPH radical scavenging activity was low in the fruit pulp than in the peel. Considering the peel extracts, DPPH radical scavenging activity was significantly (*P* < 0.05) higher in water brew and IC₅₀ value was 0.02 mg/ml. The ferrous ion-chelating effect and ferric ion reducing power of all peel extracts (2 mg/ml) were low. Furthermore, the water distillate did not show positive results for any of the above assays. Water brew of mangosteen peel with high antioxidant activity, was incorporated into a carbonated beverage at 1:19 ratio of water brew to beverage combination. The IC₅₀ values of the beverage and the new formulation were 31.34 mg/ml and 13.76 mg/ml respectively. The enhancement of the radical scavenging activity of the beverage was over two folds. This study reveals that mangosteen has a considerably high antioxidant power in the hot water brew. Furthermore, the extract can be utilized to enhance the antioxidant capacity of beverages.

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Production of tomato sauce and tomato leather using dehydrated tomato powder

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Tomato is one of the most popular and widely grown, vegetable crop in Sri Lanka and is easily grown in all agro-ecological zones of the country with an average yield of 9.8 metric tons per hectare. Tomato is consumed throughout the year with different forms. A wide variety of tomato products are prepared by concentrated juice or pulp, which need high cost technology for good quality products. But cost of processing methods should be minimum to be successful in present competitive market systems. Therefore, drying is the most suitable method to fulfill the above requirements. This study was conducted to develop a suitable drying method for production of dehydrated tomato powder and to study the application of that in production of sauce and tomato leather at the post harvest and animal science laboratory, Faculty of Agriculture, Rajarata University of Sri Lanka. Ripe tomatoes were subjected to two different processing methods namely tomato pulp drying and tomato slice drying. Changes in moisture, total ash, crude fat, crude fiber, and crude protein contents were determined after dehydration. The acceptability of tomato sauce and leather produced using dried tomato powder was tested by a sensory evaluation panel consisting of 30 untrained panelist using a five point Hedonic scale. Then a suitable packaging material for storage of the tomato powder was selected based on the changes in moisture content, water activity and rehydration ratio of the product. Results revealed that blanching at 60 °C hot water with 5% citric acid and 5% salt was successful to preserve colour in dried powder. The drying at 55 °C for 48 h was sufficient to reduce the water activity up to 0.61 and to obtain a shelf stable product with good physico-chemical properties. Results further revealed that drying of tomato slices was better than that of tomato pulp in manufacturing tomato powder. Dried powder packed in pouches made out of triple laminated Al foil could be stored at 27±3 °C and 82±3 % relative humidity for three months without quality deterioration. Tomato powder produced using dried tomato slices and dried tomato powder could be effectively used in manufacturing sauce and tomato leather with excellent quality characteristics.

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Effect of processing temperature and preservative on quality of banana puree

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Thermal processing is a technique widely used to preserve foods, which could be applied to utilize banana to produce a dessert food named banana puree. A research was performed to investigate the quality of banana puree using different concentrations of a preservative and various processing temperatures. Fresh fully ripe sugar banana fruits were peeled and dipped in different concentrations of 500 ppm, 750 ppm and 1000 ppm potassium metabisulphite solutions for 5 minutes. The treated fruits were blended and the puree was heated to different temperatures of 70 °C, 80 °C and 90 °C for 15 minutes. The processed products were filled in sterilized glass bottles and assessed for nutritional qualities and sensory attributes.

Nutritional analysis was carried out for titrable acidity, ascorbic acid and total sugars for both fresh fruits and puree. The puree heated to 70 °C had the better nutritional qualities compared to the puree heated to 80 °C and 90 °C. The titrable acidity of fresh banana was found to be 0.84% which was higher than that of puree. The banana puree heated to 90 °C showed low acid content than the puree heated to 70 °C and 80 °C as a result of evaporative loss of acids at higher temperature. The product heated to 70 °C and treated with 1000 ppm potassium metabisulphite showed better nutritional retention than the other treatments. The total sugars of this treatment reduced from 21.5 to 18.7% whereas the ascorbic acid retention was found to be superior to the other treatments. Sensory qualities were assessed for banana flavour, taste, colour, texture, absence of browning and overall acceptability of the treatments. The results of organoleptic assessment revealed that there were significant (p<0.05) differences between the treatments in the sensory attributes. The attractive colour was observed in the puree heated to 70 °C and higher degree of browning was developed in the fruits treated with 500 ppm potassium metabisulphite. Considering the nutritional qualities and sensory attributes, the processing temperature of 70 °C and potassium metabisulphite concentration of 1000 ppm could be used to prepare banana puree commercially.

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Determination of the survival kinetics of probiotic bifidobacteria and lactobacilli in a commercial brand of bio-yoghurt in Sri Lanka

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Probiotics are live microorganisms which, when administered in adequate amounts, confer health benefits such as reduction of lactose intolerance, prevention of diarrhoeal diseases and protection from some forms of cancer. It has been reported that probiotic products should carry >10⁶ CFU/g of probiotic organisms at the time of consumption to have the reported health benefits. However, maintenance of the viability of probiotic bacteria in bio-yoghurts during storage at refrigeration temperature remains a problem as these organisms rapidly lose their viability. Even though many studies on the survival kinetics of probiotic bacteria in developed countries have been reported, no comparable studies are reported from Sri Lanka. Therefore, this study mainly focused on determination of survival kinetics of lactobacilli and bifidobacteria in a commercial brand of bio-yoghurt produced and marketed in Sri Lanka.

At the moment only one manufacturer produces bio-yoghurts in commercial scale in Sri Lanka and the present study was carried out as a collaborative study with the said manufacturer. Bio-yoghurt samples were obtained from the factory at the time of manufacture, stored at chill temperature (4±2°C) for a period of six weeks and probiotic (Lactobacillus acidophilus and bifidobacteria) and yoghurt bacteria (Streptococcus thermophilus and Lactobacillus bulgaricus) were enumerated at weekly intervals. Titratable acidity and pH were also determined at weekly intervals during the storage period. Bifidobacteria and L. acidophilus populations were 10⁶ CFU/g and 10⁷ CFU/g, respectively at the time of purchase and showed a constant decline in numbers during storage. The usual maximum shelf-life of the particular bio-yoghurt is 28 days, but the earlier the product is consumed the better its therapeutic properties, as on expiry low viable cells of bifidobacteria (10² CFU/g) and L. acidophilus (10⁴ CFU/g) were observed. The factors that appeared to affect the viability of bifidobacteria and L. acidophilus in bio-yoghurts were pH and titratable acidity, storage temperature and antagonistic effects exerted by yoghurt bacteria. Bifidobacteria showed a faster rate of death compared to L. acidophilus. The observed decrease in probiotic bacterial population coincided with the increase in titratable acidity and decrease in pH of bio-yoghurts. Presence of L. bulgaricus appeared to affect the viability of probiotic organisms possibly due to the production of hydrogen peroxide. It can be concluded that the sooner the product is consumed the higher the chances to ingest a sufficient load of probiotic bacteria in the gut.

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Reliability of lactometers in the determination of specific gravity of milk

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One of the major problems associated with modern dairy farming is adulteration of milk with water, sugar, salt, starch like solids, in order to increase the volume. Specific gravity (SG) is used for the detection of adulteration and together with fat for pricing of milk. Therefore the objectives of this study was to compare the SG values measured by the gravimetric method with the values obtained by using different types of lactometers which are widely used in Sri Lanka and to check the reliability of lactometers and effects on specific gravity when milk is adulterated.

In the first experiment SG value of cow milk samples were collected from NLDB farms and private farms of the mid country were determined either by gravimetric method and using 6 types of lactometers (Zeal, BS 734, Dutch type, ISI, Benny and Field). As the second experiment the SG of purposely adulterated milk samples were measured using the 6 lactometers and the gravimetric method. The experimental design was a Complete Randomized Design (CRD).

SG values calculated using all six types of lactometers were different (P<0.001) from gravimetric method for cow milk. Further the gravimetric SG values (1.029±0.002) were always higher than that of calculated lactometer values (1.026±0.002). Benny, ISI and Field type lactometers (1.027±0.002) gave closer values to gravimetric method. Similarly gravimetric method gave higher SG of adulterated milk as compared with calculated values for all six types of lactometers. For solid type adulterants (sugar, salt, starch and urea), ISI and Benny gave similar values as compared to gravimetric method.

Generally it can be concluded that all the SG values obtained using gravimetric method were significantly higher than lactometer values, ISI and Benny were the best lactometer to measure the SG of adulterated cow milk, and Salt followed by sugar had the greatest effect on SG of cow milk while urea had the least effect.

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The objective of this research was to investigate the density of Sri Lankan paddy varieties. The true density, bulk density and porosity were the properties measured at the moisture content of 10% (dry basis). Information related to moisture content, volume, true density, bulk density and porosity are the basic parameters for studying the drying and storage of agricultural products. Specific gravity bottle together with water, coconut oil and Toluene (C\textsubscript{7}H\textsubscript{8}) were used to determine the true density. Due to the lack of affinity to water and low surface tension make Toluene a better liquid to investigate true density of paddy using liquid displacement method. Toluene is not absorbed by the paddy seeds and it fills even shallow groves in the seeds (due to low surface tension). Investigations revealed that the true density increases with the moisture content. The highest true density of 1221 kgm\textsuperscript{-3} was obtained for BG 300, while the lowest true density of 1205 kgm\textsuperscript{-3} was found for BG 357. Although the bulk density and porosity was found to depend on the dimensions and the shape of the seeds, the dominant factor which determines the bulk density was found to be the true density. Moreover, the investigations also revealed that the bulk density of paddy increases with the diameter of the container used to store paddy and there is no significant difference in their bulk densities with respect to the height of the seed columns. Bulk densities and true densities of BG 300, BG 358, BG 352 and BG 357 were in decreasing order and porosities of BG 300, BG 358, BG 352 and BG 357 were in increasing order.

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**Extension of post-harvest life of green leafy vegetables, *Alternanthera* and *Sesbania* through improved post-harvest practices**

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*Alternanthera sessilis* (Mukunuwenna) and *Sesbania grandiflora* (Kathurumurunga) are the main green leafy vegetables which provide vitamins and minerals to many Sri Lankan diets. They have high demand in the export market as well. However, it is difficult to export because of early senescence, wilting and defoliation. Therefore this study was mainly conducted to determine the effect of pre-cooling, time of harvesting, orientation of the bundles (in storage) and the effect of modified atmosphere on minimizing early senescence, wilting and defoliation and thereby to develop a proper method to extend the shelf life of *Alternanthera* and *Sesbania*.

The result revealed that harvesting of both *Alternanthera* and *Sesbania* leaves in the early afternoon extends the shelf life compared to morning harvesting. Pre-cooling (room cooling at 10-12 °C for half an hour) alone is effective for *Alternanthera* for reducing wilting, yellowing and weight loss while pre-cooling (room cooling at 10-12 °C for half an hour) followed by packing with gel ice was more effective against defoliation (3.45% weight loss) for *Sesbania* leaves. In the wrapping material test for *Sesbania* the least weight loss (0.25%) was observed in samples wrapped with 150 gauge low density polyethylene (LDPE) compared to other wrapping materials. However there was no difference among different wrapping materials such as LDPE, polypropylene and cling film with respect to the rate of yellowing, wilting and sensory qualities. Based on the same indices, placing the bundles vertically inside rigid form boxes was identified as the best packing procedure for both *Alternanthera* and *Sesbania*.

Sealed LDPE developed a conducive storage atmosphere for preserving the quality of *Alternanthera* up to 5 days at storage temperature of 26 °C whereas *Sesbania* could be kept for 4 days without a significant level of deterioration.

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Fungal contaminations of dried black pepper (*Piper nigrum* L.) collected from different market places in Matale area

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The major factors deciding the quality of black pepper are appearance of the final product, flavor, aroma and pungency, free from foreign or extraneous matter, long shelf life and fit for human consumption. To meet the above characteristics pepper producers should take special care during post harvest operations to avoid all unfavorable circumstances leading to deterioration of above characteristics. Out of all the above mentioned quality characteristics, most of the major regulatory bodies pay much attention on cleanliness, sanitary and phyto-sanitary issues related to the black pepper final product.

This study was conducted to investigate on fungi associated with dried black pepper that is ready for consumption. The samples collected from different wholesale and retail market places in Matale area were analyzed following the methods using United States food and drug administration bacteriological analytical manual (USFDA-BAM). The common fungi species found were *Aspergillus* spp., *Pennicillium* spp., *Mucor* spp., *Fusarium* spp. and *Curvularia* spp. Out of three different *Aspergillus* spp. observed, *Aspergillus niger* was successfully identified by studying morphological features. Internal invasion of *Aspergillus* spp. and *Pennicillium* spp. were observed in several samples.

The levels of fungi with dilution plating technique ranged from $7.3 \times 10^2$ cfu/g to $8.8 \times 10^7$ cfu/g. These results were statistically analyzed by one sample t test. Mean of the sample cfu/g was significantly higher than the IPC standard value of $1 \times 10^3$ cfu/g. The moldiness percentage observed by analysis of non surface disinfected (NSD) method ranged from 74% - 100%. The very same samples gave exactly different values for moldiness percentages when analyzed following Sri Lankan Standards. Those values ranged from 6%-24%. When the surface disinfected samples were directly plated (SD method) it gave moldiness from 4%-42%. By comparing SD and NSD values of the same sample it can be determined if moldiness is due to surface contamination or to internal invasion and growth. IPC recommends that the maximum percentage of mouldiness should be 1% (% by weight). The extraneous matter levels of the samples ranged from 0.01% - 0.08% by mass. Those values are in the accepted range of IPC (% by weight, maximum 1%).

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Performance evaluation of flat bed drying system for pepper drying

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Drying is the most important step of the pepper processing for a good quality final product. Sun drying produces poor quality final product with mould growth and contamination with dust, dirt, insect and other animal excreta. Quality is the necessary factor to enter international market. Though there are mechanical dryers in the market they are very expensive and mostly operated by electricity or fossil fuel. Hence their operation costs are very high. The study was to develop an appropriate dryer to overcome the all these issues in the pepper industry in Sri Lanka. The research was conducted at Post Harvest Technology Research Division, Research station of the Department of Export Agriculture, Matale. The dryer was an indirect heated batch type flatbed dryer operated with biomass (firewood) energy. The dryer consist with a simple drying chamber and hot air generator including furnace and heat exchanger.

Blanched pepper was used for the performance evaluation. Temperature fluctuation, moisture reduction and drying costs were considered for evaluation. The ambient temperature was fluctuated between 23 °C 31 °C during the tested period. The heated air temperature in plenum chamber was low at the beginning of the trials and increased up to 80 °C, but the drying bed temperature was not exceeded 60 °C. The moisture content of fresh pepper was raised up to 80 % after blanching. Three drying trails, 3 cm, 6 cm, and 9 cm of bed thickness were 50 kg, 100 kg and 150 kg capacities respectively. The final moisture content of three trails was reduced to 12 % within 9 hours, 10 hours, and 18 hours respectively. The drying cost of three trails was Rs. 13.86, Rs. 8.66 and Rs.10.21 respectively. Economical drying capacity of the dryer was 100 kg with 6 cm thickness. This dryer is suitable to introduce for medium scale pepper producing farmers. Further massive modification is needed to increase the capacity up to 500 kg.

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Evaluation of grain quality parameters of rice varieties stored in different storage materials

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In Sri Lanka paddy prices fluctuate severely showing a minimum price at harvest. To be benefited by higher prices, farmers strive to store paddy. But poor storage management and lack of technology cause quantitative and qualitative losses by rodents, insect attack and microbial deterioration. Most commonly farmers use polysacks (PS) to store paddy. To overcome the pest attacks an air tight storage bags are made of PVC (Polyvinylchloride) were introduced by International Rice Research Institute (IRRI). Therefore, the study was conducted at Rice Research and Development Institute, Batalagaoda to evaluate the grain quality parameters of six rice varieties (Bg352, Bg300, Bg358, Bg360, At405, At306) stored in such hermetically sealed materials (IRRI bags) and polysacks (PS) use as a control sample. Grain qualities (milling, physical, and nutritional) were evaluated after 9 months of storage paddy. Milling qualities like brown rice percentage (BR%); head grain percentage (HG%) were taken and the highest BR% was observed in Bg352 (81.26) and physical qualities such as weight of thousand grains were significantly higher in hermetically stored paddy after 9 months storage. Hardness of variety At 405 (52.58) in IRRI and At 306 (63.00) in polysacks and the highest whiteness (43.7) in Bg352 stored in polysacks. Variety At306 had the lowest milling quality characteristics than that of other varieties. There was no significant difference in head grain percentage, hardness of the kernels, whiteness and all the nutritional qualities with the two storage materials. It can be concluded from the results that quality parameters such as BR% and grain weight could be maintained better by storing hermetically. Hermetically stored paddy obtained significantly higher grain quality parameters than that of paddy stored in polysacks. Different paddy varieties showed different grain quality parameters

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Potential of activated coconut shell charcoal (ACSC) in in vitro culture of Cocos nucifera L. (coconut)

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The presence of plant growth regulators in combination with activated charcoal in tissue culture media results in undefined culture conditions. Different types/ batches of activated charcoal have varying adsorption capacities and can produce unreliable results. Coconut is a highly recalcitrant plant to in vitro regeneration and coconut tissues require guaranteed source of activated charcoal with consistent characteristics. Therefore, the objective of the study was to evaluate locally manufactured activated coconut shell charcoal (ACSC) (Haycarb PLC) as a potential source.

Immature zygotic embryos of coconut (variety Sri Lanka Tall) were cultured in basal media supplemented with different types of ACSC (A, B, C and D) and BDH charcoal (control). The optimum 2, 4-D levels were assessed by culturing of explants in media with varying 2, 4-D levels and HPLC analysis of free 2, 4-D in culture media. The suitability of the selected ACSC type was confirmed by culturing of plumule explants of coconut.

Immature zygotic embryo cultured in media containing 125 µM 2, 4-D + ACSC A and 175 µM 2, 4-D + ACSC B produced callus at frequencies (59 and 63 % respectively) comparable to that of control (63 %). HPLC analysis showed the presence of 1.5-2.5 µM (approx.) free 2, 4-D in all the three media despite the different 2, 4-D levels added. Based on HPLC analysis, the effective 2, 4-D levels to be used in combination with ACSC C/ D were determined (5 – 10 µM). However, immature zygotic embryos showed poor performance (14 and 40 % callus having a slow growth) in media containing ACSC C and D. Due to the poor mixing properties of ACSC A with the medium, only ACSC B was selected for further studies. Plumules cultured in media containing ACSC B and BDH produced comparable callusing (65 and 70 % respectively) and confirmed the suitability of ACSC B for coconut tissue culture at callusing stage.

The study enabled the selection of an effective ACSC type (B) for coconut tissue culture. Its use will result in reliable results and economical benefits over the use of imported charcoal types.

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Surface sterilization and culture establishment of Araucaria (*Araucaria columnaris*) explants excised from shoot tips of secondary shoot branches

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The current study was carried out to identify an *in vitro* micro propagation protocol for mass scale production of this species as conventional propagation through seeds is slow and inadequate while difficulties in root formation when using cuttings and production of plagiotropic plants if lateral shoots used. The importance of this plant is for reforestation, timber production and as an ornamental.

Shoot tips derived from secondary branches were excised from four year old tree and surface sterilized using three different concentrations of Clorox (5.25% Sodium Hypochlorite –NaOCl) (10%, 15% and 20%) with three different exposure time durations (10, 15 and 20 minutes) with 70% ethanol for two minutes. Explants were established in modified MS (Murashige and Skoog’s medium, 1962), WPM: McCown’s Woody Plant (Lloyd and McCown, 1981), Anderson (Anderson, W.C. 1984) and B5 (Gamberg, 1968) media with and with out using 1g/L activated charcoal. Experiments were replicated 20 times and analyzed using SAS computer software. Contaminations, browning and growth performances were recorded in weekly intervals and data were analyzed using SAS computer software. Results revealed that 10% NaOCl for 20 minutes exposure time with 70% alcohol for two minutes exposure time recorded the highest survival percentages where contaminations reduced to 30% without deaths due to chemical burning. Modified WPM with 1g/L activated charcoal, was the best establishment medium for shoot tips with minimum browning occurred in the medium as well as on explants with a height increment (1 cm/ explant) of explants. Fungal contaminations were controlled by subsequent sub culturing to the same medium. It can be concluded that Araucaria shoot tips detached from four year old tree can be successfully surface sterilized using commercially available Clorox and ethanol solutions and they can be established *in vitro* in modified WPM medium containing 1 g/L activated charcoal.

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Identification of new rice accessions as resistant to rice brown planthopper, *Nilaparvata lugens* Stål. in Sri Lanka

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Rice germplasm were screened following the standard bulk seedling test against three BPH cultures reared by the Plant Genetic Resources Center (PGRC) at Peradeniya in 2008. These BPH cultures represented non-virulent natural population collected and reared in planthouse for several decades and two, virulent populations collected from epidemic fields in Kegalle and Hakmana respectively and reared in planthouse by the Department of Agriculture from 2006 and 2007. Tested materials represented rice breeding lines of the Rice Research Centers of the Department of Agriculture at Bombuwela and Ambalanthota and rice germplasm conserved at the PGRC at Peradeniya. Indian cultivar, Ptb 33 and Taichum Native 1 (TN1) were used as resistant and susceptible checks. Results indicated significantly the highest resistance in Bw 05-1337, Bw 04-1945, Bw 06-850 and Bw 06-730 and higher resistance in Bw 06-742, Bw 05-1750, Bw 05-1846 and KDML 105. Those germplasm with the highest resistance were considered as resistant and those with higher resistant were considered as moderately resistant. More than 57 of the tested germplasm were identified as susceptible.

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Effect of host crop on mass propagation of vesicular arbuscular mycorrhizae (*Glomus mosseae*)

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Vesicular arbuscular mycorrhizal (VAM) fungi are a group of obligate plant symbionts that improve plant growth and development of associated higher plants. The potential of VAM for productivity improvement of black pepper (*Piper nigrum*) and cinnamon (*Cinnomomum verum* Presl Syn. *Cinnomomum zeylanicum* Blume) are been exploited. As an initial step, this experiment was carried out with the objectives of finding the appropriate host crop species and time of uprooting the host crop to obtain maximum possible number of spores in the inoculum.

Two hundred and fifty grams of inoculum (consisted of mycorrhizal spores and structures (*Glomus mosseae*) with sorghum roots and moist soil) was incorporated into the sterile soil in each pot. Thus initial spore density values became to 23 brown spores and 6 black spores per 50 gram of the potting media of each pot. Surface sterilized seeds of three host crops each sorghum, maize and finger millet were planted in separate pots. The experimental design was complete randomized design with 12 replicates. Three replicates from each host crop were uprooted at different time intervals i.e. 8, 10 and 12 weeks after planting. Spore density variation of potting media under each host crop was measured using wet sieving technique.

The observations of this study are comparable with spore density observations of similar studies. Two types of spores namely brown and black in colour were observed and observations of stained internal mycorrhizal structures in root pieces confirmed the success of initial inoculation of each species. Mean brown spore density value became 142 (± 98 SD) per 50g of potting media at 12 week after inoculation of each species. Brown spore density values of each species became almost equal towards harvest at 12 week and spore density of finger millet remains above 100 spores per 50gm during three uprooting times. Under local conditions, finger millet can be recommended to use as a host crop for mass propagation of VAM. This crop would give an additional income as a grain harvest also at 12 weeks.

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A time series analysis of coconut prices: seasonal variation, trends and parity

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Prices of coconut and allied products were remarkably increased in the recent past and volatility of coconut prices is a common phenomenon. As the production of coconut has not been declined (Central Bank, 2007) substantially during last decade, finding the factors behind the price increases and price volatility is important for policy formulation. Therefore, the objective of this study is to analyze price behavior of coconut and allied products.

Data required for the study were extracted from monthly bulletins of Coconut Development Authority (CDA), Central Bank Publications and the data bank of Asian Pacific Coconut Community (APCC).

Published data of coconut prices for the period from 1974 to 2006 were used for the analysis. If the data series are non-stationary, first order differences were taken. If the data series is still non-stationary, first order differences were taken in log-transformed series. Stationary data series were fitted to six conventional time series models, viz; General decomposition method, Moving average method, Winter’s method, Single exponential smoothing method, Double exponential smoothing method, and Auto regressive moving average (ARIMA) method. Mean Absolute Percentage Error (MAPE), Mean Absolute Deviation (MAD), Mean Squared Deviation (MSD) were used to test the model adequacy and accuracy. In order to find the seasonal (monthly) indices, the de-trended data series was smoothed by using a centered moving average of order twelve. After the moving average is obtained, it is subtracted from the de-trended data to obtain raw seasonal values. Within each seasonal period, the median values of the raw seasonal values were calculated. These medians make up the seasonal indices.

The results revealed that the ARIMA & exponential methods are better than other models to predict prices of coconut and coconut products in Sri Lanka. Seasonal indices of retail prices of fresh coconut revealed that high prices from December to March is normal while lower prices in July and August. However parity price analysis revealed that rate of increasing real prices of coconut is higher than that of other necessary food items such as rice reflecting relative scarcity or some other trends which should be considered in further research.

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Development and biochemical assessment of peanut beverage

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Peanut (Arachis hypogea) is one of the major types of pulses grown in Sri Lanka which condensed with fat (40.1%), protein (25.3%) and number of other nutrients essential for a healthy life. But it is still underutilized in Sri Lanka. The study was conducted to improve the peanut utilization by developing a peanut beverage similar to milk.

The peanut variety known as Tissa, which was purchased from local markets was used in this study. Mainly two procedures were adopted to determine the exact production procedure of peanut milk with the best organoleptic properties. In the first method, dehusked peanuts were directly ground and boiled to produce peanut milk while in the second method the dehusked kernels were boiled in water for ten minutes before being subjected to grinding. Flavor enhancement of the beverage was done using vanilla and banana flavors other than sugar.

Results of the paired comparison test done for the two outcomes (of the two methods) revealed that the procedure in which dehusked peanuts were boiled for 10 minutes before the grinding of kernels produced a whitish - milk like - beverage which is superior to the other. Color, thickness, taste and the overall acceptability of the plain and flavored (using vanilla and banana flavors) peanut beverage samples were evaluated. At a significance level of P <0.05, there were no significant differences of color and thickness between the three samples. The results showed that the banana flavored beverage was better than the rest in taste and overall acceptability. Proximate analysis tests showed that the product had 91% moisture, 2.33% ash (wet basis), 1.5% fat (wb) and 3.03% protein (wb). Shelf life of the peanut beverage was determined based on the microbial growth and the free fatty acid content (FFA%). FFA level significantly increased impairing a rancid taste limiting the shelf life to 14 days under refrigeration (10°C). However, no noteworthy growth of microbes could be seen during the storage period.

According to the results, boiling the soaked peanuts in water for 10 minutes provides a better quality beverage with least beany flavor. In terms of flavor reformulation, banana flavor is more suitable than the vanilla flavor. The results portray the essentiality of improving the packing and storage conditions in order to increase the shelf life of the product. Further investigations are required to determine the optimum conditions for preparing peanut beverage with improved nutritional composition.

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Studies on influence of nutrient levels on yield of rice (*Oryza sativa* L.) under System of Rice Intensification (SRI) and conventional methods of cultivation

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To assure food security in the rice consuming countries the rice production should be increased by 50 % in these countries by 2025. To achieve the projected targets of 680 and 771 million tonnes by 2015 and 2030, respectively, the productivity of rice has to be increased through adoption of suitable and newer technologies. The System of Rice Intensification (SRI) is a new methodology for increasing the productivity of irrigated rice by changing the management of plants, soil, water and nutrients resulting in both healthy soil and plants, supported by greater root growth and the soil microbial abundance and diversity. Fertilizer is one of the inputs which brings quantum jump in the yield of rice. Therefore, the investigation was carried out to evaluate the influence of different levels of Recommended Dose of Fertilizer (RDF) with and without biofertilizer on yield of rice under SRI and conventional methods of cultivation. A field experiment was conducted at the University of Agricultural Sciences, Dharwad, India during *kharif* 2006. The experiment was laid out on deep black clay (Calusterts) soil with pH 8.2, using hybrid rice variety KRH-2 by adopting split-split plot design with twenty treatments with three replicates. The treatments consisted of two methods of cultivation (SRI and conventional) as main plots and five nutrient levels (100 % RDF, 75 % RDF, 75 % RDF + biofertilizer, 50 % RDF and 50 % RDF + biofertilizer) as sub plots and two Zn levels (10 kg and 25 kg ZnSO$_4$ ha$^{-1}$) as sub sub plots. At harvest yield attributes and yield were recorded.

Significantly higher productive tillers hill$^{-1}$ (37), productive tillers m$^{-2}$ (633), panicle length (27.7 cm), grains per panicle (211), test weight (28.15 g), grain yield (6.1 t ha$^{-1}$), straw yield (7.6 t ha$^{-1}$) were recorded in SRI method of cultivation over conventional method of cultivation. The treatment receiving 75% RDF + biofertilizer recorded significantly higher yield attributes, grain and straw yield than other treatments. Higher Zn level of 25 kg ZnSO$_4$ ha$^{-1}$ recorded higher yield and yield attributes than 10 kg ZnSO$_4$ ha$^{-1}$. It can be concluded that 75 % RDF + biofertilizer with 25 kg ZnSO$_4$ ha$^{-1}$ under SRI method of cultivation is the best treatment which recorded the highest yield of rice.

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Influence of soil properties on different fractions of Zn in paddy growing soils

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Zn is found in soil in as number of discrete chemical forms differing in their solubility and thus availability to plants. The Water Soluble plus Exchangeable Zn (WSEX-Zn) and Organically Complexed Zn (OC-Zn) are considered to be available while Amorphous sesquioxide bound Zn (AMOX-Zn) is potentially available and Crystalline sesquioxide bound Zn (CRYOX-Zn), Manganese oxide bound Zn (MnOX-Zn) and Residual Zn (Res-Zn) are unavailable to plants. Distribution of these Zn forms depends on the chemical and physical properties of the soils. Therefore, this investigation was carried out to study the influence of soil properties on different forms of Zn in paddy growing soils.

Seventy five surface soil samples were collected from paddy fields in Northern Dry Zone of Karnataka state, India. The processed soils were analysed for pH, Organic Carbon (OC), clay, free Calcium carbonate (CaCO₃), free Ferric oxide (Fe₂O₃), Cation Exchange Capacity (CEC), total Zn and available Zn by standard analytical methods and different forms of Zn by sequential Zn fractionation procedure. The results revealed that concentration of different Zn fractions varied from soil to soil and the order of magnitude of different Zn fractions remained same viz., WSEX-Zn < OC-Zn < AMOX-Zn < CRYOX-Zn < MnOX-Zn < Res-Zn. The WSEX-Zn correlated significantly (p<0.05) and negatively with pH (r=-0.739**) and CaCO₃ (r=-0.551**) and positively with OC (r=0.445**) and CEC (r=0.414**). The OC-Zn showed significant and positive correlation with OC (r=0.739**) and MnOX-Zn correlated positively and significantly with clay (r=0.644**) in soils. The AMOX-Zn and CRYOX-Zn showed positive and significant correlation with Fe₂O₃ (r=0.707**, r=0.754** respectively) and clay (r=0.468**, r=0.444** respectively). The Res-Zn positively and significantly correlated with Fe₂O₃ (r=0.766**), OC (r=0.390**) and clay (r=0.443**) of the soils. The Avail.-Zn significantly and negatively correlated with pH (r=-0.441**) and CaCO₃ (r=-0.283*) and positively with OC (r=0.298**) and clay (r=0.447**). Correlation data indicated that these fractions are in a state of dynamic equilibrium among different fractions. Multiple regression equations indicated that 44.2 to 81.5 % variation in all the Zn fractions explained by the combined effect of soil properties studied.

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Transformation of applied Zn under different moisture regimes in rice soils

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Zn is one of the essential micronutrient elements most commonly deficient in flooded rice soils. It is known to occur in soil as in a number of discrete chemical forms: Water soluble plus Exchangeable Zn (WSEX-Zn), Organically Complexed Zn (OC-Zn), Amorphous sesquioxide bound Zn (AMOX-Zn), Crystalline sesquioxide bound Zn (CRYOX-Zn), Manganese oxide bound Zn (MnOX-Zn) and Residual Zn (Res-Zn) differing in their solubility and thus availability to plants. In submerged moisture condition brings about a number of dynamic changes in rice growing soils, which may influence the transformation of Zn and thus affect its availability to rice. Therefore, the present investigation was carried out to study the transformation of applied Zn in rice growing soils under field capacity and submerged moisture regimes.

A laboratory incubation was conducted using surface soil (Calcustert, pH 8.42) collected from rice fields at in Northern Dry Zone of Karnataka, India, after the harvest of paddy. Each container was filled with 1 kg of soil and treated with 3 levels of ZnSO$_4$ ($Z_1$=0, $Z_2$=10, $Z_3$=25 kg ha$^{-1}$) and 2 moisture regimes (field capacity and submergence). The experiment was laid out in Completely Randomized Design with 3 replicates. Samples were drawn periodically 30, 60 and 90 Days After Incubation (DAI) and analysed for pH, total Zn, Available Zn using standard analytical methods and different fractions of Zn by sequential Zn fractionation procedure.

Results revealed that applied Zn was transformed to WSEX-Zn, OC-Zn, AMOX-Zn, Avail.-Zn and total Zn and showed an increasing trend with increasing levels of Zn at 30, 60 and 90 DAI under both the moisture regimes. The amount of Zn recovered in WSEX-Zn, OC-Zn, CRYOX-Zn and Avail.-Zn recorded significantly (p<0.05) decrease and MnOX-Zn, AMOX-Zn, Res –Zn and total -Zn recorded significantly increase with increase of incubation period in both the moisture regimes. The recovery of applied Zn in WSEX-Zn form which represents the most readily available pool was relatively low as compared to other forms.

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Perception of Tea Growers on TRI 3000/4000 Series New Tea Clones

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Tea industry is a vital component of the Sri Lankan economy with its contribution to the foreign exchange earnings and employment to the Sri Lankan labour force. Tea Research Institute (TRI) has proposed technologies to increase the productivity. Development of new planting material is one such measure. TRI has first developed and released TRI 2000 series tea clones in 1960s and TRI released 3000 and 4000 series tea clones in 1980s and 1990s respectively. Despite efforts to establish and release clonal cuttings by the ADP funded Mother Bush Plantation Project they are still not popular among many tea growers, therefore, it is important to study the perception of tea growers on TRI 3000/4000 series clones. The objectives were to identify the characteristics of tea clones that growers look for, measure attitudes of tea growers on individual TRI 3000/4000 new clones and to make recommendations on how to improve the growers’ perception on TRI 3000/4000 clones.

The target group for the study was tea growers from Up Country, Mid Country, Low Country and Uva regions, who have begun cultivating TRI 3000/4000 clones. Using the lists of new clone growers maintained at TRI Head Office and, four regional sub stations, out of about 400 growers 40 respondents including estate managers, private plantation owners, and smallholders were randomly selected for the study. Interview schedule was the main data collection tool. In addition, focus group discussions and key informant discussions with relevant scientist and extension officers were also used. Data analysis was mainly done using Statistical Package for Social Sciences (SPSS) and rank correlation, Chi square was used to test the relationships.

Higher percentage of (61.5%) of estate managers perceived that yield is higher in TRI 3000/4000 clones. But 48.2% of private plantation owners and 34% of smallholders perceived that they give medium yield. Tea growers think that most TRI 3000 series clones are highly resistant to Shot Hole Borer (SHB) and also medium resistant to Blister Blight (BB) and drought. They also felt that TRI 4000 clones have medium resistance to SHB, BB and drought. But most growers perceived that both series have higher fertilizer response than older clones. Most of the respondents (64.3% plantation managers, 66.7% private plantation owners, and 71.4% smallholders) have medium level of perception on services provided by the TRI for their new clone cultivations.

The characteristics of TRI 3000/4000 clones which were found by TRI research are not compatible with growers’ perceived characteristics. Therefore, it is suggested that to develop programs to inform tea growers the accurate information on TRI 3000/4000 clones.

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Selection of cocoa (*Theobroma cacao* L) varieties/lines based on pod and bean physical characteristics

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Cocoa is one of the major export agricultural crops introduced to Sri Lanka in nineteenth century and present land area under cocoa is around 6500 ha. Annual export earning from cocoa is Rs 28.2 million and total production is about 1100 t. Currently, local consumption through cocoa based industries has been increased while traders' need is to collect fresh pods to process them in large scale processing units, but both farmers and traders facing a problem for estimating the dry weight of the beans to do the payments. At present, 86 important cocoa varieties/lines of both Forastero and Trinitario type are available but they were not characterized. The objectives of the current study were to select the best cocoa varieties/lines based on the some physical characteristics of pod and bean as well as to determine correlations between dry bean weight into wet bean weight and fresh pod weight in selected available cocoa varieties/lines.

Thirty four different cocoa varieties/lines available in the germplasm of the Department of Export Agriculture were selected as the treatments of the study during the year 2007. Ten cocoa pods were randomly collected from those varieties/lines to record data for one replicate of the study. Fresh pod weight and fresh bean weight with mucilage and oven dry bean weight were recorded. The experiment was conducted in three replicates.

Fourteen varieties/lines which are having less than 26 pod value were selected as the promising lines. Out of that, line Wk2 shows the lowest pod value (14 - number of pods that are needed for producing 1 kg of processed cocoa beans) having the greatest fresh pod weight (727g/pod), fresh bean weight with mucilage (222 g/pod) and the bean dry weight (71 g/pod). The highest number of beans per pod (50) was observed in the variety W6/456. Therefore, the line Wk2 could be selected as the best cocoa line having the lowest pod value (14) and the greatest bean dry weight (71 g/pod). However the lines NA32*ICS95, ICS1*NA32, W5/395, Wk6, W6/456, PA7*UIT 2, ICS6*ICS95, EARS181, W5/5, NA32*UIT1, EARS143 and EARS229 can be selected as other good varieties/lines having the pod value less than 25. Dry bean weight ($Y$) can be estimated taking the fresh bean weight with mucilage ($X$) using the equation $Y= 0.291X + 2.5361$ irrespective of the variety/line. Ratio between fresh pod weight and dry bean weight of cocoa is between 10-15 in 89 % of the varieties/lines studied.

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Evaluating the efficiency of capsicum (*Capsicum annum* L.) intercropped with bushitao (*Vigna unguiculata* L.) in sandy regosol

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Capsicum (*Capsicum annum* L.) and bushitao (*Vigna unguiculata* L.) are the two important vegetable crops throughout the year in the Eastern region of Sri Lanka and also both are compatible crops for intercropping. Evaluating cropping system is an important to select superiority over the existing system adapted by the framers in terms of biological productivity and economic potential. Therefore, an experiment was conducted to evaluate the efficiency of capsicum (*Capsicum annum* L.) intercropped with bushitao (*Vigna unguiculata* L.) at Agronomy farm, Eastern University, Sri Lanka. Capsicum and bushitao were selected as base and intercrop respectively. The experiment was laid out in a Randomized Complete Block Design with five treatments and four replications. Treatments were capsicum as a sole crop with the spacing of 40 cm × 40 cm (T1), bushitao as a sole crop with spacing of 40 cm × 15 cm (T2), capsicum (60 cm × 40 cm) with bushitao (60 cm × 40 cm) in alternative rows (T3), 30/60 cm paired row planting of capsicum with one row of bushitao between two pairs of capsicum (T4) and 25/70 cm paired row planting of capsicum with two rows of bushitao between two pairs of capsicum (T5).

The results revealed that land equivalent ratio was superior in all intercropping combinations compared with monocropping. It ranged from 1.43 (T4) to 1.63 (T5). Cost of cultivation was high in intercropping as compared to monocropping. Among intercropping, it was high in T5 (Rs 2,24,401 /ha) and low in T4 (Rs. 2,21,305 /ha). However, net return (Rs 11,95,045/ha) was high in T4 due to high capsicum yield (6.20 t/ha) followed by T3 (Rs 11,76,622/ha). Return per rupee invested was high in T1 (9.43) followed by T4 (6.83). In case of monetary return, it was high in T3 and T4 (1.09). This experiment suggests that 30/60 cm paired row planting of capsicum with one row of bushitao between two pairs of capsicum (T4) would be the most productive and profitable system in sandy regosol.

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Effects of soil moisture stress on the internal quality and yield of tomato (*Lycopersicon esculentum* Mill.)

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Studies were conducted to investigate the effects of soil moisture stress on the fruit quality of tomato cv. KC-1 viz., vitamin C, Total Soluble Solids (TSS) and acid content and to determine the most critical stage/s of growth of tomato to moisture stress. Moisture stress was imposed during the vegetative, flowering, early fruiting and fruit ripening stages. A period of four day stress was given during the above growth stages by withholding water completely at once. Moisture stress reduced the vitamin C content of fruits. The TSS and the acid content of the fruits were mildly affected by moisture stress when the stress was imposed during the fruit ripening stage. Vitamin C, TSS and acid content of the fruits were not affected by the stress during the vegetative, flowering and early fruiting stages. Moisture stress reduced the yield of tomato and the stress during the flowering stage showed the highest yield reduction compared to the other growth stages. This reduction was mainly attributed to reduced number of flowers, reduction in the size of newly formed flowers and the abscission of flowers and flower buds during the flowering stage. Hence, the flowering stage is the most critical stage of growth of tomato to moisture stress for the fruit yield, while the fruit ripening stage is the most critical stage for the internal fruit quality of tomato.

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Production of polyclonal antiserum and development of Enzyme-Linked Immunosorbent Assay for detection of Banana Bract Mosaic Virus

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Banana Bract Mosaic Virus (BBrMV) is widespread disease in banana (Musa spp.). Early identification of the disease is important in rapid propagation programmes. The use of commercially available Enzyme-Linked Immunosorbent Assay (ELISA) test kits for indexing the virus is not economical in Sri Lanka. Hence production of polyclonal antiserum and development of indirect ELISA detection technique was the focus of this study. Virus was partially purified by Hammond and Lawson method (1988) with minor modifications. Four purified virus samples were injected to a rabbit at weekly intervals for antibody production. First, containing 1 mg of virus sample in 1 ml of BK buffer (0.1 M Boric acid and 0.1 M potassium chloride pH 8.0) mixed with equal volume of 0.85% sodium chloride solution was injected to the marginal ear vein of the rabbit. Remaining three injections containing 1.5 mg, 2.0 mg, and 2.5 mg of purified virus respectively were given intramuscularly with 1 ml of incomplete Freund’s adjuvant. Bleeding of rabbit was done at one week after 2nd injection for titer check and whole blood was collected 10 days after 4th injection for antiserum preparation. Blood was incubated at room temperature for 1 hour and then at 4 ºC overnight. Serum was separated and it was centrifuged at 5000 rpm for 10 minutes to remove blood cells. An equal volume of glycerol was added to the serum and stored under -20 ºC after adding 0.025% sodium azide to the final volume as a preservative. Indirect ELISAs were performed to optimize; sample extraction buffer, antiserum dilution, incubation period after adding para-Nitro Phenyl Phosphate (pNPP) substrate, to detect virus titter of different plant parts and to identify the best plant parts that can be used in ELISA with produced antiserum. Buffer containing 0.1 M PBST buffer pH 7.4 + 0.13% Sodium sulfite + 2% Poly Vinyl Pyrrolidone (PVP) + 0.2% Ovalbumin was identified as the best sample extraction buffer. Best antiserum dilution was at 1:500 in PBS-TPO buffer keeping the Protein A conjugate dilution at 1:2000 in PBS-TPO buffer. One and a half hours after adding pNPP substrate was selected as the best incubation time at 37 ºC to get absorbance values. Comparatively higher virus titers of BBrMV were present in root tips and bract parts. Most suitable plant parts to check the presence of virus by ELISA were bract parts and leaf lamina of flag leaf or 1st leaf.

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Efficacy of Fungicides and *Tricoderma viride* in controlling white root disease of cinnamon (*Cinnamomum zeylanicum* Blume)

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A study was undertaken to examine symptom development and the effect of various fungicides to control white root disease of cinnamon. First experiment was conducted in white root disease infected young cinnamon plantation at Heellakanda in Matara district, which is located near to the rubber plantation. The disease symptoms were recorded regularly under the field condition. Second experiment was conducted in the same field, treating infected plants by using selected fungicides, such as tebiconasol 5 ml/10 l (Folicur), hexaconasol 20 ml/10 l (Eraser), sulphur 200 g/ l (Hemite sulphur), *Tricoderma viride* 200 ml of solution/ 10 l (Bio-Vaccine) and control (non- treated). Fungus infected cinnamon bushes were randomly selected for the each treatment. Total amount of plants and number of death plants in bushes were separately counted before the application of treatments. Once in a month, treatments were applied (100 ml of solution / bush). Percentage of average death and time taken to recover disease symptoms were recorded every month. According to the results of the first experiment, first visible symptom on the foliage was the colour change of leaves to off-green and yellowish. Initially this symptom was observed only on one stem in cinnamon bush and the entire canopy of affected tree was gradually turning yellowish brown and branches showed die-back causing death of the plant. Infected bushes were seen as patches in the field. According to the second experiment, death plant percentage was decreased significantly with time in treated cinnamon bushes compared to non-treated bushes (control). When compared the overall results during the experimental period, hexaconasol treated bushes had the lowest dead plant percentage (5.33%). It was also observed that seven month after the treatment, disease was controlled due to application of hexaconasol, tebuconasol and *Tricoderma viride*. In the view of experimental parameters, infected trees can be identified initially on the yellowish leaves of a plant in the bush and at that period treatments should be applied to control the disease. Hexaconasol can be described as the most suitable fungicide to control white root disease in young cinnamon plantations.

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Impact of integrated pest management for the yield of cinnamon (*Cinnamomum verum* Presl.)

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Rough bark disease (*Phomopsis* spp.), wood boring moth (*Ichneumoniptera cinnamomumi*) and weeds are major pests in the cinnamon plantations and damages of them are badly affected to the yield loss. This study was mainly attempted to determine the effects of pest incidences on the yield of mature (above ten years old) cinnamon plantations. Field trials were conducted in the Cinnamon Research Station (06° 01' 40.6'' N, 80° 33' 34.8'' E, altitude 36m MSL) in the southern province of Sri Lanka. Selected cinnamon field was divided into twelve plots and each plot was consisted 36 cinnamon bushes. Four treatments, T1– Integrated Pest Management (IPM) plots (recommended fertilizer application, weeding, insects and disease control), T2- fertilizer plots (recommended fertilizer application and weeding only), T3- weeding plots (only weeding) and T4- control plots (non-treated) were used with three replicates. All treatments were applied twice per year and dry bark yields, other yield parameters and time taken to peeling of fresh bark were also recorded twice per year. In addition, severity of the rough bark disease (*Phomopsis* spp.) and wood boring moth (*Ichneumoniptera cinnamomumi*) damage were measured every two month intervals by using severity ranking method. Annual costs and benefits were calculated with related to each experimental plot. According to the experimental results, IPM plots had the significantly (P<0.05) highest dry bark yield of 2944.9 kg ha⁻¹ yr⁻¹, when compared to fertilizer, weeding and control plots. The lowest dry bark yield (253.9 kg ha⁻¹ yr⁻¹) was recorded in control plots. Significantly highest number of new shoots (28076 shoots ha⁻¹ yr⁻¹) and harvestable stems (28764 stems ha⁻¹ yr⁻¹) were observed in the IPM plots. Similarly, stem length was comparatively higher in IPM plots. But time requirement for peeling one kilogram of fresh bark was higher in control plots (326.37 minutes kg⁻¹). On comparison, lowest damages by the pests were recorded in IPM plots. In the view of yield parameters, yield loss percentage was 36.9% due to major insect pest and disease pest in the cinnamon. According to the cost benefit analysis, total profit was higher in IPM plots. Based on the experimental results and environment impact, integrated pest management is most economical for the cinnamon cultivation.

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Investigation on pest and disease incidence on brinjal (Solanum melongena L.) intercropped with groundnut (Arachis hypogaea L.)

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A field study was conducted at the Agronomy farm of Eastern University, Sri Lanka to evaluate the prevalence of pest and disease incidence on brinjal when intercropped with groundnut compared with brinjal monocropping. This experiment was designed as Randomized Complete Block Design with four treatments [T1: brinjal monocropping (90 cm x 60 cm); T2: brinjal (90 cm x 60 cm) with groundnut (45 cm x 30 cm) in alternative rows; T3: 60/150 cm paired row planting of brinjal with two rows of groundnut; T4: 75/120 cm paired row planting of brinjal with one row of groundnut] and five replications. Observations were made at weekly intervals on pest population, especially on whitefly and leafhopper and also on disease infestation in leaves of brinjal. The results revealed that intercropping system reduced the population of whitefly and leafhopper adults and the disease incidence in brinjal plants than those in monocropping. Average number of whitefly and leafhopper adults per leaf and average number disease affected leaves per plant showed significant (P<0.05) differences between treatments. Brinjal monocropping had the highest number of whitefly (6.2±3.45) and leafhopper (6.6±2.89) adults per leaf and also highest number of disease affected leaves per plant (15.2±2.23) among the treatments whereas alternative intercropping system had the least number of whitefly (1.67±0.82) and leafhopper (1.54±0.62) adult populations per leaf and number of disease infected leaves per plant (9.0±1.16). Further it was noted that both insect pest attack and disease incidence were significantly (P<0.05) reduced in alternative row cropped brinjal plants with groundnut (T2) followed by paired row planting of brinjal with two rows of groundnut (T3) compared to those in monocropped brinjal plants. The present study suggests that intercropping can form a component of an integrated pest and disease management programme in Sri Lanka.

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Effect of particle size and soil texture on soil carbon mineralization

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Legume leaves were a good source of nutrients in many agro-ecosystems, thus reducing dependency on commercial fertilizers. Therefore many researches have been conducted to understand the pattern of legume leaf decomposition and its release of nutrients. A study on Gliricidia leaves decomposition was conducted under laboratory conditions to elucidate the effect of the particle size (S<sub>1</sub> ≤ 0.5 mm, S<sub>2</sub> = 4 mm) and texture of soil (T<sub>1</sub> = Sandy clay loam, T<sub>2</sub> = loamy sand) on microbial respiration after incorporation into the soil. The early stages of the incubation was found to be significantly influenced by the particle size of the Gliricidia leaves and later stage was not affected by it. Carbon mineralization of the soil was found to be reached to the peak at day 14 followed by gradual reductions in all the treatments except control treatments as incubation progressed. First 35 days of incubation was significantly influenced by particle size of the Gliricidia leaves and thereafter it was not affected by particle size. Carbon mineralization was significantly influenced by the texture of soil throughout the incubation period except at 7, 42 and 56 days of incubation. Hence Loamy sand soil was given significantly higher carbon mineralization than Sandy clay loam soil throughout the incubation period except above days.

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Anthocyanin production by over-expression of grape transcription factor gene 
\textit{VlmybA1-2} in transgenic tobacco and \textit{Arabidopsis}

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An \textit{myb}-related transcription factor gene of the anthocyanin biosynthetic pathway, \textit{VlmybA1-2}, from Kyoho grape (\textit{Vitis labruscana}), was introduced into two anthocyanin producing plants, tobacco and \textit{Arabidopsis} and a non- anthocyanin producing spinach under the control of the Cauliflower Mosaic Virus (CaMV) 35S promoter through \textit{Agrobacterium}-mediated transformation. \textit{VlmybA1-2} induced anthocyanin production was prominent in transformed tobacco calli and the regenerated tobacco plants were completely purple. During plant growth in pots, the intensity of purple color was reduced in leaves, whereas flowers showed intense pigmentation. Apparently, except for the color, the transgenic plants were not different from the control plants. Germinating T1 generation was a segregating population of completely dark purple seedlings and green seedlings. Green seedlings could not survive on kanamycin containing medium. Expression of \textit{VlmybA1-2} in purple plants grown on pots was confirmed by RNA gel blot hybridization. Among the \textit{Arabidopsis} T1 transformants, there were two prominent phenotypes: two completely purple seedlings with retarded growth and one with normal growth, and two seedlings with purple-green leaves and purple roots. The latter seemed similar to control plants and produced fertile and viable seeds of two distinguishable colors, purple and brown (similar to the wild type). Purple seeds could germinate on kanamycin-containing medium providing an easy method of transgenic seed identification in \textit{Arabidopsis}. Both infected and wild type spinach cotyledon bases were purple after 3 days of culture, giving no indication for identification. Regenerated putative transgenic spinach plants, similar to wild type in appearance, could survive on kanamycin-containing medium and the presence of \textit{VlmybA1-2} was confirmed by DNA gel blot hybridization. \textit{VlmybA1-2} may not be able to induce structural genes of anthocyanin biosynthesis pathway in non anthocyanin producing spinach. \textit{VlmybA1-2} alone, without the aid of an \textit{myc}-related gene partner, could induce complete pigmentation in tobacco and \textit{Arabidopsis}, indicating its potential over other previously used \textit{myb}- and \textit{myc}-related genes. \textit{VlmybA1-2} shows a potential to be utilized in future work of development of a safe and efficient \textit{in vivo} marker for plant transformation and development of plant cell systems that produce stable anthocyanins for applications as natural food colorants.

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Solution of one dimensional geometric nonlinear problems using finite different approach

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Finite Difference Method (FDM) is one of the powerful tools available to solve structural mechanics problems even in this computer age. Development of the computers has facilitated the efficient use of Finite Difference Technique and sometimes preferred over the Finite Element Method, which is widely used in most structural engineering computer software. However, advances in this type of research are limited as its true potential has not been fully realized specifically in solving nonlinear problems. In this study FDM is utilized to solve a nonlinear differential equation numerically, and thereby reducing the time and memory requirements when compared to other numerical methods.

All the structural analysis tools are essentially concerned with solving the basic differential equations of equilibrium and compatibility, although in some methods this fact might be obscured. However, the analytical solutions have not still been explored well for the differential equations of the structures, where the geometry, loading, and boundary conditions become complex. In such situations use of a numerical method is the general approach to solve the problem. In this method the solution will be obtained for chosen points on the structure, those are referred as nodes or pivotal points, by using the differential equation which could be applicable to the whole member.

The scope of this investigation is limited to the study of geometrically nonlinear large deformation problems of one dimensional members. This paper describes an application of finite difference method to solve such a single member subjected to axial tension with large deformations with a curved profile. Resulting governing equation for the member is a nonlinear non-homogeneous integral differential equation, in which an analytical solution is not feasible, though analytical solutions are available for small deformation problems. The Gauss-Seidel technique has been employed to solve a set of simultaneous equations and a new iterative approach has been developed to calculate the fixed end moment of the member under the axial tensile forces.

A computer program has been developed and results were compared with the results obtained by using Finite Element Method and with other analytical methods. Results were used to prove the consistency of the applicability of Finite Difference Approach to solve geometrical nonlinear problems for 1D structural members.
Prediction of transfer lengths based on cohesive cracking

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The integrity of the prestressed concrete members mainly depends on bond between the surrounding concrete and the steel tendon. This is an important design consideration as both the flexural capacity and shear resistance are affected by the bond strength. Especially for a member that is subjected to high moments near their ends, such as cantilevers, railroad ties and short beams etc. it is vital to predict the transfer length with confidence. Accurate estimation of prestress transfer bond based on experiment is a difficult task and is a very expensive exercise because it requires high quality material, highly skilled labour, appropriate instrumentation and a data acquisition system to monitor.

The use of high strength concrete, restricted cover and spacing conditions together with use of large diameter strands in prestressed concrete members have been increasing significantly over the years. However, the recent experimental evidences suggest that the existing code provisions do not address the bond strengths adequately. In this study, a theoretical basis has been developed based on thick-cylinder theory to predict the bond mechanism between concrete and strand. For a confined situation there are several conditions of bond development. These depend on the ability of steel to swell upon tension release and the ability of concrete to resist swelling due to the expansion of the interface. The resulting hollow concrete cylinder cracks to the surface at the beginning of transfer followed by partial or internal cracking and finally there is an uncracked region. The uncracked parts of the concrete are treated as an isotropic material while cracked concrete parts are treated as an anisotropic material. The key feature here is that concrete continues to transmit tension through cracks of concrete. The model results show excellent correlation with experimental results collected from various research work.

For the outer radius of the concrete cylinder the minimum of side and bottom cover could be utilized where the radial stress at the outer surface is zero. However when the spacing is critical this condition does not prevail. In fact the concrete has higher strength. The results show that an additional 10 mm can be added to the outer surface of the concrete to impose the same boundary condition. Comparison of both theoretical and experimental result gives a good correlation. These results also confirm the validity of the theory.

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Study on the use of waste polythene in reducing the brittleness of soft soils improved with cement

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Problematic soils with difficult ground conditions required specific geotechnical engineering solutions. Soft clays cannot directly be utilized in civil engineering projects due to the inherent properties such as very high water content, high compressibility and very low shear strength. This paper describes a study on the effect of polythene and cement on engineering properties (compaction and California bearing ratio) of clayey soil improved with cement and polythene. The amount of cement and polythene added to the clayey soil sample, as a percentage of dry soil mass were in the range of 1%-3% and 0.25-1.5% respectively. The results of the study showed that cement and polythene could change the engineering properties of clayey soil. The maximum dry density was found to increase while the optimum water content was found to decrease with increased cement content. Brittleness of soil is increased when cement is added into the soil however, it can be suggested that due to the properties of polythene, as observed, brittleness is decreased. It was also found that percentage of cement in changing the mechanical properties of soil depends on the type of soil. CBR test results of improved soil indicate possible applications in road sub bases and as a sub grade material. This study on the use of waste polythene in improving problematic soil with cement was able to prove that this application is economical in improving soft soils and safe in disposing waste polythene. Recommendations are also made for further research with different cement contents and different waste materials to be used as clay liners.

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Utilization of quarry dust in geotechnical applications

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Quarry dust is a byproduct of rubble crusher units and commonly available material due to the vast usage of crusher metal in construction industry. This product can be used to improve engineering properties of poor quality soils, in order to develop a cost effective method for highway sub grade construction. As such, research reported in this paper illustrates the effect of usage of quarry dust as an admixture to improve the engineering properties of poor quality soils with combination of cement.

Poor quality soils which were rejected by the one of the main road construction projects in Sri Lanka were selected as the test samples. These poor quality soils were mixed in the laboratory with different percentages of quarry dust and 2% of cement on the weight and left to harden for a period of seven days. Further, shear strength behavior of soil-quarry dust mixes were reported in this paper.

The results of the subsequent tests revealed that addition of quarry dust alone to improve engineering characteristics of poor quality soil is not much effective. In order to further improve the engineering characteristics, 2% of cement was recommended to mixing with soil-quarry dust mixture. Therefore, problems associated in the construction of highways over clayey sub grade can be reduced significantly by mixing with quarry dust and cement.

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Labour demand in construction industry: A case of residential building

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Construction production is a unique process which incorporates several resources such as material, finance, machine and man. Of all the resources and factors of production man has the highest priority and is the most significant factor of production and plays a crucial role in areas of productivity and quality. This research has found the labour requirements for specific construction skills and investigated the current issues of labourers in Sri Lankan construction industry using data from final accounts of residential building projects and interviews with professionals in construction firms. Using collected data, the labour required for 1 m² of gross floor area for selected work sections of masonry, concreting, tiling, plastering and painting were calculated. It was observed from the calculations that the labour required per unit of floor area does not proportionately increase as the gross floor area increases. Labour intakes for luxury buildings are higher than for semi luxury buildings. For concreting for the semi luxury building skilled labour requirement is 0.078 labour days/m² and 0.467 labour days/m² for unskilled labourers. For luxury buildings it is 0.087 & 0.522. In case of masonry the skilled and unskilled labour required for semi luxury buildings are 0.495 & 0.871 and 0.640 & 1.026 for luxury buildings. For wall tiling the skilled and unskilled labour required for semi luxury buildings are 0.101 & 0.114 and 0.114 & 0.128 for luxury buildings. For floor tiling the skilled and unskilled labour required for semi luxury buildings are 0.324 & 0.364 and 0.331 & 0.372 for luxury buildings. In case of plastering the skilled and unskilled labour required for semi luxury buildings are 0.295 & 0.440 and 0.376 & 0.560 for luxury buildings. For painting the skilled labour required for semi luxury and luxury buildings are 0.340 and 0.576 as the painting work does not require unskilled labourers. It was found that the masonry work requires higher amount of labour involvement and wall tiling require lesser amount of labour input in both semi luxury and luxury residential buildings.

The research also revealed that the industry faces the problem of recruiting and retaining labourers. In addition, there has been a shortage for labourers in the skills of masons, carpenters and tile setters due to increased construction activities, reasons related to wages, behaviour of labour subcontractors, job security, attitudes of management towards etc. Thus, the industry uses the strategies of giving job security, maintaining good payment system, maintaining good working conditions, emergency assistances etc to retain the labourers.

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Critical review of shear design procedures related to reinforced concrete beams

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Shear design of reinforced concrete beams has always been uncertain as the true nature of the supporting mechanism has not been clear. Throughout the years various models in research have been adopted to fit the true behaviour of the beams in shear, while some models have been incorporated in major codes of practice without adequate verification. This study attempts to evaluate key approaches and compare the results to expose the large differences associated with such practices.

In hindsight it is seen that the various truss models used as a theoretical basis has actually hindered our understanding rather than helping it. For the purpose of review the basic truss model, compression field theory, modified compression field theory, simplified method and shear friction have been considered in this study. These approaches have been adopted because they appear to be logical and fit neatly with our understanding of trusses. However these models have been made more and more complicated in order to provide a reasonable fit with test results. A common example in literature (200 mm x 400 mm x 5 m) having a rectangular shape and loaded with a concentrated load of 150 kN at mid-span has been used for the comparison. According to the flexural design 3 bars of 16 mm Tor steel at the top and 3 bars of 25 mm Tor steel at the bottom have been used as the main reinforcement. For the shear design a round bar of 10 mm mild steel was chosen for the stirrups. Normally the failure of beams due to shear depends on the loading stage of the beam reflecting magnitudes and patterns of the load. Although there is a comprehensive amount of data based on test results a test series aimed to facilitate computations based on all five methods has been adopted in this study.

Designs show spacing of shear reinforcement should be provided as 180 mm (basic truss model), 165 mm (compression field theory), 345 mm (modified compression field theory), 380 mm (simplified method) and 330 mm (shear friction). In summary, these results reveal that there are large differences and similarities with the currently used approaches as seen for the present example. It can be concluded both truss model and compression field theory underestimates the shear capacity. In fact other 3 methods have twice the capacity. This difference can be attributed to the contribution of concrete parts in tension. Here cracked concrete continue to transmit tension across cracks.

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Design and development of a battery operated rubber tapping machine

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There is an acute shortage of rubber tappers in the areas where rubber trees are grown. This situation has arisen because of the migration of the labour within Sri Lanka to urban areas to work in factories and the exodus of labour to Middle East, Korea, and many other countries.

This necessitates the introduction of some sort of machinery in rubber plantations so that a large number of trees can be tapped by a lesser number of workers. The rubber tapping machine described here has been designed and constructed with that intention.

The developed tapping machine consists of tapping head, motor, battery and frame. The cost of production of the machine is Rs 5512.00.

Working capacity, latex yield, quality of tapping and number of blades use in tapping head were considered as criteria of evaluation of the tapping machine. Testing was done at Yatiyana, Matara.

Working capacity of battery operated tapping knife and conventional knife are 2.21, 2.52 respectively. Therefore the working capacity of the battery operated tapping machine was 12.3% higher than the conventional knife.

Yield variations of two treatments are not significant. Average latex yield of designed tapping machine and tapping knife are 106.28ml and 109.7ml respectively. Therefore it was observed that the yield of mechanically tapped trees were somewhat lower than the knife tapped trees.

Although few performance criteria’s of the designed tapping machine are not significantly different with the conventional knife, it is beneficial for the local farmers due to high working capacity of new designed tapping knife.

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Comparison of shear strength of beams based on different codes of practice

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In the design of concrete structures, design for flexure can be achieved by providing longitudinal reinforcement accurately. However design of transverse reinforcement has not been understood as yet. Major design codes do not give adequate guidelines and are loose on predicting shear behaviour to match the test results. Hence a detailed study is required to improve the situation. The main objective of this study is to carry out a state of the art review and to evaluate the shear design approaches. This involves finding when such theories are justifiable for reinforced concrete.

In this study a comparison of test results based on 12 simple test beams and shear strength predicted by several major codes are evaluated. These test beams have been subjected to single or two point loads. A part of test data is presented in Table 1

Table 1: Comparison of test results and shear strength predicted from codes

<table>
<thead>
<tr>
<th>Author</th>
<th>$f'_c$ (MPa)</th>
<th>$D$ (m)</th>
<th>$b$ (m)</th>
<th>Tested strength</th>
<th>Calculated shear strength (kN)</th>
<th>BS</th>
<th>Canadian</th>
<th>ACI</th>
<th>Australian</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hsiung &amp; Frantz</td>
<td>43</td>
<td>.49</td>
<td>.152</td>
<td>110.3</td>
<td>108.4</td>
<td>109.5</td>
<td>109.3</td>
<td>116.5</td>
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</tr>
<tr>
<td>Hsiung &amp; Frantz</td>
<td>43</td>
<td>.49</td>
<td>.305</td>
<td>200.2</td>
<td>217.2</td>
<td>219</td>
<td>219</td>
<td>233.3</td>
<td></td>
</tr>
<tr>
<td>Hsiung &amp; Frantz</td>
<td>43</td>
<td>.49</td>
<td>.457</td>
<td>339</td>
<td>325.2</td>
<td>328</td>
<td>328</td>
<td>249.4</td>
<td></td>
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<td>325.2</td>
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</tr>
</tbody>
</table>

For all practical beams material and load factors are taken as unity. From the results it is clear that codes give safe or conservative designs in most situations. In the BS code there are limitations on the use of high strength concrete. It is restricted to the use of concrete characteristic strength to a maximum of 40 MPa. Recent studies have shown ACI shear design procedure underestimates the influence of the reinforcement ratio. This leads to underestimate the shear contribution from the concrete. The shear predictions based on the Australian code seems to give slightly high estimates. Australian code also has restricts the use of high strength concrete. In conclusion shear predicted by various codes avoid shear failures rather than designing for shear strength.

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Design and development of a multistage root crop harvester for power tiller

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Harvesting includes cutting or digging, gathering and handling of crops up to their final removal from the field. Crops growing in the soil, like potatoes sweet potato, Ground nut and similar tuber crops are lifted with digging tools or implements. Most types of tools engage the use of some of the hand muscles and require a pressure which is quite high for continuous work over long periods. The effort required of the muscles can be reduced considerably by using appropriate mechanization.

Use of manpower for the root crop harvesting is uneconomical due to high labor cost. Therefore a power tiller operated Tuber crop Harvester was design and constructed. This machine was not only useful to lifting the tubers in the ground but also to separating them from the soil. The designed harvester consists of a strong frame with rear wheel, front disc colters, digging shovel with lifting plate and horizontally oscillation type cleaning grille. Harvesting operation of this machine is carried out in three harvesting stages such as leaf stripping, soil separating and loading.

The results show that the Effective field capacity and Effective working width of designed harvester were 0.1ha/hr, and 0.5 m respectively. These results are significantly different with manual method. Travel reduction, and average operating speed of designed harvester were 15% and 2.0km/hr respectively. The total cost of production of designed harvester was Rs 35000.

A new harvesting technique, can however be employed successfully. It was observed that the soil and weather conditions at the time of harvest play a decisive role regarding the quality of the harvested tubers.

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An environmental burden analysis of synthetic dyes vs. natural dyes

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This research is mainly concerned with the investigation of the potential of using natural dyes in place of synthetic dyes. It is well known that synthetic dyes are causing major environmental pollution issues in Sri Lanka and abroad. Though much work has been done not much effort has been spent on finding alternatives to the synthetic dyes which is perhaps the best way of managing pollution. Although dyeing with natural dyes has not received due attention of the scientists as well as of the industrialists, recently the textile industry is being confronted more with enquiries on the theme of “dyeing with natural dyes”. Within the textile manufacturing chain, wet processing is clearly identified as having a potential adverse effect on the environment. The major problem threatening the textile industry today is environmental pollution, arising out of the wet processing of textiles.

The objective of this study is to demonstrate the limited trace elements present in natural dyes (i.e. to demonstrate near zero burdens on the environment) and the final effluent Chemical Oxygen Demand COD (to test the hypothesis that the effluent is less problematic and therefore easy to treat). Both hypotheses have been investigated for the selected, best dye yielding biomaterials. Characterisation of eco-friendliness of natural dyes reveal that no major harm is caused to the environment when compared with the synthetic dyes.

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Prestress transfer using controlled detensioning process

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For several decades, the use of prestressed concrete has grown rapidly because of its efficient and economical advantages. These structures are most commonly used in bridges, buildings, piling work and marine structures where large spans and/or corrosive environments are present where cracking of concrete is detrimental. With the use of new high strength materials and larger diameter prestressing strands the benefits of prestressed concrete can be extended further.

Pretensioned prestressed concrete can be produced in a number of ways. Among them several options can be considered depending on the structure constructed and how prestress is transferred. In the recent times radial and longitudinal cracks have been observed due to high tensile stresses developed in concrete around prestressing steel. In practice to eliminate these harmful conditions modifications are required to ensure serviceability functions of the composite high quality material.

Often excessive prestress is reduced by lowering the tensile stress in the prestressing steel or / and the magnitude of the eccentricity towards the end of the member which is vulnerable to this type of effect. In the global context debonding of tendons towards the end of a member, draping of tendon towards the central portion of the member or controlled detensioning can be applied to achieve the desired outcomes. All these techniques require a sound basis for prestress transfer which is achieved by bond. Some of the practices are prohibitive to developing countries due to the high cost of holding down devices buried in the concrete. Further in third world countries cost of hardware is expensive as opposed to cheap labour encountered in production.

This research is aimed at strengthening our understanding of bond mechanism by extending cohesive cracking approach established by experiment and matched by a sound theoretical basis to complement each other. Currently some of the global practices are carried out by relying on intuition as opposed to theoretical formulations.

This study covers a comprehensive analysis of bond development for the controlled detensioning process. The experimental verification is not part of the present scope. However the parameters influencing such as strand diameter, initial prestress, concrete and concrete strength have been identified.

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A low cost two wheel tractor operated tine tiller for paddy cultivation

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Tillage means the preparation of the growth zone in the soil for plant development. It is the first and most important operation in paddy cultivation. Without proper land preparation, higher yield of crop production by applying other input cannot be expected. The paddy farmers in Sri Lanka use expensive, untested, imported ploughs for land preparation. The commercial ploughs used in many developed countries, which are beyond the financial capabilities of local paddy farmers. A properly designed Tine Tiller can puddle the paddy soil with less power. So far in Sri Lanka tine tillers are not fabricated for two wheel tractor. The share of the Tine Tiller cut and puddles the soil. As a result, the plough-man can till a field in a judicious way in one operation without leaving any unploughed strip of land. Considering the above facts, a low cost three bottom Tine Tiller for two wheels Tractor was designed and constructed after testing first model plough in the field and implementing necessary modifications.

An experiment was conducted in the paddy field to compare the performances of the developed Tine Tiller with conventional Mouldboard plough. Effective field capacity, Effective working width, soil inversion, Field efficiency, Ploughing depth, Travel reduction, Fuel consumption, Average operation speed, and cost for production of Ploughs were considered as criteria for the evaluation of designed plough.

The results show that the Effective field capacity and Effective working width were 0.05ha/hr, and 0.60 m respectively. Above observations for conventional plough were 0.03 ha/hr, and 0.30m respectively. Therefore effective field capacity and effective working width were greater by 60% and 90% respectively. These results are significantly different. Ploughing depth, Travel reduction and operating speed of the designed plough were 24.5cm, 12.4% and 2.6km/hr respectively. Above observation for conventional plough were 15.4 cm, 16.7% and 1.65km/hr respectively. These results are significantly different. Fuel consumption of designed plough and conventional plough was 8.2L/hr and 11.1L/hr respectively. The total cost of production of designed plough and conventional Mouldboard plough was Rs 15500 and Rs 45000 respectively. On the basis of above results, design plough can be recommended as better tillage equipment for paddy cultivation.

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Use of coir dusts in vertical drains as a substitution for sand

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This research project studied the applicability of soft ground improvement with an introduction of coir dust in vertical drains as a filling material with sea sand, as a useful means of reducing and optimising waste.

As a developing country, Sri Lanka has already launched major development projects, therein utilizing undesirable grounds is unavoidable due to limited usable land. Normal practices like removing and replacing of soil as well as pile foundation in overcoming undesirable conditions of the soft ground may not be economically and environmentally feasible for a developing country like Sri Lanka. At the same time, solid waste management has become a major concern all over the world as it appears with many issues. Waste reduction, reuse and recycle have become major issues in recent days. As a major coconut producing country in the world, Sri Lanka produces annual net waste of coir dust around 527,800 t. Having considered the means of reducing and reusing the coir waste in a useful manner, the applicability of ground improvement with an introduction of coir dust in the vertical drains as filling materials with sea sand was studied in this research.

The permeability characteristics of mixed materials of coir dust and sea sand as well as sea sand were analysed and a comparison made of consolidation behaviour of high plasticity clay with vertical drains under two conditions - vertical drains filled with sea sand alone and the drains filled with mixed materials. Those without vertical drains were also discussed. The results of consolidation tests showed that the soil improved with vertical drains consist of coir dust accelerate the consolidation process compared to the unimproved soil. It was observed that the coefficients of permeability of mixed samples were within the range of \(10^{-2}\) cm s\(^{-1}\) which is a typical value for sand drains.

The optimum percentage of coir dust to be used in vertical drains with sea sand as filling materials was finally established by considering the permeability and consolidation characteristics with a cost analysis for practical applications.

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**Operation of two-axis solar tracking by the discharge of water from a tank hanging from a non-circular sprocket wheel**

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Two-axis solar tracking system operated by the discharge of water from a bottom hole of a tank filled with water was designed, constructed and tested. The water tank is hanged by a chain passing over a circular sprocket wheel mounted eccentrically on a shaft free to rotate about a North-South axis. A counterweight is also hanged by another chain passing over a circular sprocket wheel mounted on the same shaft.

In the morning, the water tank is filled to top. The water tank and the counterweight on either side of the shaft balance in such a way that the solar panel is facing the East as required. As the water drips out from bottom hole of the tank, the reduction in weight causes the shaft to rotate until the moments by the water tank and the counterweight equalize.

This study shows that a custom-designed noncircular sprocket wheel can be used instead of the eccentric circular wheel, and the contour of the non-circular sprocket wheel can be designed taking into consideration the reduction of weight of the tank with time and the required rotation for solar tracking. In addition to the hourly tracking by this mechanism, provision can be made to tilt the solar panel about the second tracking axis manually on a weekly basis to compensate for the seasonal variation of the Sun’s declination. The additional cost involved in making this robust mechanism is justifiable because two-axis tracking can give about 30% more solar power on average and much more on days which are cloudy at noon but not in the morning or afternoon.

To prevent vibrations due to wind, the water tank and the counterweight can be placed at ground level and be surrounded by a shield.

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Removal of reactive dye from wastewater using coir pith based adsorbent

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Adsorption of reactive dye, cibacron blue onto coir pith from aqueous solutions was studied to enable comparison with alternative commonly available absorbents. Coir pith was treated with hydrochloric acid to enhance adsorption properties. Batch experiments were conducted to determine the factors affecting adsorption and kinetics of the process. Fixed bed column experiments were performed to study practical applicability and breakthrough curves were obtained. Coir pith is capable of binding appreciable amounts of cibacron blue dye from aqueous solutions. The adsorption capacity was highest at solution pH range 2 to 3. The adsorbent to solution ratio and adsorbent particle size affect the degree of dye removal. The equilibrium data were satisfactorily fitted to Langmuir and Freundlich isotherms. Highest dye uptake of 66 and 46 mg/g were observed for hydrochloric acid treated coir pith and granular activated carbon respectively. Kinetic studies revealed that rate of adsorption increases with temperature. The kinetic data fits to pseudo first order model and the intra-particle diffusion model. The intra-particle diffusion is not the only rate limiting step. Fixed bed adsorption capacities were lower compared to batch experiments. Coir pith is a suitable adsorbent for cibacron blue dye removal from wastewater.

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Laboratory experiments to investigate the suitability of low-replacement sand compaction piles for developing countries

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Strength parameters of a sand compaction pile are normally checked by standard penetration test (SPT). Empirical equations, which are derived from numerous data obtained from uniform sand, are adopted for evaluating the internal friction angle (\( \phi' \)) value of the sand pile. However, constraint conditions of a sand pile in the clay improved with sand compaction piles (SCPs) are considered to be very different from that in the uniform sand. Due to simplicity, speed, continuous profiling and amenability to theoretical modeling, cone penetration tests (CPT) can be used to evaluate \( \phi' \) for SCP.

In this research, laboratory tests were done with a miniature cone, which consisted of two strain gauges to measure tip resistance and probe resistance, inserted into a sample of saturated sand in a triaxial set-up. Before inserting the cone the sample was consolidated under different confining pressures such as 50, 100, 200 and 400 kPa and then the cone was penetrated at a constant rate to find out the ultimate cavity expansion pressure and the volume change of the sample. These tests were done with two different relative densities of 60% and 72% Toyoura sand. It was observed that the laboratory test results for the ultimate cavity expansion pressure were in good agreement with the cavity expansion theory proposed by Nawagamuwa (2002).

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Effect of nonlinear behaviour of cable structures

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Analysis of structures for nonlinear behaviour has become one of the major challenges for the modern structural engineer. Even though almost all the structures have some form of nonlinear behaviour, due to the complexity of analysis and limitations of computational techniques, which consider all such effects, are cumbersome, hence most of the analyses are simplified. Considerations of all such nonlinearities are extremely difficult in structural analysis.

In this study of nonlinear behaviour, the scope is limited to geometrical nonlinearity issues. Geometrical nonlinear behaviour is significant in large deformation structures such as suspension bridges, guyed towers, transmission lines, cable stayed bridges etc. Equilibrium of such structures has to be considered in its deformed configuration, which itself is an unknown prior to the analysis.

Although in some methods it is considered null bending stiffness of cables, actual description of the cables has to consider both bending and axial effects. In linear analysis it is adequate to use bending deformation relationship for curvature. But when the deformations are large, actual bending deformation relationship is given by large deformation formula, which is known as the Euler-Bernoulli Equation. Axial effects also have to be considered in the equation when the deformations are large. Hence the equilibrium equation for the large deformation structures becomes a nonlinear second order integral differential equation where an analytical solution has not been found.

Scope of this paper has been limited to single dimensional structures in a two dimensional plane. This paper described the effects of consideration of large bending deformation relationship, and other large deformation nonlinear effects on cable structures. All possible causes of geometrical nonlinearities were considered and behaviour of the cable structures was studied. Analysis is carried out by using MATLAB programme, which is capable of accommodating all mathematical operations. Results were compared between with and without nonlinear effects. It is found that the effect of consideration of actual bending deformation relationship is very much significant when the deformations are large.

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Flyovers and urban landscape; responsiveness of the flyovers

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The definition of a city is identified by several ways subjected to different perceptions. It is fair enough to identify it as a process which is evolving. The process is always powered by the human needs compromising the inferior to the superior. Today the focus is to create human friendly cities and heavy traffic is concerned as an obstruction to the human responsiveness of urban landscape.

It is vital to solve the traffic and provide better connectivity for people. At the same time the solution for such should not complicate structure of the urban landscape in a way to affect the image of a human friendly city. The balance between both, the human activities and traffic should be enhanced. But flyovers or the viaducts are placed in the city with a mere concern on traffic and there is no assessment ever made to identify the responsiveness of the flyovers on urban landscape which is becoming more critical today with the development of the cities.

It is true that the solution of the flyovers is essential to enhance the urban process, which serves human activity of getting connected. But understanding more of the solution and the side effects due to the implementation of such could enhance the urban landscape in a very human friendly manner.

Basically here the expression of the flyover is analyzed in an architectural point of view. Through different parameters such as legibility, permeability, visual appropriateness, etc the responsiveness can be measured. Materials for analysis are gained through the photographic studies, physical surveys and observations and they are analyzed based on scholar’s ideas and with surveys involving the people. Then with the expression gained can be improved not only to solve the traffic demands but to improve and influence the urban process in a positive manner.

Observing the present scenario it is evident that the flyovers are merely built as a solution to the traffic. Further it creates more lost spaces in the city. These lost spaces are critical even today as such spaces are missed used and these can be a threat to a better habitation.

The study would generate the real responsiveness of the flyovers apart from the successfulness of the traffic solving ability. These will prove the vitality of the flyover as an object placed in the urban landscape. This could influence engineers, architects and urban designers, etc to be more innovative and responsible towards the urban landscape which is very sensitive for a better habitation.

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Design of a jatropha oil extractor for domestic use

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Jatropha Curcas seed has been recognized as a suitable seed for oil extraction, which has added advantages such as rapid growth, higher seed productivity, suitable for tropical and subtropical regions of the world. It can grow almost on any type of soil whether gravelly, sandy or saline and thrives even on the poorest stony soils and rock crevices. Considering the above facts, the project “Design and Development of a Jatropha oil Extractor for Domestic Use” was carried out at the Department of Mechanical and Manufacturing of Engineering, Faculty of Engineering, University of Ruhuna.

Existing coconut oil and Jatropha oil extractors were studied and tested the oil yield of existing Jatropha oil extractor in Thanamalwila area. Average oil yield of existing machine was founded to be 17.67% (Weight basis). Two extractors were designed to maximize the oil yield (about 26%). In the primary oil extractor two helical gear profiles were used to press and squeeze the Jatropha seeds to maximize the oil yield rather than only pressing. The secondary oil extractor was designed for further oil extraction from the cake which is more similar to the existing oil extractor. Design calculations were done for the gear profile, bearings and shaft in the primary extractor. Designed oil extractor could be improved by introducing electrical motor for mass scale oil production. Oil yield could be further improved by varying the particle size and moisture content of Jatropha seeds.

Jatropha oil has substantial prospects such as long-term substitute for diesel fuels, soap production, direct use in cooking stoves and oil lamps (replacing kerosene oil lamps) and Jatropha seedcake could be used for producing bio gas and fertilizer.
A study on finfish and shellfish species in the NARA mangrove reserve, Kadolkele, Negombo, Sri Lanka

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This study was conducted to understand Finfish and Shellfish diversity to enhance the knowledge on biodiversity of NARA mangrove reserve, Kadolkele 10 ha in extent is located on the right bank of the northern part of Negombo Estuary (7°11’ N, 79°50’ E). The ecological value of mangroves is the least concern of people in the surrounding area and this mangrove patch is frequently under threat due to high land demand and its high economic value. It is essential to understand biodiversity and other relevant ecological features in order to determine strategies to conserve this mangrove forest. In total, 29 mangrove species, including 18 considered as true mangroves present in this reserve. There were no any detail taxonomic studies to understand faunal composition of this reserve. Diversity of fauna in mangrove forests of Sri Lanka is so immense but is a relatively poorly dealt subject. The main objective of the present research was to explore the species diversity of finfish and shellfish species in mangrove reserve and provide information for formulate guidelines for the conservation and management of Kadolkele mangrove reserve. Data was collected from random sampling in surrounding water bodies from February to December 2007. Monthly sampling was carried out using cast nets and monofilament gill nets. Collected finfish and shellfish species were identified using available keys and descriptions. Results of the study indicated that there was a high diversity of finfish species which consisted of 35 species belongs to 27 families. The fish include freshwater forms, brackish water forms, fresh-brackish water migratory forms and marine- brackish migratory species. Shellfish species represented by 4 shrimp species (i.e. Penaeus indicus, Penaeus merguiensis, Penaeus monodon, Metapenaeus dobsoni), fresh water prawn (Macrobrachium rosenbergii) and crab species (Scylla serrata). Families with the highest abundance of finfish were Cichlidae, Belontidae and Anabantidae. Oreochromis mossambicus, Trichogaster pectoralis and Anabas testudineus species dominated in families of Cichlidae, Belontidae and Anabantidae respectively. Knowledge of the species composition of finfish and shellfish of this mangrove reserve is an important prerequisite, not only to understand all the aspects of structure and function of this reserve, but also to formulate guidelines for their conservation and management.

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Mass production of water flea (*Moina micrura*) in fresh water ornamental fish culture

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In ornamental fish culture, live organism feed may increase the growth and survival rate of juveniles for many species of fish. The water flea (*Moina micrura*) is an excellent natural food for nursing economic fish and type of food observed were composed mainly of bacteria, small protozoa, *Chlorella* sp. and decomposed organic matter. Laboratory and field experiment for development techniques for mass production of water flea were carried out with different media such as freshly cultured unicellular algae, *Chlorella* and organic manure.

The production trial was carried out in the round fibre glass tanks (600 liter capacity) which were enriched with inorganic fertilizers with *Chlorella* and organic cow manure alone. Water temperature and pH were measured daily. Initial stocking of 2000-3000 individuals of *Moina* culture with inorganic fertilizers and *Chlorella* produced 6.5±0.14 number/ml on the sixth day of culture period which was significantly higher than resulted of 3.05±0.07 number/ml with the loading of cow manure as organic fertilizer. Surface water temperature ranged between 27.5 - 29.0 °C and 27.13 - 28.13 °C and water pH varied between 7.25 – 8.45 and 7.30 – 8.10 found to be conductive for optimum growth of *Moina* culture with *Chlorella* and organic manure respectively. Water pH of all tanks were declined towards the end of the culture period.

In comparison, the results of propagation and growth of water flea – *Moina* observed in this study was remarkably higher loading of inorganic fertilizers with inoculation of *Chlorella* than loading with cow manure as organic fertilizer. The quantity of *Moina* sp. produced using the *Chlorella* is more suitable for commercial production.

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Gonad development and evidence of protogyny in *Lethrinus nebulosus* (spangled emperor) from coastal waters off Negombo

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Spangled emperor, *Lethrinus nebulosus* is known to exhibit protogynous hermaphroditism (i.e. change sex from female to male). Gonad development and evidence of protogyny were investigated for *Lethrinus nebulosus* living in coastal waters off Negombo. Monthly collections were made from August 2007 to February 2008 from Negombo fish landing centers. Sexual dimorphism was not evident and males and females were not distinguishable externally. Gonads were prepared and analyzed using standard histological techniques. All stages of the mature male and female had rounded gonads with no specific features for macroscopic identification. Male and female maturity stages were assessed microscopically based on the most advanced germ cells (oocyte or spermatocyte) presented. Transitional gonads were characterized by appearance of spermatocysts and degenerated of oocytes in the same developmental stage. In addition, strands of stromal tissue within the lamellae were thickened and secondary strands were branched, increased blood vessels and sperm sinuses within the gonad wall provided early indication that sex transition had been initiated in *L. nebulosus*. The minimum size at which 50% of males and females attained first sexual maturity was estimated to be 30.5 cm and 40.5 cm respectively. Transition occurred around 28.5-40.4 cm size class when females were matured. Males were predominated in the smaller size classes whereas females in the larger size classes. Most of the fisheries management theories have developed for gonochoristic populations and not applicable to these hermaphroditic species. Therefore, knowledge of hermaphroditism has critical implication in fisheries management.

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Lysozyme and morphological variation between *Puntius dorsalis* (long-snouted barb) and its presumably conspecific red-fin variety

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The present study analyses the morphology and isozyme variation of *Puntius dorsalis* and the red-finned variety presumed to be conspecific to *P. dorsalis*. The external appearance of the red-finned variety is closer to that of *P. dorsalis* than of any other formally described congener. However, one distinctive autapomorphy in morphology of the red-finned variety is the presence of 3½ transverse rows of scales above lateral line (along the dorsal-anal fin diagonal), while it is 4½ in *P. dorsalis*. Among the putative isozyme loci resolved for seven enzymes, *Idh*, *Mdh*-1 and *Pgm* display fixed allelic differences between the two varieties indicating reproductive isolation and species-level divergence. Red-finned variety is morphometrically distinguishable from *P. dorsalis* by having a longer snout (8.7%SL Vs. 5.9%SL) and longer head (28.6% Vs. 25.8%). Morphology based classification function correctly classified 100% of the fish into their *a priori* groups indicating a reliable morphological discrimination between the two varieties. Present results provide evidence against the erroneously presumptive recognition of the red-finned variety as a color morph of *P. dorsalis*, and display species-level divergence between the two varieties.

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Antimicrobial activity of *Rhizophus Stolonifer*

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Antibiotics producing microorganisms found in nature are not only useful in medicinal purposes but are very useful in agricultural disease management, enzyme production, etc. *Rhizophus* spp is one of the most common genera of fungi in soils and other natural habitat consisting of organic matter. *Trichoderma* was isolated from soil and characterized into different isolates based on colony, vegetative and reproductive characters. Antifungal and antibacterial activities of those isolates were studied against *Pythium ultimum*, *Rhizoctonia solani*, *Fusarium oxysporum*, *Bacillus* sp, *Escherichia coli*, *Pseudomonas* and *Streptococcus*. One of the isolates (Isolate no 5) showed marked effect on antimicrobial activity against *Rhizoctonia solani*, *Bacillus* sp and *Pseudomonas* sp and this isolate was identified as *Rhizophus stolonifer*. Further bioassays on fungal, bacterial, protozoan and nematode were done using the crude extracts of *Rhizophus stolonifer* in methanol and distilled water. Methanol extract exhibited antifungal activity whereas the water extract displayed antibacterial activity. The organism produces volatile and water soluble antibiotics and shows significant inhibition on the formation of sclerotia of *Rhizoctonia solani*. Antiprotozoan activity was also observed but there was no effect on the motility of nematode. This organism also produced the enzyme amylase which is widely used in the food industry. In order to use the antibiotic compounds and enzymes in this extract, they will have to be purified and the characteristics and mode of inhibition should be further studied.

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Study of the effect of UV-B radiation on tadpoles of *P. Cruciger* and *B. melanostictus* under laboratory conditions

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Consequent increase of ultraviolet-B radiation has been identified as a possible cause of amphibian population declines and malformations together with other stressors such as pesticides and trematode infection (Ouellet et al., 1997, Johnson et al., 1999 and Blaustein et al., 1994). Two common anuran species; the common hourglass tree frog (*Polypedates cruciger*: Ranidae) and common toad (*Bufo melanostictus*: Bufonidae) were exposed to UV-B radiation (312 nm) to receive Erythemal dose (0.08 relative response) of the action spectra under laboratory conditions. Biological weighted doses were estimated to match 50%, 25% and 10% of the average daily irradiance of UV-B. Since the average daily irradiance of UV-B is not reported for Sri Lanka the calculations were done to match the irradiance in the Asian region (17.92 × 10^{-3} Wm^{-2}). The study was carried out with five days post-hatch tadpoles (Gosner stage 26, N=320 from four clutches) and was continued until their metamorphosis. Survival was recorded daily and malformations were reported weekly. Growth; snout-vent length, body weight and the time required for forelimb emergence of half the number of tadpoles in a given treatment (TE_{50}) were reported at metamorphosis. Significant effects were observed on the survival of both species and approximately 50% reduction was reported in the high dose (7.6 X10^{-2} Wm^{-2}). Growth retardation was a common feature observed in both test species. They exhibited a dose-dependent increase in malformations, mainly composed of skin malformations, lumps and swollen abdominal regions. Malformations were more common and severely exhibited by the tree frog than common toad. This might be related to species specific differences in photolyase levels, skin pigmentation and activity levels. Uncertainty of calculated UV-B irradiance in the study area might affect the accuracy of the results. Hence, recording solar irradiance is an essential part in future studies. Laboratory as well as field studies should be carried out to investigate the role of ultraviolet radiation on local amphibian populations.

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Species richness and diversity of reptiles of the Giritale nature reserve of North-Central province, Sri Lanka

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Herpetofaunal assemblage of Sri Lanka contains 176 species of reptiles. The reptile fauna of the wet zone forests has been studied comprehensively. However there is a paucity of data related to species diversity, abundance and habitats of the reptiles in the dry zone forests. Therefore the present study concentrated in recording the species diversity of reptiles at the Giritale Nature Reserve, a dry zone forest of Sri Lanka. Four habitat types, namely, grasslands, paddy fields, forests and human habitations within the nature reserve were identified using digital maps. Reptiles in each habitat type were recorded using three quadrates (10m×10m) each month from May 2006 to April 2008. Visual encounter surveys (VES) were conducted along three 1km line transects in each habitat every month. Reptile species richness (S) and Shannon-Weiner Diversity Index \{H'\} were calculated. Four hundred and eighty nine individuals of 31 species and ten families of the orders Squamata and Chelonea were recorded during the study. These included one Boidae species, eight Colubrids, one Elapid, one Uropeltid, one Viper species, six Agamid Lizards, six Geckoes, four Skinks, two Monitors and one Tortoise species. Endemic species recorded were the Sri Lankan Flying Snake (\textit{Chrysopelea taprobanica}), Schneider’s shield tail (\textit{Rhinophis oxyrhynchus}), Painted lipped lizard (\textit{Calotes ceylonensis}), Whistling lizard (\textit{Calotes liolepis}), Sri Lankan Kangaroo lizard (\textit{Otocryptis nigristigma}), Blotched Ground gecko (\textit{Geckoella yakhuna}), Kandian Gecko (\textit{Hemidactylus depressus}), Haly’s Tree Skink (\textit{Dasia halianus}), Common Supple Skink (\textit{Lankascincus fallax}) and Spotted Skink (\textit{Mabuya madarazi}). The total abundance was highest in the human habitations with 12.20±9.21 (Mean±SD) and the lowest was in grasslands with 0.75±0.94 (Mean±SD). Highest species richness of 18 was recorded in the forest habitat and the lowest species richness of 5 was observed in the grasslands. Highest Shannon diversity index (H') of 2.29 was recorded in the human habitations while grasslands had the lowest diversity index of 1.07. However, the Shannon Weiner evenness (J) was highest in the paddy fields (J= 0.94) and was lowest in the grassland habitats (J= 0.66). \textit{Sitana ponticeriana} and \textit{Calotes versicolor} were the most common reptile species within the Nature Reserve. Since the Giritale Nature Reserve provides a suitable habitat for thirty one reptile species including ten endemic species every effort should be taken by the management to preserve this prime habitat for reptiles.

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Habitat use of the Sri Lanka grey hornbill (Ocyceros gingalensis) and malabar pied hornbill (Anthracoceros coronatus coronatus) at Giritale nature reserve

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Despite the fact that the Grey Hornbill (Ocyceros gingalensis) and Malabar Pied Hornbill (Anthracoceros coronatus coronatus) are two of the most attractive bird species in Sri Lanka, little information is available regarding their population densities and habitat preference. Twelve line-transects inside the nature reserve and three line-transects in the perimeter of the nature reserve was randomly located. Six circular plots (radius of 50m) were selected along these transacts and habitat data were recorded. Cluster analysis revealed the presence of five different habitat types. Three line transects were then placed in each of these habitat types. Each bird contact was assigned to one of five height categories. Density of the two hornbill species was calculated. Total of 101 Grey hornbills and 20 Malabar pied hornbills were recorded during the study period from March 2006 to February 2007 at the study site. The mean abundance of Grey hornbill during the breeding season (from March to August) (Mean±SD, 0.233±0.218) was significantly low when compared to that of the non breeding season (from September to February) (Mean±SD 0.889±0.453) (t=-3.191, p<0.01). The mean abundance of Malabar pied hornbill during the breeding season (Mean±SD 0.078±0.078) did not differ significantly from that in the non breeding season (Mean±SD 0.144±0.453) (t=-0.829, p>0.05). There was significant difference between the abundance among the five different habitats (F=10.84, p<0.0001) while the abundance of Malabar Pied hornbill did not differ between habitats (F=2.156, p=0.0759). Forests had the highest number of Grey hornbills with large proportion using in the canopy or flying above the canopy. Highest number of both species were observed in the forest and scrub forest while no hornbills were observed in the tank and scrub habitat. The present study revealed that the preferred habitat of the hornbills is the forest also since these birds do not occur in large numbers in the Giritale nature reserve they warrant protection.

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A preliminary investigation on the genetic diversity of *Penaeus monodon* shrimp stocks captured in different geographical locations in Sri Lanka

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The biological and economic importance of *Penaeus monodon* makes it necessary to study its genetic diversity and the population genetic structure to improve the species in important economic traits. In addition, it would also help in the knowledge-based fishery management and aquaculture development of this important biological resource. To study this genetic diversity, samples of *P. monodon* were collected from the areas of Hendela, Negombo, Katunayake, Chilaw, Kalpitiya and Beruwela. The DNA extracted from the pleopods of these samples was subject to PCR amplification, targeting the cytochrome C oxidase I (COI) gene segment in the mitochondrial genome. Nine sequences approximately 450 bp in length were obtained from the PCR products. These included 2 samples from Hendela, 1 sample from Katunayake, 1 sample from Negombo, 3 samples from Chilaw, 1 sample from Kalpitiya and 1 sample from Beruwela.

The sequences when aligned showed several regions that were 100% homologous (10 to 26 base pair regions) in all the samples analyzed indicating conserved regions within the gene segment studied. A sample from Chilaw and a sample from Hendela showed the same nucleotide substitutions in 24 positions showing a low genetic diversity existing between the *P. monodon* stocks of Hendela and Chilaw. The phylogenetic analysis showed that the samples from Hendela, Negombo, Katunayake, Chilaw and Kalpitiya occupying one clade and the Beruwela sample occupying a completely separate clade. These results show that the stocks of the western and the north western regions of Sri Lanka are different in origin to the origin of the stocks of *P. monodon* of Beruwela.

As this is an ongoing project, more samples will be collected and analyzed from regions considered in this study. In addition, samples will be collected from areas in the southern, eastern and north eastern regions of Sri Lanka such as Koggala, Kokilai and Batticaloa. The genetic diversity of *Penaeus monodon* in Sri Lanka could be further confirmed by analyzing these additional samples.

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A study on the detection of genetically modified (GM) soy food using PCR–based amplification method

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Availability of genetically modified (GM) crops and their products in the worldwide market have increased with time. GM foods have recently been subjected to debate among consumers in Sri Lanka. Due to the variability in acceptance levels among the consumers and public, appropriate labeling of GM foods has become essential. For careful monitoring detection is important. To detect GM foods, reliable and sensitive techniques are required. Two basic methods could be used for detection of genetically modified food; Polymerase Chain Reaction (PCR) – based amplification methods and protein based methods.

The aim of this research project was to detect the presence or absence of genetic modifications in samples of soybean seed, leaf and soybean derived products, available for consumption in the Sri Lankan market, using PCR–based amplification method. A soybean sample with genetically engineered herbicide resistance was used as the positive control. This is the major engineered trait found in GM soy crop worldwide. The herbicide resistance in Roundup Ready™ soybean is conferred by the incorporation of 5-enol-pyruvyl-shikimate-3-phosphate synthase (EPSPS) gene obtained from Agrobacterium tumefaciens strain CP4 into the soybean genome. The transgene construct consisted of CaMV 35S promoter, EPSPS coding region and a Nopaline synthase (NOS) terminator. Detection of any of these elements in the genome of the test plant can be used to prove that the test sample is GM.

Genomic DNA was extracted from soybean leaves, seeds and soybean derived products; soy meat, soy flour and soy milk powder, using a modified CTAB method with additional purification steps. The DNA extracts of the test samples were amplified with primer pairs directed against CaMV 35S promoter and NOS terminator, separately by PCR. The expected sizes of the amplified bands for CaMV promoter and NOS terminator for the positive control are 123 bp and 109 bp. The amplified products were subjected to gel electrophoresis and stained with Ethidium bromide for visualization. Bands of expected sizes were detected for the positive control, and not detected for any of the test samples. According to the results it can be concluded that the raw soybean (2), soybean leaves (1) and soy derived foods; soya meat (12), soy flour (1) and soy milk powder (1), tested from the Sri Lankan market are not genetically modified.

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Extremely low genetic variability in *Etroplus suratensis* (Cichlidae) revealed by isozymes, microsatellites and mitochondrial DNA sequences

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Genetic variation in several populations of *Etroplus suratensis* in Sri Lanka was studied by isozymes, selected microsatellites, and DNA sequence of the control region (D-loop) of the mitochondrial (mt) genome. Based on seven resolvable enzymes, only a single isozyme locus, PGI-2 showed polymorphism albeit of poor degree (~1.2%), while all other nine isozyme loci were monomorphic in three populations (n=34, 20, and 30). Four PCR-amplified microsatellite loci with dinucleotide repeat motifs were not variable in the two populations studied (n=25 and 23) indicating that *E. suratensis* populations seem to be homogeneous at these microsatellite loci. Further analysis of DNA sequence of TmoM27 microsatellite locus and the flanking region (327 bp) among 48 individuals did not contain even a single SNP (single nucleotide polymorphism) site whereas the same locus of other Cichlids including *E. maculatus* is reported to be variable. DNA sequence of a 760 bp fragment of the mitochondrial control region did not contain any SNP among the 48 individuals analysed. The results suggest the possibility that extremely low genetic variability prevails in *E. suratensis* populations in Sri Lanka. A likely explanation for this may be the initial colonization of the island by a small number of genetically homogenous founders. Further loci from more geographic locations including India would be useful to investigate this hypothesis further. Potential inbreeding and associated loss of genetic variation has been linked particularly to island populations, thus, an interesting postulate to test is whether the island populations of *E. suratensis* have less genetic variation than mainland populations by using Indian counterparts of the species.

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Intraspecific variation in morphology was studied in *Puntius singhala*, a freshwater Cyprinid endemic to Sri Lanka. In *P. singhala*, significant morphological heterogeneity was evident among some of the six freshwater populations studied, although the level of differentiation was not large. The differentiable variation in morphology among fish populations has been suggested as indicative of the presence of stock structuring and restricted movement among geographically isolated populations. In *P. singhala*, the observed variation may be defined as differentiable variation in some populations as evidenced by the results of the Discriminant analysis (Wilk’s Lambda = 0.167, p<0.001). The variation observed has no significant correlation to the inter-locality geographic distance, thus isolation-by-distance was not a plausible explanation, while phenotypic plasticity may have contributed more for the observed variability in morphology. Testing for sexual dimorphism in the pooled sample revealed slight yet significant between-sex differences in three of the size corrected character measurements, i.e. caudal peduncle length, dorsal finbase length and pectoral fin length where the males had slightly longer dimensions than females.

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Construction of rice endosperm specific expression cassette containing Glu-B1 promoter- GFP reporter-Nos terminator by overlap extension PCR

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Glutelins are major rice proteins expressed under endosperm specific glutelin promoters. Glu-B1 is such a promoter that has shown to be active in rice endosperm specific expression. Glu-B1 was cloned and characterized in a previous study as part of an ongoing project to express the wheat protein, glutenin in rice. The present study reports the construction of a Glu-B1-GFP-NosT expression cassette in view of evaluating the promoter activity of the isolated Glu-B1 promoter of rice.

Fusion PCR was employed to combine rice Glu-B1 promoter gene with green fluorescent protein (GFP) gene containing nopaline synthase terminator. GFP gene is a reporter gene and was used to test the activity of the Glu-B1 promoter. Rice glutelin promoter (Glu-B1) was amplified from previously cloned Glu-B1 promoter. Reverse primer for Glu-B1 amplification was designed to contain 24 nucleotides of the 5' GFP sequence. GFP gene with nopaline synthase (Nos) terminator was amplified from the pCAMBIA 1302 vector using specific primers. The two amplified gene products were fused using overlap extension PCR. Amplification resulted in the fusion product (1350bp). The partial sequence of the fusion product (5'Glu-B1 promoter and the 3' GFP –NosT region) was analysed with Clustaw multiple sequence alignment program. The 5' end (260bp) of the fusion product showed 93% similarity to Glu-B1 promoter and contained all potential cis-element motifs published for Glu-B1 promoter sequence (AACA-2 motif, GCN4 motif, A/G box, AACA-1, and TATA box). A 397 bp region obtained for the 3' end of the fusion product showed 98% similarity to the 3' end of the GFP gene containing the nopaline synthase 3'UTR sequence and the Poly A signal. The sequence analysis confirms the fusion of the two Glu-B1 promoter to the GFP reporter gene.

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Fat content and fatty acid profile of skin and muscle of the Indo-Pacific sailfish, *Istiophorus platypterus*

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The total fat content and fatty acid profile of the skin, dorsal muscle, ventral muscle and belly flap of the Indo-Pacific sailfish, *Istiophorus platypterus* (Thalapatha) were determined. Three fish samples per month were obtained from Pitipana, Negombo landing site over a period of eight months (August 2007 - March 2008). Total fat content was determined by the Majonnier method. For analysis of fatty acids, oil was extracted using the Bligh & Dyer method and the Fatty Acid Methyl Esters (FAME) were prepared by the sodium methoxide method. FAMEs were then identified by injecting into the Gas Chromatograph and GC peaks were identified comparing retention time with previously prepared standard (Cod liver oil) and reference standard (GLC 411). The concentration of each FAME was calculated as a percentage of total FAMEs. The total mean fat content of the edible portion of *I. platypterus*, was lower than 5%. Therefore *I. platypterus* can be considered as a low fat fish (low < 5%, medium 5-10, high>10%). The percentage content of fat in the skin and muscles were as follows; skin (6.52 ±0.53), ventral muscle (2.52± 0.19), dorsal muscle (1.79± 0.27), belly flap (3.91± 0.15). The highest storage of fat was reported in the skin, while the lowest storage was reported in the dorsal muscle. The composition of saturated fatty acids (SFA), monounsaturated fatty acids (MUFA) and polyunsaturated fatty acids (PUFA) were as follows; skin 56%, 39%, 44%; ventral muscle 44%, 46%, 33%; dorsal muscle 39%, 42%, 24%; Belly flap 52%, 34%, 38%. The predominant fatty acids in the ventral muscle, dorsal muscle, skin and belly flap were the C16:0(Palmitic acid), C 18:0(Stearic acid), C22:1(Erucic acid) and C 22:5n-3 (Docosapentaenoic acid). The proportion of eicosapentaenoic acid (EPA, 20:5n-3) and docosahexaenoic acid (DHA, 22:6n-3) in the fat of skin (2.31%,7.23%) and belly flap (2.06%, 5.36%) were significantly high (P<0.05) compared to ventral muscle (0.86%, 2.74%) and dorsal muscle (1.78,2.07%). A negative linear correlation between the total fat content and moisture content (Pearson's correlation -0.732, P<0.05) was also recorded.

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Levels of exposure to nitrogen dioxide of individuals traveling from suburban areas to a selected site in the city of Colombo

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The city of Colombo like many other urbanized cities in developing countries faces a situation where the concentrations of gaseous air pollutant levels are on the increase. Individuals traveling from suburban areas to the city of Colombo along busy roads are exposed to these pollutants which increases the risk of respiratory health effects. Of these pollutants, Nitrogen dioxide is a gaseous pollutant which is associated with a range of respiratory health effects.

This study was done to determine and compare the levels of exposure to Nitrogen dioxide of individuals traveling from selected suburban areas to the City of Colombo.

Four students traveling from four suburban areas; Dehiwala, Moratuwa, Maharagama and Kadawatha, to a common site in the city of Colombo (Department of Zoology, University of Colombo) were selected for the study. The total exposure of each student for a period of four working days (Monday morning to Friday morning) was measured using a passive sampling unit. Minimum measurable concentration of the unit is 1.2 µg/m$^3$. Simultaneously their home levels were also measured throughout the same period. The final NO$_2$ concentrations were obtained using a standard colorimetric method. Sampling was carried out for a period of six consecutive weeks.

Individual exposure levels to Nitrogen dioxide during normal day to day activities ranged from 48.0 µg/m$^3$ to 126.3 µg/m$^3$. The home levels ranged between 23.8 µg/m$^3$ and 57.7 µg/m$^3$. Considering the mean exposure levels, statistical analysis showed that the exposure during normal day to day activities was significantly higher than their respective home levels in all subjects (P<0.05). All recorded values were below the WHO one-hour standard value of 200 µg/m$^3$.

The study concludes that individuals traveling from suburban areas to the City of Colombo for normal day to day activities are exposed to significantly higher concentrations than their home levels. Although these values do not exceed the WHO standard level, previous studies have shown that long term exposure to these levels can cause significant respiratory health problems.

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A preliminary study on the effects of dredging on the environmental parameters and occurrence of crustacean and fish species in the Lunawa lagoon

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Lunawa lagoon, which is situated in the District of Colombo, has been highly degraded over the last two decades due to many anthropogenic activities. Lagoon restoration is being carried out through dredging and the removal of the sand bar at the sea outfall for the first time in Sri Lanka by the Coast Conservation Department. Thus, the evaluation of the success of such an effort is of utmost importance as the Coast Conservation Department is planning to use this methodology in their future restoration programmes. Main objective of this research was to study the effect of dredging on some environmental parameters and occurrence of phytoplankton, zooplankton, crustacean and fish species in the Lunawa Lagoon.

Three sites comprising of, a site where dredging has completed (site 1), a site where dredging was ongoing (site 2) and a site where no dredging has been done (site 3) in Lunawa lagoon south were studied twice a month for a period of 6 months from June to December 2007 to collect data on some selected water quality parameters, phytoplankton and zooplankton. Site 1 was also sampled for fish and crustaceans where fish were taking place. The results obtained were statistically compared using MANOVA to determine the inter-site variation of lagoon waters.

There was significant inter-site variation (p<0.05) with respect to all observed environmental parameters except pH and temperature. Site 1 and 2, show marked increase in Salinity, Dissolved Oxygen (DO), Electrical Conductivity (EC) and a marked decrease in Orthophosphate, Nitrate, Sulphide and Biological Oxygen Demand (BOD$_5$). In contrast to these, Salinity, Dissolved Oxygen (DO) and Electrical Conductivity (EC) in site 3 remained in lower ranges than sites 1 and 2 while Orthophosphate, Nitrate, Sulphide and Biological Oxygen Demand (BOD$_5$) remained at higher ranges than sites1 and 2.

Shannon wiener diversity indices for phyto-planktons and zooplanktons in the 3 sites suggest that sites 1 and 2 are still moderately polluted and site 3 is heavily polluted. Number of fish and crustacean species which was 2 at the beginning of the study has increased to 11 at the end in site 1. These observations reveal the fact that dredging of Lunawa lagoon has positively affected on environmental parameters in lagoon and occurrence of crustacean and fish species and dredging also has contributed in reducing the pollution level of the lagoon.

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Coastal vegetation structure and resistance southern coast of Sri Lanka in the mitigation of tsunami impacts

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The present study is an attempt to investigate the relationship between coastal vegetation structure and its capacity to resist wave energy. Thickness of tsunami sand deposits at Rekawa, Kalametiya and Kirinda were measured and used as indicators of degree of resistance by vegetation against tsunami wave that passed through the mangrove vegetation at the respective localities. Belt transects of 30 -40 m long which were laid perpendicular to the lagoon/estuarine shoreline and parallel to each other and at 30-70 m distance from the shoreline were used to collect data on vegetation structure and each was divided into 10 m ×10 m plots. The locations of each tree, sapling, seedling and stump of trees and also girth and height of trees were measured. Moreover thickness of the sand deposited by tsunami wave was taken by digging 1´ × 1´ pits on the ground. Thus pits were made in each plot along seaward to landward gradient.

The results suggest that mangroves and Pandanus odoratissimus communities of closely spaced trees with widely branching canopies, trees with intermediate diameter and greater forest width provide the greatest resistance against tsunami by reducing inundation distance inundation depth and flow velocity of tsunami waves, which explained that coastal forests lessen damage to property and reduce loss of life. Results further explained that wide crowns with prolific branching of Avicennia marina and P. odoratissimus with stilt/ prop roots and dense foliage exhibit the greatest drag resistance against the tsunami wave.

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Assessment of knowledge, attitude and contribution of coastal communities in marine turtle conservation

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The Marine Turtle Conservation Strategy and Action Plan for Sri Lanka prepared in 2005 highlights the importance of local involvement in marine turtle conservation providing alternatives to the coastal communities developing their talents and increasing awareness in the sustainable use of natural resources. A questionnaire study was conducted in six coastal villages with different nesting frequency and turtle by-catch to assess the knowledge of the coastal community about marine turtles and their attitude and contribution towards conservation of marine turtles. From each village 100 randomly selected villagers were interviewed. Majority of the coastal community was poor with only primary or less education and mainly involved in fishing or fishing related occupations. Respondents from nesting areas had a significantly better knowledge about turtles than those from no nesting villages. Most of the villagers had a positive attitude towards sea turtle conservation and claimed that they contribute to conservation of sea turtles by not consuming turtle meat or eggs or by selling or purchasing turtle products for the last ten years. However, respondents from northwestern parts of the island where there is high turtle by-catch had poor knowledge about marine turtles and continue to consume or sell their meat. Non-governmental organizations such as Turtle Conservation Project (TCP) conducts community based conservation activities like in-situ nest protection and research and educational programmes aimed at local communities previously dependent on marine turtle egg poaching in southern and southwestern coast. Political instability and civil war in the northern part of the island often hamper conservation activities where live turtles are sold openly in some areas of Mannar. This study highlights the importance of introducing awareness programmes specially focusing northwestern coastal areas where there is high incidental by-catch and also enforcement of legislative measures controlling killing of turtles and poaching their eggs needs to be strengthened in the northern part of the island.

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Formation of acid sulphate soils after the Nilwala development project at Matara, Sri Lanka

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Acid sulphate soils (ASS) are characterized by the occurrence of pyritic minerals in subsoil. When such soils are drained and aerated, pyrite is oxidized and hydrolyzed often release toxic quantities of sulphuric acid, iron, aluminium and heavy metals. The south-west coastal belt of Sri Lanka is subjected to frequent flooding and high urbanization with development activities which facilitate the formation of ASS. The ‘Nilwala Flood Protection Scheme’ based on the Nilwala Ganga basin near Matara, is a drainage project, implemented to protect the town of Matara, and other villages from floods. Implementation of the project has lead to several environmental problems and mainly affected on paddy cultivation. Investigations were done in order to find out the possible formation of acid sulphate soils in Malimboda and Kapuduwa sites where large paddy lands were abandoned and the rice yields severely reduced due to said project.

Identification and characterization of ASS were done using field investigations and laboratory measurements. Four meters (4m) thick peaty layer was observed in many borehole logs starts at a depth of 2m below. Soils in both sites contained potentially acidic substances of jarosite, ferric hydroxides, gypsum and aragonite. The pH of these soils appears to be maintained at about 4.0. Total actual acidity (TAA) of the Malimboda and Kapuduwa sites were 0.52-76.68 and 0.00-33.92 moles H\textsuperscript{+}/ton, respectively. Total potential acidities (TPA) at the Malimboda site were in the range of 17.95-541.72 moles H\textsuperscript{+}/ton whereas the values at the Kapuduwa site were in the range of 60.93-660.16 moles H\textsuperscript{+}/ton both of which exceeded the action criteria values (after Ahern et al. 1998). Malimboda site had actual acid sulphate soils and potential acid sulphate soils (PASS) whereas in the soils of the Kapuduwa site recorded high amount of PASS. Eh-pH diagrams for iron and sulphide showed a trend to formation of iron (III) from iron (II). During the formation of acid sulphate soils, sulphuric acid may form from pyrites and iron (III) species in the soil. The results seem to suggest that a potential acidity study of soils should, therefore be, include in the management plan of Matara district to minimize the impacts on acid sulphate soils. Currently abandoned paddy lands may be re-cultivated with a proper soil management system and selecting of rice varieties tolerant to this specific environment.

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Studies on the efficacy of Toxorhynchites larvae and three larvivorous fish for the control of Aedes larval populations in water storage tanks in the Matale district

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A study was carried out to compare the feeding efficacy of Tx. larvae (L3 & L4) & 3 larvivorous fish species on Aedes larvae from May 2007 to February 2008 in Kaudupellella in the Walliwela G.S division, Matale. The frequent and prolonged interruptions of the water supply to the area, had led people to store water in suitable containers. Ground level water storage tanks (20%-80%) and water storing barrels (8.33% -54.55%) formed the majority of Aedes positive outdoor containers. Ae. albopictus, Ae. macdougali and Ae. vittatus breeding was recorded in water storage tanks. In outdoor water storage tanks Ae. macdougali was dominant (61.61%) followed by Ae. albopictus (37.79%) and Ae vittatus (0.5%).

Toxorhynchites splendens and Tx.minimus were recorded from the area. Feeding efficacy of Toxorhynchites larvae, Poecilia reticulata (Guppy), Puntius bimaculats (Ipilikadaya) and Rasbora caveri (Dandiya) were determined in the laboratory. Aedes larvae consumption rate( time to devour 10 Ae. albopictus L3 larvae in a vessel of 78.57 cm² of surface area ) of Toxorhynchites larvae was significantly lower, with a mean time of 330 minutes, while P. reticulata, P. bimaculats and R. caveri needed 16.66, 27.32 and 24 minutes respectively. However, there was no significant difference (P= 0.062) between the consumption rate of the 3 fish species.

A field study was carried out in 34 selected houses to determine feeding efficacy of Toxorhynchites larvae, P. reticulata, P. bimaculats and R. caveri on Aedes larval populations in outdoor cement tanks by noting the percentage reduction of Aedes larvae per 100 cm² surface area of tanks after a week. Toxorhynchites larvae caused a 20%-83.33% reduction after a week with no clear correlation between the number of Toxorhynchites larvae added and the percentage reduction. A complete reduction (100%) was achieved with P. bimaculatus and R. caveri with 1-3 fish per tank. P. reticulata also gave 100% reduction except on one occasion (90%) with only 2 fish per tank. Possibility of Tx. larvae being lost during removal of water by the householders was higher than losing the fish species. The three fish species used were highly efficient than Tx. larvae in Aedes consumption in outdoor cement tanks. Thus Puntius bimaculatus, R. caveri and P. reticulata may be used to control Aedes larvae in water storing cement tanks successfully.

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Some entomological aspects and physico-chemical characteristics of the breeding habitats of *Aedes aegypti* and *Aedes albopictus* in a dengue high risk area in the Colombo district, Sri Lanka

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Dengue and Chikungunya have emerged as important public health problems in Sri Lanka. Some entomological aspects and physico-chemical characteristics of the breeding habitats of *Aedes aegypti* and *Aedes albopictus*, vectors of dengue, were studied in the Narahenpita Public Health Inspector’s area of the Colombo district from August to November 2007. Larval surveys were carried out in 352 (10%) randomly selected premises to investigate all possible *Aedes* breeding habitats. *Aedes* larvae were collected and identified using larval identification keys. The selected physico-chemical parameters in *Aedes* positive containers were measured *in situ* using standard instruments. All entomological and physico-chemical data were statistically analyzed.

Dengue vector breeding was observed in 81 premises. Of the 702 water holding containers encountered during the study, 127 were *Aedes* positive. The key breeding habitat of both *Aedes* species in the study area was plastic containers (18.9%). The rest with comparatively high percentage of larval breeding were glass bottles (16.54%), coconut shells (15.75%), tyres (9.45%), clay pots (8.66%), metal ware (6.3%), bamboo stumps (6.3%) and fish tanks (5.51%). For *Ae. aegypti* and *Ae. albopictus*, there were no significant differences either between the number of containers positive or in the mean number of larvae per positive container. Both vector species were prevalent in the study area.

The mean temperature of *Aedes* breeding water was 30.1 ± 0.8 °C and the pH values were more or less neutral (mean 6.65 ± 0.47). The mean dissolved oxygen concentration was 4.09 ± 1.02 mg/l. The breeding sites had a wide range of conductivity (50.2- 1451 μS/cm), turbidity (6.94- 519 NTU) and salinity (0.1- 0.8 ppt). There was a significant positive relationship between the total *Aedes* larval density and the dissolved oxygen (DO). *Ae. albopictus* larval density was positively and significantly related to DO, but negatively related to pH. Hence, the container management to reduce oviposition sites as well as changing the water quality in essential water receptacles is among the best approaches for controlling *Aedes* breeding in order to prevent the transmission of dengue in densely populated urban areas.

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Relationships among *Garcinia* L. (Clusiaceae) species in Sri Lanka: evidence from vegetative morphology

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The genus *Garcinia* L. (Family: Clusiaceae) embraces about 200 species, and is represented by ten species in Sri Lanka, including five endemic species. The species circumscriptions and the identification of Sri Lankan *Garcinia* species hitherto were primarily based on reproductive morphology and anatomical characters. However, identification of *Garcinia* has become practically challenging. Present study aims to show the relationship among *Garcinia* species in Sri Lanka and to construct a field identification key, based on vegetative morphological characters.

A total of ninety seven individual plants representing the eight native species were sampled and forty seven vegetative morphological characters were selected and analyzed using similarity methods. Bark and leaf architectural characters were used to prepare the dichotomous key.

Results recognized the previously circumscribed taxa, with few exceptions. The sampled species falls into two major groups characterized by leaf morphological features especially the leaf venation pattern. The first group comprises *G. hermonii*, *G. thwaitesii*, *G. echinocarpa* and *G. spicata* (‘Hermonii’ group) having coreacious leaves, white colour sap and the presence of an extra distinct parallel secondary vein. The second group includes *G. quaesita*, *G. zeylanica*, *G. morella* and *G. terpnophylla* (‘Quaesita’ group) characterized by non-coreacious and comparatively small leaves. Major groups further divided into sub-groups supported by bark colour and tertiary venation. Principle component analysis illustrates variations within species of *G. hermonii* and *G. terpnophylla* highlighting the presence of different morphotypes. One of the clusters of *G. hermonii* is closely related to *G. spicata* than the other individuals. The farthest interrelationship of the ‘Hermonii’ group is shown by *G. echinocarpa* and its uniqueness is supported by stilt roots and leaf shape. The ‘Quaesita’ group is composed of highly interrelated species. *Garcinia zeylanica* shows very close affinities with *G. morella*. *Garcinia quaesita* does not form a strong cluster due to its wide variation in leaf size and shape. *Garcinia terpnophylla* shows an isolated placement in the ‘Quaesita’ group, indicating its many shared characters with the members of the ‘Hermonii’ group. The relationships found in this study provide insights to the phylogeny of the species. The dichotomous key constructed using conspicuous vegetative characters, is a valuable tool for identification of Sri Lankan *Garcinia* species in the field.

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Antinociceptive activity of aqueous leaf extract of *Tetracera sarmentosa* L. in rats

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The aim of this study was to examine the antinociceptive potential of the aqueous leaf extract of *Tetracera sarmentosa* (Family: Dilleniaceae Sinhala: korasa), which is used for bone fracture treatment in the traditional system of medicine in Sri Lanka and suggests that it may have pain relieving properties as well.

The water extract was prepared by refluxing the macerated leaves (350 g) in distilled water (5200 ml) for 20 hours. Different doses of the extract (500, 750, 1000, 2000 mg kg⁻¹) were orally administered to male rats (n=6(treatment)-8(control) per group) or vehicle (1 ml 1% w/v gum acacia) and the analgesic potential evaluated using three models of nociception (hot plate, tail flick and formalin test).

The 500 mg kg⁻¹ dose showed significant (p≤0.05) prolongation of the reaction time in the hot plate test in the 4ᵗʰ hour, 750 mg kg⁻¹ dose in the 3ʳᵈ and 4ᵗʰ hours and the 1000 mg kg⁻¹ dose in the 1ˢᵗ-4ᵗʰ hours post treatment respectively. In contrast, none of the doses of the extract prolonged the reaction time in the tail flick test. In the formalin test, 1000 mg kg⁻¹ significantly reduced licking duration and the number of lickings in the 1ˢᵗ phase (0-5 mins) and all the four parameters (number of lickings, number of number of liftings of the formalin injected hind paw, lifting duration and time spent on licking) in the 2ⁿᵈ phase (20-6- mins). Further, the prolongation of the reaction time in the hot plate test induced by aqueous leaf extract (ALE) was not suppressed by metochlopramide and atropine. Further, the ALE did not have any sedative action (in terms of rat hole board test) and motor deficiencies (in terms of bar holding and bridge test).

The results indicate that the ALE has a genuine mild to moderate oral antinociceptive action which is mediated supraspinally and peripherally through a noncholinergic, nondopaminergic and non sedative mechanisms. Furthermore, the results show that the ALE is also effective against inflammatory pain as well.

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Differentiation of *Hortonia ovalifolia* and *Hortonia floribunda* by DNA barcoding

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*Hortonia* is an endemic genus which belongs to the family Monimiaceae. In Sri Lanka, Monimiaceae is represented only by the genus *Hortonia* which, according to the Flora of Ceylon, consists of three species. A recent phytochemical investigation, found identical chemical compounds among the three species which has raised the question of species limits of *Hortonia*. This led us to investigate the genus *Hortonia* using short orthologous DNA sequences known as DNA barcodes to re-evaluate its species limits. DNA barcoding is recognized as a powerful framework for identifying organisms and discriminating among closely related species.

Leaf samples of *H. ovalifolia* and *H. floribunda* were collected and kept at -20°C until use. Genomic DNA was extracted using a recommended procedure. Purity of the extracted DNA was confirmed by spectrophotometry. DNA from both species was subjected to polymerase chain reaction (PCR) using specific primers for nuclear internal transcribed spacer (ITS) and *trnH-psbA* spacer regions. PCR amplified ITS and *trnH-psbA* regions were purified using gene clean kit, phosphorylated and ligated to a pBlueScript (pBS) vector previously digested with EcoRV. The ligated vector was transformed to *E.coli* strain JM109 and the cells were grown at 37°C in LB medium containing ampicillin for 12-15 hours. Cells were harvested followed by plasmid purification. Purified plasmids containing the DNA of interest were subjected to sequencing. Sequence homology of ITS and *trnH-psbA* regions from both species were compared using MacVector software.

DNA sequence comparison of ITS and *trnH-psbA* regions of *H. ovalifolia* and *H. floribunda* show a 2.49% and 1.5 % sequence divergence, respectively. ITS is the most commonly sequenced locus used in plant phylogenetic investigations at the species level and *trnH-psbA* spacer is the most variable plastid region in angiosperms. These high sequence divergence values clearly indicate that *H. ovalifolia* and *H. floribunda* are two different species. Therefore the present study strongly supports the recognition that there are two distinct species of *Hortonia*. DNA sequencing studies on *H. angustifolia* are in progress to completely re-evaluate the species limits of the genus *Hortonia*.

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Study of physicochemical properties of foods that influence the glycaemic responses

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The carbohydrate foods of diverse nature exhibit different postprandial blood glucose responses. Thus, the concept of Glycaemic Index (GI) was introduced to rank starchy foods depending on their blood glucose raising potentials. The GI values have been identified to be influenced by various physicochemical properties of the food items. Therefore, this study was designed to analyse the effects of certain physical properties of the starch/granule (granular structure, degree of gelatinization), chemical properties of foods (amylose) on some published and unpublished GI values.

Table 1: Food items analysed, GI values (n=10), water absorption indices (WAI), water solubility indices (WSI) (n =6), amylose (n=3), granular structure.

<table>
<thead>
<tr>
<th>Food</th>
<th>GI±SE M</th>
<th>Amylose (g/100g starch)</th>
<th>WAI±SD</th>
<th>WSI±SD</th>
<th>Granular structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red rice (cooked) – (RR)</td>
<td>99±8</td>
<td>34</td>
<td>2.9± 0.0</td>
<td>6.9± 0.6</td>
<td>a, b, c</td>
</tr>
<tr>
<td>White sliced bread - (WSB)</td>
<td>100±1</td>
<td>35</td>
<td>3.0± 0.2</td>
<td>17.7± 0.3</td>
<td>a, b, c</td>
</tr>
<tr>
<td>String hopper (red rice flour)--- (SHR)</td>
<td>103±10</td>
<td>29</td>
<td>3.5± 0.1</td>
<td>3.4± 0.2</td>
<td>b, c</td>
</tr>
<tr>
<td>Wholmeal bread - (WB)</td>
<td>103±7</td>
<td>28</td>
<td>2.8± 0.1</td>
<td>14.5± 0.3</td>
<td>a, b, c</td>
</tr>
<tr>
<td>String hopper (wheat flour)--- (SHW)</td>
<td>104±1</td>
<td>24</td>
<td>4.2± 0.1</td>
<td>9.2± 0.8</td>
<td>b, c</td>
</tr>
<tr>
<td>Ordinary bakery bread - (OBB)</td>
<td>114±9</td>
<td>32</td>
<td>3.4± 0.1</td>
<td>13.0± 0.3</td>
<td>b, c</td>
</tr>
<tr>
<td>Manioc</td>
<td>120±8</td>
<td>45</td>
<td>3.7± 0.1</td>
<td>4.4± 0.1</td>
<td>b, c</td>
</tr>
</tbody>
</table>

Published data (Proceedings of SLAAS 2008, pp 164-166); a –Intact; b- swollen; c- disintegrated.

The WAI is an indicator of the gelling capacity of the starchy source. SHW had the highest WAI followed by manioc. WSI expresses the amount of soluble substances dissolved in the medium. The bread varieties have high WSI values indicating hydrolysis and leaching of more soluble substances (proteins, amylose) during cooking. When the starch granules were examined under light microscope some intact granules were observed only with WSB, WB and RR. All the others had extensively swollen or disintegrated granules. The percentage of amylose is reported to be inversely associated with the glycaemic responses. However, manioc with the highest amylose content showed the highest GI. This could be explained by its high WAI and extensive disintegration of granules. All the cooked foods have significantly higher (p<0.05) WAI and WSI contents than their corresponding raw flour except the high WSI in raw manioc flour. The amylose contents of cooked flour were significantly higher only in wheat flour preparations and manioc (p<0.05). The increase in WAI, WSI and amylose could be due to gelatinization during cooking process and breakdown of amylopectin to amylose. According to the present study the degree of gelatinization has played the major role in influencing the glycaemic responses of foods.

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In vitro micropropagation of horn plantain cv nethrampalam (AAB)

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Banana is the most widely consumed fruit in Sri Lanka, and is an attractive perennial fruit crop for small farmers. The cultivar ‘Nethrampalam’ is a member of the family Musaceae, which belongs to the genomic group AAB. ‘Nethrampalam’ has been popularized recently among the growers due to its demand but has not been widely spread due to the limited supply of quality planting material in sufficient quantities.

At present, even though there are established micropropagation protocols for many varieties of bananas including Embul, Embon, Rathambala etc. there is no such established micropropagation protocol for cultivar ‘Nethrampalam’. However with a mass production, there is a greater potential to reduce the production cost and thereby cut down the prices of the fruits and suckers. On the other hand, when there is a mass production it is possible to export and also for value addition, i.e. banana chips.

The shoot tip of healthy sword suckers was used as the starting material. Initially the suckers were washed thoroughly to remove the adhered soil particles. The final size of the explant was about 2.0-3.0 cm in length and about 3.0 cm in diameter. Thereafter the shoot tips were surface disinfested with varying concentrations and durations exposed to chemicals such as ethanol (96% (v/v) commercial grade), Clorox\textsuperscript{TM} (a commercial bleach, 5.25% (v/v), Sodium hypochlorite). After surface disinfestation, the shoot tips were inoculated onto Murashige & Skoog (MS) basic medium (1962) supplemented with benzyl amino purine (BAP) and indole acetic acid (IAA). After two sub culture stages, they were regenerated on MS medium supplemented with BAP (1.25 mg/L) and IAA (1.25 mg/L). Plants were successfully rooted on MS medium with indole butyric acid (IBA, 1.25 mg/L) and were acclimatized in the greenhouse.

The highest survival percentage (80%) was obtained when shoot tips were dipped in 30\% (v/v) Clorox\textsuperscript{TM} for 20 min and 10\% (v/v) Clorox\textsuperscript{TM} for 10 min. The culture medium supplemented with 5.00 mg/L of BAP and 2.50 mg/L of IAA, showed a better proliferation of inoculated shoot tips. The study showed that sub culturing enhances shoot multiplication and the histological analysis confirmed that the shoot tips have initiated proliferation.

During the study, a protocol for micropropagation of Horn plantain cultivar ‘Nethrampalam’ using shoot-tips was successfully developed with the quantification of in vitro multiplication. However, more research is needed to develop the technology for commercial scale application.

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Traditional foods and their blood glucose responses

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Glycaemic Index (GI) classifies carbohydrate rich foods according to their effects on postprandial blood glucose responses. Thus carbohydrate rich foods are categorized as high, medium and low GI foods respectively. Low GI foods are claimed to have many health benefits. Most traditional foods consumed by our ancestors have now become underutilized. According to folklore and Ayurvedic medicine consumption of traditional foods appears to have had a beneficial effect on blood glucose responses. Thus the objective of the present study was to determine the GI of foods prepared from flour of Madu (Cycas circinalis) seeds and Kithul (Cariota urens) stem. The flour and seeds were collected from Matale and Kurunegala districts, which are known to have a wide distribution of these plants. Madu roti was prepared with Madu flour (37%) wheat flour (37%) and coconut (26%) and Kithul roti with Kithul flour (74%) and coconut (26%). Madu pittu contained Madu flour (37%) and rice flour (37%) and coconut (26%). Kithul thalapa (Kithul flour 100%) was mixed with sufficient amount of water and cooked under a medium flame. Foods were prepared under standardized conditions. For the determination of glycaemic index healthy individuals (n=10); Body Mass Index 22 ± 2; ages 20-30 years; were given the control (prima crust top bread) and test foods both containing 50g of available starch after an overnight fasting (8-10 hours). Fasting and after consumption of control and test foods, blood samples were taken at 30,45,60,90,120 min on each day and GI was calculated by FAO / WHO standard method. This study was carried out as a randomized crossover study. Glycaemic Indices of Kithul thalapa Kithul roti, Madu roti, Madu pittu were 128±11, 57± 4,66 ± 6, 72 + 4 respectively. According to these results Kithul roti can be categorized as a low GI food and Madu roti and pittu as medium GI foods whereas Kithul thalapa is a high GI food. Kithul roti showed a significantly low GI (p=0.02) value when compared to Kithul thalapa preparation. High GI could be due extensive gelatinization of starch granules in Kithul thalapa during preparation. Madu pittu GI was significantly lower (p<0.05) when compared with earlier reported GI of rice and wheat pittu preparations. Some traditional Sri Lankan food preparations elicit low blood glucose responses and therefore use of this flour for food preparation could be beneficial in controlling the glycaemic response.

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Microspore staging for haploid cell culture in *Oryza sativa* sub species *indica* (rice)

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Microspore staging is a necessary adjunct in developing a successful anther culture protocol for haploid plant production because *in vitro* response depends to a large extent on the stage of pollen development at explant inoculation. This requires a staining procedure to identify correctly the stages of pollen most suitable for culture and a correlation between the pollen stage and an easily observable marker to facilitate the selection of explants at required maturity. The objective of this study was to test the validity of such a correlation between the stage of microspore development and that of a visual marker in rice. This was tested using iron – alum haematoxylin stain on pollen of different developmental stages from three *indica* rice varieties, Bw 267-3, Bw 361 and Ld 3-12-36. Panicles, to obtain pollen, were harvested based on the indicator which was the measured distance from the flag leaf auricle to the penultimate leaf auricle, when this distance was 2.5, 5.0, 6.0, 7.0, 8.0, and 9.0 cm.

Uni- and bi- nucleate pollen stages were clearly recognized with the haematoxylin stain. Uni-nucleate pollen was present in anthers of panicles that were harvested when the indicator distances were 2.5 – 7.0 cm but absent from the anthers of those panicles that were harvested when this distance was ≥ 8 cm. This indicated that at these latter stages of maturity, pollen development had progressed beyond the uni- nucleate stage in all rice varieties examined. This idea was further supported by the observation that in these panicles (of ≥ 8 cm), only bi- nucleate stage pollen was present. Although bi- nucleate pollen could also be observed in panicles of 7 cm length difference between flag and penultimate leaf auricles in all three rice varieties, and in panicles when this distance was 6 cm in rice varieties Bw 361 and Ld 3-12-36, these were present generally at a lower frequency (3-11%) in comparison to the frequency of uni nucleate pollen (16-19%). A large percentage of cells that were analyzed could not be categorized as being of uni- or bi- nucleate type and possible improvements to the staining technique needs to be examined further. However, irrespective of the cells that could not be staged, the identified stages clearly demonstrated that uni- nucleate stage microspores that are the most suitable for *in vitro* culture for haploid plant production in rice could be obtained from panicles that corresponded to a distance 2.5 – 7.0 cm between flag leaf and penultimate leaf auricles, with more mature panicles within this range containing a higher frequency of uni- nucleate pollen.

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Deployment of a website implementing bioinformatics algorithms for simple sequence analysis

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Bioinformatics refers to the creation and advancement of the algorithms, computational and statistical techniques, and theory to solve formal and practical problems arising from the management and analysis of biological data. Hence the development of algorithms plays an important part in bioinformatics. They are the tools which filter out information out of a sea of raw data. An algorithm is a systematic procedure for solving a problem in a finite number of steps. A computer can be used to solve a problem only if the problem can be converted into an algorithm. The users of bioinformatics utilize a number of tools to prepare, analyse and compare individual sequences. Most of these tools need to be installed in the system to be used for even trivial tasks like DNA to RNA conversion.

The main objective of this study was to identify such trivial tasks and implement a website where users can carry out this task easily: without installing any software and without deep computer knowledge.

Implemented website consists of two main parts. Common tasks, which consist of tools to prepare the sequences for analysis in bioinformatics and algorithms, which are used in pairwise sequence comparison. A personal computer with selected software installed was used for the designing and creation of the website. The algorithms used widely in sequence comparison were selected as implementable algorithms. Navigation system which is used to create the links between the individual pages of the website was entirely planned and created. Each task completed was considered as a problem and it was converted into a simple algorithm. Individual pages were created based on these algorithms. User interface was designed, the code to check the user input for errors (validation) was written, page was tested for errors using several different inputs, and the output produced was compared with an already available program’s output for accuracy. Each page was designed and necessary code was written following the same sequential pattern given above. The website will shortly be hosted on the internet to allow the users to complete simple sequence preparation and analysis tasks without any need for special software to be installed and will give a single tool for the researchers to complete tasks which need several different currently available tools.

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Growth and improvements for *Gliricidia sepium* as a source of bioenergy

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Bioenergy can play an important role in the energy sector in Sri Lanka, since it can be obtained from sustainable grown fuel wood. This study was initiated to investigate the growth parameters and improvements in *Gliricidia sepium* (Jacq.) Walp. for mass propagation, as a plantation crop for bioenergy needs. Two experiments were carried out. Experiment 1 was initiated to study the effect of different stem maturity stages (green wood, semi hard wood and hard wood) and commercially available hormone mixtures on the rooting of *Gliricidia* cuttings. Clonex gel and Clonex powder, contained indole buteric acid (IBA) as the active ingredient in a concentration of 3 g/l and “Radipormon” contained 3% Napthylacetic acid (NAA). Experiment 2 was initiated to study the effect of different phosphate sources (Triple super phosphate (TSP), Eppawala rock phosphate (ERP), High graded ERP (HERP), ERP+“Biophos”*) and the length of stem cuttings on growth of *Gliricidia sepium*. “Biophos” is a commercially available, concentrated *Bacillus megatherium* culture.

Results of experiment 1 revealed that the mean number of roots at 11\textsuperscript{th} week after planting was significantly higher in hard stem cuttings compared to semi hard and green stem cuttings. Application of hormones has significantly improved the number of roots in all types of stem cuttings. In hard stem cuttings both NAA and IBA gel were better, compared to IBA powder in increasing the number of roots. Root length was significantly higher in IBA treated hard wood stem cuttings compared to green wood stem cuttings at 11\textsuperscript{th} week after planting. Further, root length of hard wood stems treated with IBA gel was significantly higher compared to hard wood stems treated with IBA powder. It was observed that roots emerged mainly from the lower part of the cut surface lining in green and semi hard wood cuttings, while, in hard wood cuttings roots were observed throughout the cut surface lining. Nodulation was higher in hard stem cuttings compared to semi hard and green stem cuttings and in general application of hormones increased nodulation in *Gliricidia*. However, there was no significant difference observed among hormone types, for nodulation. Results of experiment 2 revealed that shoot and root growth were higher in stem cuttings in phosphate incorporated soil. Length of stem cuttings also had an effect on both shoot and root growth of *Gliricidia sepium*, with better results associated with longer stems.

The main conclusions are that, hard wood stem cuttings can be regarded as better planting material compared to semi and green wood stem cuttings for mass propagation of *Gliricidia*. Also development of a good root system in *Gliricidia* can be achieved by application of rooting hormones, especially IBA gel to hard wood cuttings at the time of planting. Further, application of High graded Eppawala rock phosphate, at the time of planting can be recommended to promote root growth of *Gliricidia*.

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Occurrence of lipase activity in the pitcher juice of *Nepenthes distillatoria* (bandura)

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*Nepenthes distillatoria* (Family Nepenthaceae), an insectivorous pitcher plant endemic to Sri Lanka, is believed to contain a mixture of hydrolytic enzymes in its pitcher. These enzymes are believed to be primarily responsible for efficient digestion of insect carcasses inside the pitcher fluid. In this study we partially characterized lipase activity detected in the crude pitcher fluid of *N. distillatoria*.

Crude juice from pitchers of *N. distillatoria* was collected from Hakurugala forest patch at Ruwanwella. A simple colorimetric method for characterizing lipase in the pitcher fluid of *N. distillatoria* was developed, using 2,3-dimercapto-1-propanol tributyrate (DMPTB) as the substrate and 5,5'-dithiobis (2-nitrobenzoic acid) (DTNB) as the chromogenic reagent. Optimum pH and optimum temperature for lipase activity were determined by incubating the reaction mixture at different pHs and at different temperatures. Crude pitcher fluid was incubated in buffers at different pHs (from pH 2.0 -10.0) over a period of two weeks at 4°C to determine pH stability. To determine the thermal stability, the crude enzyme mixture was incubated in pH 4.0 buffer at different temperatures for a period of two weeks. Lipases in the crude pitcher fluid were partially purified using a DEAE cellulose column.

A detectable lipase activity was observed in the crude *Nepenthes* pitcher juice. The crude pitcher fluid had two pH optima for lipase activity at pH 4.0 and pH 5.0 indicating the presence of more than one lipase. The optimum reaction temperature was in-between 35°C - 40°C. Within the two week period tested, the lipase activity at 4°C and room temperature was not significantly reduced. In contrast, the percentage remaining activity after two weeks at 37°C and beyond was significantly low. At pH 5.0 and pH 6.0, the lipase activity was significantly stable. Enzyme activity was lost within 4 days at pHs 2, 3, 8, 9, and 10. DEAE cellulose chromatography resulted in two sharp peaks at NaCl concentrations 0.12 M and 0.18 M, indicating the presence of at least two lipases in the crude juice. Presence of these enzymes probably has a significant role in the digestion of complex organic matter in insect bodies into simpler absorbable molecules. Further studies are in progress on purification and characterization of the individual enzymes.

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Distribution of lichens with respect to pH variation of the host trees within the Horton Plains national park, Sri Lanka

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The substratum characteristics play an important role in lichen colonization. For epiphytic lichens, bark properties such as acidity, nutrient content, roughness and microclimatic factors determine the composition of lichen communities. Of these, bark acidity expressed as a pH value is considered the most important one. The objective of the study was to document the lichen (epiphytic organism) diversity, with respect to the bark pH variations of host trees, within the Horton Plains National Park (HPNP). The surface pH was measured from the bark samples collected at the 1.5 m above the ground level of 451 trees. Data were analyzed using correlation analysis (Minitab 14.0). According to the observations most of the lichens (349 species) present in study sites preferred a relatively low pH range (4.0-6.0). The dominant macrolichens within this pH range were Lobaria retigera, Pseudocyphellaria beccarii, Heterodermia microphylla and dominant microlichens were Graphis sp. and Myriotrema sp.. Only few lichens (45 species) preferred an extremely low pH range (3.00 - 3.99) or extremely high pH (8.00 - 8.99) range. The highest number of lichen species preferred a low pH range (4.0-6.0) in the continuous forest such as Heterodermia leucomelos, Pseudocyphellaria beccarii, Graphis sp.. Whereas in forest patches most lichen species such as Lobaria retigera, Pseudocyphellaria intricata, Thelotrema sp.. preferred a relatively higher pH range (5.0-7.0). Trees having larger diameter such as Calophyllum walkeri, Eugenia maboaeides possessed high bark pH values while smaller trees such as Symplocos cochinchinensis, Actinodaphne speciosa showed slightly low pH values. A high density of lichen species was observed in trees with a smaller diameter when compared to trees with a larger diameter. The variation of bark pH seemed to be affected by tree diameter where trees with larger diameter showed a basic condition. This may be a result of less amount of leaching experienced by trees with large diameter having larger crowns. When an acidic bark condition is present, it influences the species composition and is probably the most important factor determining the natural lichen flora of the trees.

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Spoilage of some cooked rice varieties consumed in Jaffna peninsula

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Rice is one of the major cereals and staple food for one half of the world population and also about 2.7 billions in Asian countries. *Bacillus cereus* is the most prevalent pathogenic *Bacillus* sp. found in foods causing food spoilage including rice although other *Bacillus* spp. have also been recognized as food poisoning bacteria. In the present study spoilage of cooked rice of three rice varieties namely country rice, red raw rice (Moddaikkaruppan) and Samba (LD 450) was investigated. The biochemical investigation showed the presence of Gram positive and Gram negative bacteria in cooked rice. The country rice was spoilt by *Bacillus pumilus* and *Bacillus cereus*. Red rice was spoilt by *Bacillus cereus, Bacillus pumilus* and *Bacillus laterosporus* and Samba was spoilt by none of the *Bacillus* spp. *Bacillus cereus* was found to be the most common food spoilage bacterium in cooked rice. Further studies have to be done to see whether there is any variation in *Bacillus* spp. causing spoilage in rice in different parts of the country.

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Structural complexity of strand vegetation and coastal erosion along the South, South West, and West coasts of Sri Lanka

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Structural complexity of coastal vegetation at eight different coastlines (Weligama, Unawatuna, Hikkaduwa, Ambalangoda, Induruwa, Kalutara, Moratuwa, and Uswetakeiyawa) was analyzed to determine the effect of structural complexity of coastal vegetation on coastal erosion. Vegetation samples were obtained along the belt transects laid perpendicular to the shoreline at each study site. Biomass, cover, density, basal area, diversity, and species richness of coastal vegetation were analyzed to determine the structural complexity of coastal vegetation. Coastal vegetation structure varied among different coastlines with varying erosion rates. An ordination was performed using principal component analysis to examine the relationship between coastal vegetation structure and erosion rates of different coastlines. Analysis revealed that there is a statistically significant relationship between erosion rate and the structural parameters of the coastal vegetation in the zone close to the shoreline (0-10 m). Which means erosion rates decreased with increasing values of structural parameters (indicating structural complexity) of coastal vegetation in the zone (0-10 m) close to the upper limit of the wave breaking area of the coast.

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Identification of different coconut cultivars for beverage purposes

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Tender nuts (seven and eight months after pollination) of 10 selected coconut cultivars, viz. Dwarf Green (DG), Dwarf Yellow (DY), Dwarf Red (DR), Dwarf Brown (DB), Cameroon Red Dwarf (CRD), King Coconut (KC), Bodiri (BD), Murusi (MU), Bothal Thembili (BT) and Juvan (JU) were collected from Lunuwila, Pallama and Galle area.

Nut water samples (six nut water samples from each cultivar) were diluted 100 times, purified using Sep-pak cartridge and analysed for sugars (Glucose, Fructose and Sucrose) using a high performance liquid chromatography (HPLC) system (Waters, USA) with a sugar-pak column. Contents of K$^+$, Na$^+$, Ca$^{++}$ and Mg$^{++}$ were determined using an Atomic Absorption Spectrometer (GBC, Australia).

According to the analysis of sugar profiles, seven-month old nuts of BD showed significantly higher sucrose (2-fold, $P < 0.001$) and invert sugar (glucose and fructose; approx. 50%) contents compared to the mean of all cultivars (Fig. 1 a, c & e). This resulted in a 50% higher total sugar content in seven-month old nuts of BD. Similarly, eight-month old nuts of BD contained 3-fold higher sucrose content and about 30% higher invert sugars resulting in an increase of total sugars by 40% compared to the mean of all cultivars (Fig. 1 b, d & f). Thus one-fold increase of sucrose content and about 20% decrease of invert sugar content were observed from 7 - 8 month period. BT showed the lowest sucrose, invert and total sugar contents out of the tested cultivars. No significant differences were observed among other cultivars with respect to above parameters in both developmental stages.

BD also contained about 45% and 55% higher K$^+$ contents respectively in nut water of 7 and 8 month-old nuts compared to the mean of all cultivars (Fig. 2 a & b). However, it contained significantly low ($P < 0.01$) Na$^+$ and average contents of Mg$^{++}$ and Ca$^{++}$ in both developmental stages (Fig. 2 c & d). Cultivars JU, DG and DB also contained higher levels of K$^+$ in both 7 and 8 month old nuts. Although the Na$^+$, Mg$^{++}$ and Ca$^{++}$ levels of JU and DB were approximately similar to those of the rest, DG showed significantly higher (3-fold) Mg$^{++}$ content in both developmental stages. DR also showed an increase of Mg$^{++}$ similar to that of DG.

Accordingly, BD appeared more suitable as a beverage with higher content of sugars (both sucrose and invert) and K$^+$ of which sucrose and K$^+$ prominently contributing for its taste.

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Diversity and conservation of endemic flora in Waturana fresh water swamp forest: a critically endangered habitat in Sri Lanka

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Waturana (6° 37’- 6° 38’ N, 80° 11’- 80° 12’ E), the last remaining fresh water swamp of 12 ha, is an abode for three site specific endemic species, Mesua stylosa, Stemonoporus moonii and Areca concinna and many globally and nationally endangered plant species. Comprehensive floristic survey was carried out to determine the floristic richness, species distribution, life form variations and the conservation status of endemic plants in this habitat. Quantitative vegetation sampling was performed by laying twelve quadrats, each 100 m², in a stratified random manner representing different micro-habitats.

The plant species in the total 12 ha enumerated 172 species of vascular plants represented in 74 families and 138 genera. Out of the total species, 75 species (44 %) were endemics and the density of the endemic species was 6.25 ha⁻¹. Endemic species were comprised by different life forms: 50.7% trees, 32.0% shrubs, 2.7% lianas, 6.7% orchids, 2.7% ferns and 5.3% aquatic plants. Highest number of endemic species were recorded for the family Dipterocarpaceae having six endemic Dipterocarp species. At national level four critically endangered, ten endangered and eight vulnerable species were recorded. Most abundant endemic tree species was Macaranga digyna (Euphorbiaceae). Most dominant endemic sapling and seedling species were Stemonoporus moonii (Dipterocarpaceae) and Calamus radiatus (Arecaceae). Principal component analysis based on plant abundance data revealed the existence of three plant communities. Based on relative abundance Macaranga digyna was the most abundant endemic tree species in all three communities. Garcinia quaesita, Mangifera zeylanica and Canthium campanulatum were found to be the most abundant endemic saplings. The most abundant endemic seedling species were Macaranga digyna, Stemonoporus moonii and Calamus radiatus in three different communities.

The fate of these species in Waturana could be symptomatic of a large number of rare plant species distributed in small fragmented patch. Site specific endemics could be relict as last remnants of taxa whose distribution has shrunk and where the human induced habitat destruction rendered the species critically endangered. High habitat specificity and small population sizes were two distinct biological features that complicate the conservation of these endemic plant species in Waturana fresh water swamp forest.

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Biological parameters of the life history of rice moth, *Corcyra cephalonica* (Lepidoptera, Pyralidae), on maize seeds

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Biological parameters of the life history of the rice moth *Corcyra cephalonica* on maize seeds was studied under ambient laboratory conditions (29±2°C & 84%RH). Developmental period of this moth ranged from 37 to 49 with a mean value of 48.25±3.4 days on partially milled maize seeds. Adults when emerged are sexually mature. Females have a pre-oviposition period less than one day. Majority of eggs, were deposited within the first four days after emergence of the female. Fecundity ranged from 152-319 (mean=245.05±6.5) and egg hatchability was found to be 72%. Five larval instars were recorded on the basis of the width of the head capsule and the body length. Adult longevity ranged from 7 to 10 days for males and 7 to 14 days for females. Sex ratio (male: female) of the adults emerged was 1:1.

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Screening of some local plants for oviposition deterrent potential and larval mortality of the rice moth, *Corcyra cephalonica*

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Methanol extracts of eighteen plants belonging to different botanical families were screened under laboratory conditions to identify their effects on oviposition and larval mortality of the rice moth, *Corcyra cephalonica*. Each plant extract was tested at a concentration of 12g/l. Compared with the control, considerably higher larval mortality was observed in leaf extracts of *Allium sativum* (47%), *Occimum sanctum* (56%) and seed extract of *Anacardium occidentale* (53%). Also, the seed extract of *Anacardium occidentale* elicited significantly higher oviposition deterrence (153.27±4.8) than those of controls (212.67±7.9, 199.00±3.6). However, leaf and seed extracts of *Azadiracta indica* and seed extract of *Piper nigrum* proved to be the most effective of all the eighteen plants tested showing 100% larval mortality. This was followed by leaf (81%) and seed (61%) extracts of *Annona squamosa*.

Furthermore, maximum oviposition deterrent was observed in the tests treated with leaf (130.20±7.1) and seed (110.60±7.1) extracts of *Piper nigrum*. Based on the results it is therefore, evident that among the eighteen plants tested *Piper nigrum*, *Azadiracta indica* and *Annona squamosa* posses a high potential in controlling the rice moth through larval mortality and by preventing oviposition by females.

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Fruit fly infestation of mango, *Mangofera indica* L. (Anacardiaceae) – a survey in Hambanthota district

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A survey was undertaken to determine the infestation of mangoes by Dacine fruit flies at 15 different sites in Hambanthota district of southern Sri Lanka during the peak period of 2008 mango fruiting season. Five main localities namely, Beragama, Hungama, Kattakaduwa, Wadigala, and Waralande were selected and at each locality three sites were surveyed. At each site, mango fruits were collected from 1 to 2 trees. Five to twenty ripe fruits per tree or occasionally unripe fruits were picked from trees or collected from the ground. Different varieties of mangoes, i.e., “Karthakolomban”, “Petti amba”, “Kohu amba” and “Wal amba” were included for the survey. The fruit flies in mangoes were reared until the adulthood and identified up to the species level using taxonomical keys.

Of the 15 mango samples of different varieties collected from 15 sites, i.e., one tree per site, 13 samples were infested by fruit flies irrespective of the variety. The highest number fruit fly emergence (57.39 per Kg weight) was recorded from mangoes sampled at Hungama, while the lowest (5.27 per Kg weight) was at Wadigala. Three Dacine fruit fly species, i.e., *Bactrocera dorsalis*, *Bactrocera kandiensis* and *Bactrocera invadens*, were recovered. *Bactrocera dorsalis* and *B. invadens* were recovered from all the fruit fly positive mango samples, i.e., from 13 samples. *Bactrocera kandiensis* was not recorded at all the three sites in Wadigala. At Beragama, Hungama, Kattakaduwa, and Waralande all the three species and at Wadigala only *B. dorsalis* and *B. invadens* co-occurred, respectively and these species shared same mango samples. Except one locality, i.e., Wadigala, *B. invadens* was found to be the predominant species while *B. kandiensis* was the least prevalent species. Our study reveals that *Bactrocera* infestation is widespread on mango at the selected localities in Hambanthota district and *B. invadens* is the predominant species which could become a great threat not only to mangoes, but also for other fruit production in Hambanthota district.

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Cut flower infesting thrips: A preliminary study

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Damage by thrips to cut flowers in particular makes flowers unmarketable. Hence, there is an urgent need to identify thrips damage to cut flowers and the species causing the damage, at an early stage of cultivation. A preliminary study was carried out to identify and record the thrips species infesting cut flowers and also, to identify the damage caused by them. Six, cut flower farms in Nuwara Eliya, Hakgala, Bandarawela and Peradeniya were selected for the study. At each location, cut flowers in different stages: buds, unopened flowers, fully open flowers as well as leaves and shoots were closely examined for thrips and their damage. In all, a total of 17 different species of cut flowers were examined from the six farms. Thrips infestations were recorded only from 14 cut flower species namely, Rose, Anthurium, Aster, Gladiolus, Super Daisy, Statice, Chrysanthemum, Baberton Daisy, Ox -eyed daisy, Tulip, Agapanthus, Madonna lily, Golden rod and Gerberas.

No thrips were recorded from Everlasting, Orchids and Alstroemeria flowers during the study period. A total of 11 thrips species in 6 genera (Frankliniella, Haplothrips Microcephalothrips , Retithrips, Scirtothrips and Thrips) were recorded from the 14 cut flowers and their vegetative parts. Of the thrips recorded, only 9 species were confined to flowers. In anthurium, the same thrips species infested unopened young flowers and leaves. In rose, both flowers and buds were infested with *Thrips hawaiiensis* and the leaves and axillary shoots with *Scirtothrips dorsalis* and in addition, leaves were also infested with *Retithrips syriacae*. Roses grown in Hakgala were not infested with thrips while in Bandarawela and Peradeniya heavy infestations were recorded. Damages of varying degree were seen in the cut flowers infested with thrips. Thrips attack in cut flowers resulted in scarring and discolouration of petals and deformation of buds and flowers.

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Antibacterial activity of *Allium sativum* on *Xanthomonas axonopodis* and *Pseudomonas solanacearum*

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The aim of the study was to test the antibacterial activity of different organic solvent extracts of *Allium sativum* (garlic) on plant pathogenic bacteria like *Xanthomonas axonopodis* and *Pseudomonas solanacearum*. Garlic bulbs were dried in an oven at 40 °C and powdered. This powder was successively extracted in soxhlet apparatus using dichloromethane, ethyl acetate and ethanol. Solvent from each extract was completely evaporated. Working stock was prepared using the mixture of acetone and DMSO. Antibacterial activity of these extracts was assessed by agar well diffusion method. Nutrient agar plate containing $10^6$ cells / ml of bacterium was prepared and allowed to set. The well of 8.0 mm of diameter was made on it and 50 mg / 100 µl of each extracts was inoculated into the well. Streptomycin was used as standard and the solvent mixture DMSO and acetone was used as control. The antibacterial activity was recorded by measuring the zone of inhibition after 24 hours of incubation at 37 °C. Each experiment was carried out in triplicates and the mean value was taken. The result revealed that all the test samples had the ability to inhibit both *Xanthomonas axonopodis* and *Pseudomonas solanacearum* at 50 mg / 100 µl concentration and the degree of zone of inhibition varied in the range of 11.0 mm to 31.0 mm. *Pseudomonas solanacearum* was found to be more sensitive to ethyl acetate extract of garlic. Dichloromethane extract showed comparatively lesser inhibitory effect on *Xanthomonas axonopodis* (11.0 mm) and moderate inhibition on *Pseudomonas solanacearum* (15.0 mm). Ethyl acetate extract on *Xanthomonas axonopodis* and ethanol extract on both *Xanthomonas axonopodis*, and *Pseudomonas solanacearum* showed better inhibitory effect producing zone of inhibition ranging from 22.0 mm to 25.0 mm. The standard experiment revealed that the diameter of zone resulted by 50 µg of streptomycin in *Xanthomonas axonopodis* and *Pseudomonas solanacearum* were found to be 22.0 mm and 24.0 mm respectively. Although 50 mg / 100µl of ethyl acetate and ethanol extract showed better inhibitory effect on test pathogens further bioassay should be done with 50 µg of purified compounds to compare these effects with the standard.

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Inhibition of bacterial growth by different solvent extracts of *Emblica officinalis*

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Since ancient time human has used plants to cure infectious diseases in various traditional systems. In the recent decade research interest in plants has increased to find out the novel active compounds for the treatment of various ailments. The aim of the study was to evaluate the effect of different solvent extracts of dried fruit of *Emblica officinalis* on some gram negative bacteria. Dried fruit powder of *Emblica officinalis* was soaked with Hexane for 72 hours and filtered with No.1 Whatman filter paper. This procedure was repeated for three times and all the extracts were pooled together. The residue was dried and successively extracted with other solvents namely DCM, ethyl acetate, ethanol, methanol and water. The solvent from each set was removed using rotary evaporator and later these extracts were kept in the desiccator. Antibacterial activity of these samples was evaluated against gram negative bacteria, *Pseudomonas aeruginosa*, *Klebsiella* sp., and *Escherichia coli* by agar well diffusion method. Nutrient agar plate containing $10^6$ cells/ml of bacterium was prepared and allowed to set. The well of 8.0 mm of diameter was made on it and 50 mg/100 µl of each extract was inoculated into the well. Streptomycin (50 µg/100 µl) was used as standard and the mixture of DMSO and acetone was used as control. Plates were incubated at 37°C for 24 hours and the activity was recorded by measuring the diameter of zone of inhibition. All experiments were repeated in triplicate and the results are expressed as mean value. The results showed that ethyl acetate, ethanol and methanol extracts exhibited higher antibacterial activity against *Pseudomonas aeruginosa*, *E.coli* and *Klebsiella* sp and the diameter of the zone varied from 22.0 ± 0.36 mm – 26.0 ± 0.26 mm. Inhibitory effect of water extract of the entire sample on test bacteria was found to be less compared to the effect of ethyl acetate, ethanol and methanol. Further hexane extract inhibited none of the test pathogens while DCM extract showed very less effect on all the pathogens. The result of the standard experiment indicated that the diameter of the zone resulted by ethyl acetate, ethanol and methanol extracts was higher than the used concentration of streptomycin on test organisms. The bioactive compound / compounds present in these active solvent extracts could be a useful source for reporting a new antimicrobial agent / agents.

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Microbial control of *Microcystis aeruginosa* bloom in a hypereutrophic lake

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*Microcystis* (Cyanophyceae) is well known all over the world as one of the most common bloom-forming cyanobacteria which have harmful effects on animals and potentially on human beings. The mortality of *Microcystis* due to microbial processes has been highlighted as an important factor in the termination of the bloom. Thus, the present study was carried to ascertain the potential impact of algicidal agents on *M. aeruginosa*. The surface phytoplankton samples were fixed with acidified Lugol's solution and counting was carried out using a haemocytometer. Algicidal bacteria and protozoa were enumerated by modified plaque count method and the grazing effect of the flagellate *Polytomella* sp. on *M. aeruginosa* was studied by fixed concentrated samples. The grazing effect was confirmed by adding cycloheximide (200 mg l⁻¹), a specific inhibitor of protein synthesis in eukaryotes.

Dominant phytoplankton species during the study period were the *M. aeruginosa*, *M. wesenbergii*, *Spirulina* sp., *Merismopedia* sp., *Koliella* sp. and *Melosira* sp.. *M. aeruginosa* and *M. wesenbergii* quantitatively dominated in most sampling dates and constituted >75% of the phytoplankton community when the bloom reached its peaks on 6 October 2005 and 14 October 2006 respectively. Densities of algicidal bacteria were relatively high with large fluctuations from June to August 2005, from December to January 2006 and from August to November 2006. From September to November 2005 and from April to July 2006 algicidal bacteria were undetectable. Algicidal protozoa (*Penardochlamys* sp.) had appeared in August and increased until it reached to the maximum (6.0 x 10² PFUml⁻¹) on 20 October. Protozoa and bacteria cell density tended to increase, following the increase of the cell density of *M. aeruginosa* and a sudden decline of *M. aeruginosa* was detected when the cell density of algicidal agents were increased. The cell density of *M. aeruginosa* was suppressed and not exceed when the cell density of *Polytomella* sp. was greatest *in situ* and it was confirmed *in vitro* grazing experiment. In the laboratory, the degradation of *M. aeruginosa* was detected when the isolated bacteria and the amoebae *Penardochlamys* sp. were added to the algal lawn but not when only the culture filtrate was added, showing that the bacterium and amoebae killed the alga by direct contact. The conclusion of the present study is that algicidal bacteria and protozoa are important agents for the decomposition of *M. aeruginosa* bloom.

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Changes in microbial loop components during the formation and decay of *M. aeruginosa* bloom

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Effect on temporal changes in microbial loop components due to formation and decay of algal blooms has been well documented. The present study was focused on the temporal changes of microbial loop components with respect to the occurrence of *M. aeruginosa* bloom in Beira Lake from May 2006 to February 2007. Surface plankton samples were collected from 10 l plastic bucket and 100 ml portion of water sample was fixed with acidified Lugol’s solution at a final concentration of 1%. Enumeration of phytoplankton, ciliate, and flagellate were done using a hemocytometer. Zooplankton of each sub samples was counted using a Sedgwick-Rafter counting chamber. Viable bacteria counts were taken by standard pour plate method.

The cell density of *M. aeruginosa* was low until 29 July (2 x 10⁴ cells ml⁻¹) and increased (10⁷ cells ml⁻¹) from 30 September. Viable bacteria abundance ranged from 1x10⁵ to 6x10⁶ CFU ml⁻¹ and increased gradually from May and reached to a peak (6x10⁶ CFU ml⁻¹) on 15 June. A sudden decline of viable bacteria abundance (10⁵ CFU ml⁻¹) was detected with increasing the cell density of flagellates. The abundance of the ciliate *Coleps* sp. was ranged from 6x 10⁵ to 1x10⁶ cells ml⁻¹ and reached to the maximum of 6 x 10⁵ cells ml⁻¹ on 02 July resulting with sudden decline of flagellate density. The results showed statistically significant prey-predatory interaction between bacteria-flagellates (P<0.002) and flagellates-ciliates (P<0.003) during the pre-bloom condition. Abundance of copepods increased (10³ ind. ml⁻¹) with increased cell density of flagellates (P<0.004) and ciliates (P<0.002). During the *M. aeruginosa* bloom period bacteria density was low (10⁵ CFU ml⁻¹) and tended to increase (4-5x 10⁶ CFU ml⁻¹) during the collapse of the bloom. The density of flagellates increased with increasing *M. aeruginosa* cell density which followed decrease of bacterial cell abundance. This may due to release of predatory pressure from flagellate on bacteria. The densities of copepod nauplii and small copepods were in the order of magnitude of 10³ ind l⁻¹ before and after the bloom. Thus, the increase and decrease of different microbial loop component during the course of the *M. aeruginosa* bloom suggests that the dissolved organic matter produced from *M. aeruginosa* temporarily enhanced the energy flow from bacteria, flagellate, ciliate to zooplankton through bacterivorous ciliates.

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Reanalysis of the minimum number of individuals at Bellan-bandi Palassa prehistoric site using skeletal remains

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Bellan-bandi Palassa is a Mesolithic heritage site in Sri Lanka. Bellan-bandi Palassa fossil remains at present are being stored at the National Museum, Colombo. According to the published literature the Minimum Number of Individuals (MNI) estimated using skeletal remains excavated from Bellan-bandi Palassa open-air habitation site is controversial and it ranges from 9-25. Due to the variation in the reported MNI an attempt was made to reanalyze the MNI in the present available collection. The exact bones used by the previous researchers to estimate the MNI has not been well documented.

The MNI is best derived from the number of unpaired single bones present. Regarding skulls the MNI estimate is simply equal to the number of complete or nearly complete skulls. For paired elements MNI is generally the number of either left or right elements, depending which is the greater. In the absence of complete bones, using the bone fragments alone to identify the side of the particular bone fragment could be hard. Present collection contained mixture of fragmented bones. In this study the number of mandibles, number of long bones and atlas and axis vertebrae were used to estimate the MNI in the collection. When different bones are considered the estimated MNI value varied. With regard to mandibles it was 15, lower ends of left and right side of humerus 13, upper ends of radius 09, upper ends of left ulna 09, left femoral fragments 11, left tibial fragments 12, right fibula fragments 11 and atlas and axis vertebra 07. Thus, MNI varied from 07 to 15 in the studied fragmented bone collection. Due to highly fragmented state of the osseous remains the MNI estimated using the complete or partially complete mandibles are considered most accurate and in this Bellan-bandi Palassa fossil remains the estimated MNI is most likely 15. DNA studies are in need to derive the most accurate number.

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SECTION E1

501/E1

Community response to road traffic noise

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A study was carried out to determine community response to noise levels in the vicinity of traffic routes. Noise levels in category A, B and C grade roads were measured and the responses of the residents living within 25 meters from the edge of the traffic routes were assessed through a sample questionnaire.

The questionnaire was administered through personal interviews to 100 residents in randomly selected dwellings in the vicinity of the Colombo – Kandy main road (approximately 30 km from the city of Colombo). The questionnaire contained background questions related to the respondents and their households, annoyance levels and the perception of the respondents. The survey captured factors such as gender, age, education, employment, income, condition of the dwellings, distance to the road, location of bedrooms, windows, living environment, effect of noise on their activities, as well as their views on noise reduction and implementing regulations.

The analysis of the survey data show that most residents living in the vicinity of the traffic routes are disturbed by traffic noise. However, only 38% consider it as an annoyance while 16% consider it as a nuisance at all times. The survey indicates that Sri Lankans do not react strongly to traffic noise except when they watch TV or speak over the telephone. There is a strong relationship between the road traffic noise level and the percentage of respondents feeling “highly annoyed”. In general, the closer the dwelling is to the traffic route, the higher the annoyance level of the residents. When the equivalent noise levels reach the recommended permissible level of 63 dB(A), the percentage of highly annoyed reached 60%. Residents in some of the areas are exposed to very high noise levels (above 75 dB(A)) which need to be addressed through policy decisions. The results agree well with the published work carried out for road traffic noise annoyance in Spain and Egypt.

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Baseline $^{137}$Cs levels of soil and grass in three selected sites in Sri Lanka

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$^{137}$Cs is a man made radionuclide released to the environment as a result of nuclear reactor accidents and Nuclear Weapon Testing. Once released to the atmosphere $^{137}$Cs settles down on earth surface and get attached to the soil particles. Because of the relatively long half life and high affinity to fine soil particles $^{137}$Cs remain in soil for long periods of time.

In this study an attempt was made to set up baseline radioactivity concentration of $^{137}$Cs in soil and grass using gamma ray spectrometry. Baseline information over a period of time allows any increase in radioactivity from man made source to be identified. Continuous soil and grass sampling was done at two sites in Colombo and one site in Ranpokunagama over a period of six months. The minimum activity concentration measured in both types of samples is below the detection limit. The maximum activity concentration of 5.5 Bq.kg$^{-1}$ of was measured in soil while in grass the maximum activity concentration was measured as 6.0 Bq.kg$^{-1}$ of dry weight. It was also observed that one site in Colombo showed higher values for $^{137}$Cs concentrations than the other two sites studied.

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Time series forecasting models for air temperature at Katunayake

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Air temperature is one of the most important parameters for various human activities in many fields. Therefore accurate predictions of short-term and seasonal changes of the air temperature are very important. This paper presents the results of a study carried out to develop prediction models for the monthly means of daily maximum and minimum air temperatures in Katunayake area.

For this study Katunayake area was selected as it is one of the main industrialized zones in Sri Lanka and there is an international airport. There are a large number of productions, for which some chemical reactions that heavily depend on air temperature are required. So, the knowledge of future fluctuation of the air temperature can be very important to plan the production. Also airliners depend heavily on the information about the changes in air temperature and the knowledge of future fluctuations can be very useful. This study is focused on the above topic as there is a lack of statistical models to predict air temperature in this area.

Monthly means of the daily maximum and minimum temperatures collected at Katunayake weather station from January 1971 to December 2003 are used for this study. Classical decomposition method and Box-Jenkins method are the main statistical forecasting methods used in this study. The models are fitted on the assumption that future values can be predicted from its past history. Additive decomposition model and seasonal autoregressive integrated moving average (SARIMA) model are identified as suitable models to predict the monthly means of daily maximum and minimum air temperature. In common Box-Jenkins notation, the fitted models for both monthly means of the daily maximum and minimum temperatures can be written as ARIMA(1,1,1)(0,1,1)12. Using several statistical model comparison criteria, both the models are found to provide accurate predictions.

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Preparation and characterization of size controlled nanocomposites with polyaniline

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It is expected that useful photoconducting nanocomposites can be created by combination of PANI as p-type semiconductor and n-type semiconductor nanoparticles such as CdS and TiO$_2$. Upon irradiation, electrons are thought to be transferred from PANI to nanoparticles. Subsequently, the charges move to the respective electrodes. We have chosen CdS and TiO$_2$ as n-type semiconductors.

Photovoltaic devices with CdS/PANI and TiO$_2$/PANI were fabricated and photovoltaic response under solar irradiation of 100 mW cm$^{-2}$ tungsten lamp was studied. CdS/PANI nanocomposites produced a maximum short circuit current density of 24 $\mu$A cm$^{-2}$. TiO$_2$/PANI nanocomposites produced a short circuit current density of 40 $\mu$A cm$^{-2}$ which increased to 100 $\mu$A cm$^{-2}$ when the electrolyte KI/I$_2$ was introduced into the system. These nanocomposites produced a short circuit current density of 1600 $\mu$A cm$^{-2}$ and 350 $\mu$A cm$^{-2}$ with RuI$_2$(OH)$_2$ dye and extracts from Dioscorea alata respectively. The photoresponse of TiO$_2$/PANI nanocomposites almost doubled with exposure to UV light.

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Formal verification of PAY HERE SMS protocol using SPIN

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The PAY HERE is a Short Message Service (SMS) protocol offered by Dialog Telekom PLC. Dialog Telekom subscribers who have Hongkong and Shanghai Banking Corporation Limited (HSBC) credit cards, can use this protocol to top-up their mobile phones. In the PAY HERE system, a subscriber has to first register for this service through HSBC. On successful registration for the PAY HERE service the subscriber will receive a SMS from Dialog Telecom. Now the subscriber can top-up his mobile phone by sending a SMS with his mobile phone number and the top-up amount. Then Dialog Telecom will debit the said amount from subscriber's credit card and send a SMS to the subscriber confirming the amount has been top-up to subscriber’s mobile phone account.

The research goal was to find out whether the PAY HERE SMS protocol was reliable and if not, propose modifications to the protocol. For this purpose it was checked whether money atomicity, goods atomicity and validated receipt properties were exhibited by the protocol. The model checking tool, Simple Promela Interpreter (SPIN) was used to model the PAY HERE protocol. The behavior of the subscriber and Dialog Telecom were modeled as Promela processes. The money atomicity, goods atomicity and validated receipt properties were modeled as Linear Temporal Logic (LTL) formulae. When SPIN tool was run in verification mode against LTL formulae, it showed that the PAY HERE protocol exhibits both money atomicity and goods atomicity properties. But it was found out that validated receipt property was violated by the PAY HERE protocol.

The validated receipt property violation was eliminated by introducing a new SMS message for the subscriber, which gets a reference number for the top-up transaction. This reference number is used in the subsequent top-up SMS request send by the subscriber to Dialog Telecom. The said modifications were modeled and the SPIN tool was used to formally check that the modified PAY HERE protocol has validated receipt properties without compromising money atomicity and goods atomicity properties.

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Development of a computerized herbarium catalogue and a taxonomic database for the herbarium of University of Colombo

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The herbarium can be considered as a collection of preserved plants stored, catalogued, and arranged systematically for study by the different stakeholders from many walks of life. Well developed information systems are an urgent need to fully manage both the information and the functions of herbaria. But, in Sri Lanka the huge amount of information stored in the herbaria are underutilized due to lack of proper information management.

This study was emphasized on the development of a computer system for the herbarium of Department of Plant Sciences, University of Colombo by incorporating computer and botanical knowledge. The major objective of the project was the establishment and management of a flexible integrated database of herbarium botanical information, to improve the efficiency of herbarium usage.

It was designed for three main components. Initially, total of over 4000 plant specimens belong to 176 angiosperm plant families were systematically arranged. The families were arranged alphabetically, following the genera within each family and the species within each genus. The second phase comprised of the interface designing and coding of the system, which was done using the programming language: Visual Basic.NET. The developed Herbarium Information Catalogue (HerbCat) Beta Version comprised of approximately 5000 lines of Visual Basic codes and the Microsoft Access database contained 24 fields in 10 tables and this system included data entry and search facilities. These options were allowed to access by different users depending on the user type; Administrator or Limited User. Users with limited accessibility privileges were only allowed to search the herbarium information in the database and view the basic herbarium information with in the University of Colombo herbarium. In addition they are allowed to view the herbarium database information summary. Unlike the limited users, the users with administrator privileges are allowed to access lot of other advanced options such as data insertion and information revision with all the accessibility options of the limited users. Both users can search the taxonomic database for the full information of a specific angiosperm plant species using the Family, Genus, common names, locality, etc. Finally, the information in the herbarium was inserted in to the developed system. As the initial trial, 252 of herbarium sheet data were inserted in to the system those belong to 4 angiosperm plant families. This completely novel system requires time to become accepted by different stakeholders and further continuation of the data entry is needed to develop a fully functioning taxonomic database for the herbarium of University of Colombo.

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Use of electrolytes with $I_3^-/I^-$ redox couple as UV filter of dye sensitized solar cells

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Dye-sensitized nanocrystalline TiO$_2$ solar cells offer an alternative for fabrication of low cost thin film solar cells. These solar cells consists of a dye adsorbed porous nanocrystalline TiO$_2$ matrix deposited on conducting tin oxide glass (CTO) interpenetrated by $I_3^-/I^-$ redox electrolyte. Since TiO$_2$ is a high band gap semiconductor electron and hole pairs are generated in conduction band and valence band of TiO$_2$ by the absorption of ultraviolet radiation. But dye only absorb light in visible region and inject electrons to the conduction band of TiO$_2$. Electrons in conduction band diffuse to the CTO glass on which the TiO$_2$ film is deposited. Hole in the valence band transfer to the electrolyte could reduce the constituents of the electrolyte as well as the dye. Therefore photo generation of holes in TiO$_2$ due to absorption of UV light has to be eliminated by filtering the UV component of the incident light. We have found that electrolyte with $I_3^-/I^-$ redox couple itself is a good UV filter in this study.

TiO$_2$ films on CTO glass was deposited by doctor blade method using a slurry made by grinding 1 g of Diggusa p-25 powder, 2 ml of acetic acid and ethanol in an agate mortar and sintering at 500 °C. The film was dye coated by immersing in a solution of Indoline dye dissolve in ethanol. The cell is fabricated by placing the dye coated film on a CTO glass and filling the capillaries of the film with an electrolyte containing $I_3^-/I^-$ redox couple in acetonitrile. Sticking a glass slide on the CTO glass with two strips of double-sided tape at two edges such that to make a space between the CTO glass and the glass slide makes the UV filter on the top of the cell. Electrolyte was introduced in between to form the filter.

From the absorption spectra it was clear that electrolyte absorb all the radiation less than 500 nm. The Indoline dye absorbs light in visible region and the action spectrum of the photo electrochemical cell peaked at around 600 nm. I-V measurement data clearly showed that there is no any significance change in the photocurrent and photo voltage after imposing the electrolytic filter. The photovoltage and photocurrent of the cell was also observed illuminating the cell from the backside. When the cell was illuminated from the backside, light passes through a thin layer of electrolyte in between the TiO$_2$ film and counter electrode. This seems an easy way to cutoff the UV component of the incident light. But the photocurrent and photovoltage of the cell was reduced when it was illuminated from the backside. This is attributed to the series resistance of the TiO$_2$ matrix since the germination of electron occurs far apart the CTO glass. But when the cell is illuminated from the front, most the incident radiation is absorb by the dye on TiO$_2$ close to the CTO glass so that the injected electrons travel only a short distance.

The need of a storage tank of electrolyte arises to compensate the build up of pressure inside the cell due to thermal expansion of electrolyte when the cell was placed outdoor. These results indicate that it is more advantages to make the storage tank in front of the cell to function also as a UV filter.

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Electron kinetics of dye-sensitized solar cells made from Al$_2$O$_3$ coated SnO$_2$ nanocrystalline films

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The scope of study on Dye-sensitized nanocrystalline photovoltaic solar cells (DSNCS) expands as a low cost alternative for photovoltaics and arouses the fundamental research interests of the investigators. The utilizing of ultra thin layer Al$_2$O$_3$ on SnO$_2$ crystallites of DSNCS has been providing fascinating results as it delivers a high open circuit photovoltage relative to the DSNCs fabricated only with SnO$_2$ crystallites. The photo excited dye molecules adsorb on the SnO$_2$ outer layer suppose to inject electrons into the conduction band of SnO$_2$ via tunneling through the Al$_2$O$_3$ barrier. Suppression of recombination of electrons in conduction band with the dye cations and the acceptors in the electrolytic interface, build up the quarsi-fermi level of SnO$_2$ resulting increase in the photo voltage. The determination of the electron diffusion length is made by the competition between the back ward reactions and the collection of electrons at the substrate $L_n= (D_n . \tau_n)^{1/2}$ where $D_n$ is the electron diffusion coefficient and $\tau_n$ is the carrier life time. Though the increment of photovoltage and the efficiency is interpreted as a consequence of the blocking layer, no previous research has been done to study the electron kinetics of this cell. Our studies were conducted to analyze the electron’s $D_n$ and $\tau_n$ in SnO$_2$/Al$_2$O$_3$ DSNC using intensity modulated photocurrent (IMPS) and intensity modulated photo voltage (IMVS) spectroscopy.

The SnO$_2$/Al$_2$O$_3$ composite film was deposited on a conducting tin oxide (CTO) glass by the following method. 2 ml of Tin oxide Colloidal was grinded with a few drops of acetic acid in a mortar. 2.05x10$^{-3}$ mg of AlCl$_3$ was weighed and grinded thoroughly with the SnO$_2$. This paste was diluted with ethyl alcohol to be suitable for spraying onto the conducting tin oxide (CTO) glass plates (0.25 cm$^2$) kept on a hot plate at 120 °C. After spraying, it was sintered in a furnace at 500 °C for 30 minutes. These cells were kept immersed in a Ruthenium bypiradyl dye for one hour for dye adsorption. The cell was prepared by placing CTO glass coated with Pt on the film and filling the capillary space with an electrolyte. All the procedures were followed as mentioned above to deposit SnO$_2$ film on CTO glass except the addition of Al$_2$O$_3$ to the mixture. Intensity modulated photovoltage spectroscopy (IMVS) and Intensity modulated photocurrent spectroscopy (IMPS) measurements were carried out using a blue light emitting diode ($\lambda_{max}$=470nm) driven by a frequency response analyzer. The LED provided both the dc and ac components of the illumination. $D_n$ and $\tau_n$ were calculated from the minima of the IMVS and IMPS curves respectively at different intensities. The lifetime of electrons decreased with the increment of light intensity for both SnO$_2$ and Al$_2$O$_3$/SnO$_2$ cells but the lifetime of the electrons in Al$_2$O$_3$/SnO$_2$ film is always higher compared to bare SnO$_2$ cell. The diffusion coefficient increases as the light intensity increases where the diffusion coefficient is also higher at any particular light intensity for Al$_2$O$_3$/SnO$_2$ cell. Since both the $D_n$ and $\tau_n$ are greater, diffusion length of electrons in Al$_2$O$_3$/SnO$_2$ cells is large. Nevertheless electrons transport efficiently and recombination losses are minimal in the DSNC constructed with Al$_2$O$_3$coated SnO$_2$ films that claim for the high photovoltage and efficiency. This is a different approach to interpret the enhancement of high voltage and efficiency previously reported on the Al$_2$O$_3$/SnO$_2$ dye-sensitized solar cells.

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Adaptive finite element method for solving electromagnetic field problems

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Finite element method (FEM) is a popular powerful computer oriented method of solving boundary value problems in the engineering field. The accuracy of the finite element solution can be improved by both \( h \)-refinement (increasing the number of triangles in the mesh domain) and \( p \)-refinement (free mesh with higher order polynomial approximation). But most of the available FEM-software give only the first-order finite element solution. Since the above refinement algorithms have complexity in programming they are simply avoided in these software. This paper produces new solutions for electromagnetic filed problems using the \( hp \)-FEM. For the purpose, we have considered two numerical Examples such as AC conductor and cable system.

The first example describes a rectangular, stranded AC conductor which is surrounded by a copper sheet so that the boundary of the conductor is a flux line and the current density is a constant inside. The exact, first-order \( h \)-FEM and \( p \)-FEM solutions (second order solution) are analyzed to compare the errors produced by these methods. The \( h \)-refinement of the mesh is obtained by reducing the area of each the triangle from 10% to 5%. In this example, the number of known nodes (25 nodes) and unknown nodes (176 nodes) of both \( p \)-refinement and \( h \)-refinement are equal and therefore the time required for both methods to find the inversion of global matrix are almost the same. In similar way, \( hp \)-FEM is implemented to the Cable system and it produces 25 known nodes and 137 unknown nodes.

While analyzing the results of the above two examples we observed that \( hp \)-FEM provides accurate solution than the first-order. The \( h \)-refinement improves the first-order solution further and it almost converges to \( p \)-FEM solution. In this paper we have produced new highly accurate \( hp \)-FEM solution and for the above particular electromagnetic field problems.

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LiCoO$_2$- NiO- LiFeO$_2$ ternary materials for the molten carbonate fuel cell cathode

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Development of alternative cathode materials has been a main strategy for solving the problem of dissolution of the state-of-the-art lithiated NiO cathode in the Molten Carbonate Fuel Cell (MCFC). LiFeO$_2$ and LiCoO$_2$, which were earlier supposed to be the most promising candidates, could not satisfactorily substitute the lithiated NiO. On the other hand, ternary compositions of LiFeO$_2$, LiCoO$_2$ and NiO are expected to combine some desirable properties of each component.

In this work, a strategical approach of finding alternative cathode materials for the MCFC in the LiFeO$_2$-LiCoO$_2$-NiO ternary system has been undertaken. It was carried out by investigating electronic conductivity of the new materials, first in the form of bulk pellets and then in ex-situ sintered porous gas diffusion cathodes. Finally, the electrochemical performance of the prepared cathodes were investigated by performing short-time laboratory-scale cell operations.

LiFeO$_2$-LiCoO$_2$-NiO materials in three ternary sub-systems were investigated using powders synthesised by the Pechini method. The electrical conductivity study reveals the ability of improving conductivity, adequate for MCFC cathode application, by controlling the LiCoO$_2$ content in ternary compositions. The existence of LiFeO$_2$-LiCoO$_2$-NiO solid solution and two phase materials phases were detected in the phase analysis performed by X-ray diffraction.

The 20mole%LiFeO$_2$-20mole%LiCoO$_2$-60mole%NiO cathode shows a performance comparable with lithiated NiO cathodes in the cell study. Hence this study reveals the ability of preparing LiFeO$_2$-LiCoO$_2$-NiO cathodes, with considerably less NiO and LiCoO$_2$, for the MCFC application.

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Power spectral analysis of critical closing pressure and resistance area product of the cerebral circulation

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Frequency domain analysis was applied to estimate autopower spectra in critical closing pressure (CrCP) and resistance area product (RAP). Spectral analysis of CrCP and RAP were performed by Fast Fourier Transform (FFT). The CrCP of the cerebral circulation indicates the value of the arterial blood pressure (ABP) at which cerebral blood flow (CBF) approaches zero. Measurements in animals and humans have shown that the CrCP is significantly greater than zero. Studies of the cerebral circulation need to take CrCP and RAP into account, to obtain more accurate estimates of cerebrovascular resistance changes, to reflect the correct dynamic relationship between instantaneous ABP and CBF. By modelling the cerebral circulation we have attempted to understand it and predict its response to various physiological challenges in clinical issues. This analysis was performed on 48 healthy subjects and 11 hypertensive subjects. Arterial blood pressure (ABP) and cerebral blood flow velocity (CBFV) were non-invasively recorded using photoplethysmography (Finapres) and Transcranial Doppler ultrasonography (TCD).

We found the power spectra in CrCP, RAP, could be diffracted into three components at specific frequency ranges, designated as high-frequency (HF, 0.1Hz-10th harmonic), low-frequency (LF, 0.05 Hz-5th harmonic), and very low-frequency (VLF, 0.02Hz-2nd harmonic) components. We have not directly measured middle cerebral artery diameters, and caution must therefore be exercised in interpreting our RAP results. Our spectral analysis results indicated that low-frequency power (2nd harmonic) is a reliable index of autoregulation. The previously reported very low frequency oscillations in CBF detected using TCD in human also identified frequency bands around 0.0064Hz, 0.02Hz and 0.037Hz. Therefore frequency domain analysis offers an opportunity to understand underlying mechanism of dynamic regulation in cerebral circulation.

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Trends in ozone depleting substances (ODS) consumption in Sri Lanka

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Ozone layer depletion, and global warming and associated climate change are the two most important global problems in the environmental sector today. Sri Lanka has ratified international conventions and protocols related to these problems. Obligations under the Montreal protocol on substances that deplete the ozone layer is to eliminate consumption of Ozone Depleting Substances on given date as stated in the protocol.

Since signatory to the Montreal protocol in 1989, Sri Lanka has put in place national regulations and policies to fulfill its obligations. Analysis of consumption and import of all ODS shows a declining trend except MeBr and HCFC. Of the total ODS consumption in Sri Lanka, CFC amounts to nearly 86% and has reduced gradually. With this trend Sri Lanka has achieved zero consumption of CFC and Halons by 1st of January 2008, two years in advance of the Montreal Protocol targets. All other ODSs have shown a systematic reduction which has fulfilled the protocol obligations.

The consumption of MeBr has increased and it is attributed to increase demand for Quarantine and Pre shipment usage which is exempted as essential use by the Protocol. There is increase in usage of HCFC due to industrial development of the country and will be controlled in the future in advance with the protocol.

Note: Consumption of any ODS is the amount of virgin ODS used in that country during the particular year. Sri Lanka does not export any ODSs and only depends on import. Sri Lanka has banned import of CFC (including CFC 12) by 1st of January 2008. As same the consumption of CFC is zero from 2008 onwards.

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Synthesis and electrical characterization of Li(Ni\textsubscript{1/3}Co\textsubscript{1/3}\textsubscript{-x}Mn\textsubscript{1/3}Mg\textsubscript{x})\textsubscript{O\textsubscript{2}} and Li(Ni\textsubscript{1/3}Co\textsubscript{1/3}Mn\textsubscript{1/3-x}Mg\textsubscript{x})\textsubscript{O\textsubscript{2}} for lithium ion rechargeable battery positive electrode

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Li(Ni\textsubscript{1/3}Co\textsubscript{1/3}Mn\textsubscript{1/3})\textsubscript{O\textsubscript{2}} which is commonly known as 333 material, is an important member of the Li(Ni\textsubscript{y}Co\textsubscript{1-2y}Mn\textsubscript{y})\textsubscript{O\textsubscript{2}} system (y = 1/3), hence, has recently been investigated as a promising candidate for positive electrode materials in lithium ion rechargeable battery (LIB). It is believed that presence of Mg$^{2+}$ prevents occupancy of the Li$^+$ layers by Ni$^{2+}$ in these layered materials and does not cause local structural collapse and is beneficial for the thermal and electrochemical stability.

New material compositions of two systems, Li(Ni\textsubscript{1/3}Co\textsubscript{1/3-x}Mn\textsubscript{1/3}Mg\textsubscript{x})\textsubscript{O\textsubscript{2}} (x=0, 0.11, 0.22, 0.33) were synthesized in the form of fine powders by the Pechini method. Subsequently powders were calcined at 900 °C for 4 h. The phase and particle size analyses were carried out on calcined powders with X-ray diffractometry and a particle size analyzer, respectively. The a.c. impedance and d.c. (four probe method) electrical characterizations were performed on the pellets sintered at 1000 °C for 4 h.

The phase analysis revealed the formation of solid solutions of appropriate 333 phase (R3m layered structure) in the materials doped with Mg content up to 0.11. The electrical conductivity of 333 (i.e.x=0.0), at 25 °C is about $1\times10^{-4}$ S/cm and $2\times10^{-3}$ S/cm at 200 °C. For the new compositions prepared substituting Co and Mn by Mg, the electrical conductivity is almost $7\times10^{-4}$ S/cm and $4\times10^{-2}$ S/cm at 25 °C and 200 °C, respectively. The d.c electrical conductivity increases in an exponential way for all the materials with temperature, indicating semiconductor behaviour of the materials. The electrical conductivity of Li(Ni\textsubscript{1/3}Co\textsubscript{1/3-x}Mn\textsubscript{1/3}Mg\textsubscript{x})\textsubscript{O\textsubscript{2}} system increases with Mg content up to x=0.22, then decreases significantly. But the conductivity is still higher than that of 333 material even at x = 0.33. Quite interestingly in the system where the Co was substituted with Mg, electrical conductivity increases with Mg content then decreases almost to the same value of 333 material. However again the conductivity increase in the cobalt free system (i.e. x=0.33) unexpectedly. All these materials prepared by Pechini method show of having appropriate particle size for LIB positive electrode. Altogether, this study shows potentiality of, Mg doped Li(Ni\textsubscript{1/3}Co\textsubscript{1/3}Mn\textsubscript{1/3})\textsubscript{O\textsubscript{2}} materials prepared by Pechini method, for LIB positive electrode application.

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Establishment of chemical parameters to distinguish between Sri Lankan teas of different geographical origins

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Unblended Sri Lankan teas are classified as high grown (HG), medium grown (MG) and low grown (LG) based on their geographical origin. In the quality control purposes, it is an added advantage if suitable chemical data that are helpful to distinguish between different teas are available. Present study explains the identification of the geographical origin of teas based on the total phenol, caffeine and catechin contents. Even though the quantities of these substances have been reported, the origin, whether the tea is pure or blended and the particle size of teas have not been specified in such studies.

Total phenol contents (TPC) were determined by Folin-Denis colorimetric method. Caffeine contents (CFT) and catechin contents (CTC) were determined by the comparison of the signal areas of these compounds in HPLC chromatograms using calibration plots. The results indicate that there is no significant difference in the total phenols, caffeine and catechin contents in tea samples collected within a geographical area. However, the compositions of these compounds varied significantly among the tea samples from different geographical origins (HG, MG and LG). The results are summarized in Table 1.

Table 1. Comparison of the TPC, CFT and CTC contents of Sri Lankan teas

<table>
<thead>
<tr>
<th>Origin</th>
<th>TPC (g kg⁻¹)</th>
<th>CFT (g kg⁻¹)</th>
<th>CTC (g kg⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HG</td>
<td>8.58 ± 0.33</td>
<td>8.22 ± 1.69</td>
<td>2.78 ± 0.51</td>
</tr>
<tr>
<td>MG</td>
<td>10.85 ± 0.64</td>
<td>10.73 ± 0.90</td>
<td>0.06 ± 0.02</td>
</tr>
<tr>
<td>LG</td>
<td>11.65 ± 0.56</td>
<td>29.89 ± 0.94</td>
<td>1.65 ± 0.11</td>
</tr>
</tbody>
</table>

Each data point represents the mean of three replicates + standard deviation

The results indicate that due to widely different quantities of TPC, CFT and CTC, a clear idea about the geographical origin of teas can be obtained by comparison of TPC, CFT and CTC.

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A new way to compare the antioxidant activity of phenolic substances of different plant extracts

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With the growing evidence of potential health risks associated with the consumption of synthetic antioxidants, the demand for natural antioxidants has increased rapidly. In the assessment of the antioxidant activities of plant extracts IC$_{50}$ values of the extracts or antioxidant activity of a known concentration (g/L) (but not the concentration of active ingredients) of an extract, is determined. However, the results of such experiments do not clearly reflect the quality of antioxidants of the plant extracts due to the fact that the amounts of active antioxidant ingredients are not considered for such evaluations. In the present study the DPPH radical scavenging activities of phenolic extracts from different plant sources were compared. For this comparison, the colorimetrically measured total phenol contents of the phenolic extracts of different samples were adjusted to an equal concentration by suitable dilutions and the DPPH radical scavenging activity of each phenolic extract was measured (Figure 1). Five samples from each plant extract were used for the study and the measurements were done in triplicate.

Interestingly, observation of the variation of DPPH radical scavenging activities along y axis at a given concentration of phenolic substances indicates that the antioxidant activities of the phenolic extracts from different sources vary even at equal total phenol concentrations. This can be attributed to the fact that the antioxidant quality of the individual phenolic compounds is different in different plant extracts. The antioxidant activity by DPPH assay of the seed extracts of A and C is even superior to that of synthetic antioxidant, BHT.

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Development of novel food packaging film made up from chitosan, fish gelatin, and determination of its physical and biodegradable characteristics

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Waste accumulation is one of the burning problems faced by the fisheries industry in Sri Lanka. Fish head, skin, bones, viscera and fins like body parts directly go as waste in the fish market, harbors and retail outlets. Part of those wastes directly dumped into the sea leads to serious marine pollution. The rest is buried in the soil in haphazard manner. This research was focused to develop a novel biodegradable film by means of fish waste based substances and explore possible value addition to overcome the waste problem faced by the fisheries industry in some extend.

Chitosan and fish gelatin are biopolymers which are extracted from marine food processing industrial waste. Chitosan 1%, Chitosan-fish gelatin 2:1, Chitosan-fish gelatin 1:1 films were prepared during the research period. Chitosan films had a slight yellow appearance which gets intense as the thickness of the films was increased. Mechanical characteristics; tensile strength and elongation at break of Chitosan 1%, Chitosan: Fish gelatin 2:1 and Chitosan: Fish gelatin 1:1 films were 36.6, 16.2, 31.0 Mpa and 25, 25 and 5% respectively. Accordingly, Chitosan 1% film exhibited the highest tensile strength. Tensile strength of the films increases with fish gelatin content. Nevertheless, it remains less than Chitosan 1% film. On the other hand, commercial cheese packaging film (reference film) displayed the least tensile strength of 5 MPa. Statistical evaluation of the films showed a relationship between mean tensile strength and fish gelatin content at 5% confidence level.

The results of biodegradation test revealed that Chitosan films visually remain unchanged for a period of about two weeks prior to initiation of biodegradation. In contrast, Chitosan film incorporated with fish gelatin exhibited faster degradation. The commercial cheese packaging film does not exhibit any visual biodegradation during the test period.

Upon optimization of the characteristics, this novel film can be developed to meet the requirements of a commercial packaging film without any burden to the environment at the end of its service life.

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Oral hypoglycaemic activity of *Nyctanthes arbor-tristis* Linn in wistar rats

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The leaves of *Nyctanthes arbor-tristis* Linn. (Night jasmine, Sepalika and Pavalamallihai), has been used in Ayurvedic medicine in the treatment of diabetes mellitus. At present, powdered leaf is used in the preparation of ‘Kashayas’ administered to diabetic patients. The flowers are also used by diabetic patients as an infusion to be taken to reduce blood sugar levels. The present study was undertaken to study the oral hypoglycaemic activity of the leaves and flowers of the above plant prepared by traditional methods. The animal model used was the healthy, male Wistar rats subjected to glucose challenge.

Leaf and flower extracts of *N. arbor-tristis* Linn. showed significant oral hypoglycaemic activity in rats subjected to glucose challenge. The extracts were administered to rats orally via Sondi needles and they were subjected to mild anaesthesia with diethylether before blood was drawn. Blood samples were taken from the lateral tail vein of rats two hours after the administration of extracts.

The leaf extract prepared according to the traditional ‘reduction of eight volumes to one (patha ata eketa sindaweema’ method showed the highest hypoglycaemic effect and proved to be the maximally effective dose. This extract showed the highest reduction in the serum glucose level, two hours after the administration. Further the administration of the leaf extract for eight consecutive days significantly lowered the serum fasting glucose levels as well as the post-glucose challenge values.

The oral hypoglycaemic activity of the leaf extract was compared with metformin at a dose comparable with the human dose and the leaf extract proved to be more effective than metformin in reducing the serum glucose concentration after glucose challenge.

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Screening of non-root vegetables for commonly used pesticides in the upcountry region in Sri Lanka

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Many farmers often use pesticides indiscriminately. They tend to use higher doses than what is usually recommended and do not pay attention to the limits on application during the pre-harvesting period. This may be the main reason to detect the pesticide residues in vegetables. In the past, residue levels have occasionally been detected above the Maximum Residue Levels (MRL). In the study, residue levels of 14 pesticides which are commonly used in the upcountry area were determined in 300 samples including beans (51), leeks (129), cabbage (90) and lettuce (30). Samples were collected from agricultural instructional divisions of Nuwaraeliya, Kandapola, Lindula and Keppetipola in Nuwaraeliya and Welimada divisional secretariat divisions according to a statistical plan.

The samples were extracted by standard method and analyzed by GC/ECD, NPD & MSD and HPLC/DAD. The monitored pesticides and the ranges of their Limit of Quantification (LOQ, as mg kg\(^{-1}\)) for the selected crops are imidacloprid (0.02 - 0.04), carbofuran (0.08 - 0.1), carbaryl (0.02 - 0.04), carbosulfan (0.08 - 0.1), chlorpyrifos (0.004 - 0.01), fipronil (0.008 - 0.02), prothiofos (0.008 - 0.02), permethrin (0.01 - 0.02), deltamethrin (0.01 - 0.02), diazinon (0.004 - 0.005), pirimiphos-methyl (0.005 - 0.01), phenthoate (0.01 - 0.01), profenofos (0.008 - 0.02) and fenthion (0.005 - 0.02). Percentage recoveries obtained for all pesticides were in the acceptable range of 70 to 110.

Residues of carbofuran, carbaryl, carbosulfan, prothiofos, diazinon, phenthoate and fenthion were not detected. Residues of chlorpyrifos, profenofos, permethrin fipronil, deltamethrin, imidacloprid, carbaryl and pirimiphos-methyl were detected in 27, 11, 4, 2, 2, 1, 1 and 1 number of samples respectively. Chlorpyrifos level in four cabbage and three bean samples exceed the Codex MRLs (1 for cabbage & 0.01 for beans in mg kg\(^{-1}\)). Even though imidacloprid in cabbage and carbaryl in lettuce were detected, the levels did not exceed the MRLs (0.5 for Imidacloprid & 10 for carbaryl in mg kg\(^{-1}\)). Local or international MRLs are not available for 13 pesticide-crop combinations for which residue levels exceeded the LOQs and that is 76% of the total pesticide-crop combinations in which pesticide residues were detected. Therefore it is difficult to predict how safe these vegetables for human health with respect to the pesticide residues. Thus it is very important to generate MRLs for common pesticides for fruit and vegetables consumed in abundance in Sri Lanka.

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Evaluation of the shelf life quality of deep frozen coconut based products

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Coconut kernel is the major energy source in the diets of coconut producing countries. Ready to use coconut milk, the water extract of the coconut kernel, has a great demand in the market specifically for its nutty flavour. Studies were conducted to evaluate the storage quality of deep frozen coconut cream, scraped coconut and coconut chips. Coconut cream pasteurized and scraped coconut and coconut chips were blanched at 70°C for 1.5 minutes. A known weight of each product was packed in nylon low density polyethylene, triple laminate and polyethylene and stored in a freezer at -10°C. The shelf life was evaluated by free fatty acid content, peroxide value and total plate count (Pour plate method). The acceptability was tested by triangle test using a semi trained panel in two weeks intervals. FFA content increased during the storage period, but none of the products exceed the standard level of 1%. The development of FFA in products packed in triple laminates was slow and peroxides were not detected up to 8 weeks of storage period. At the 8th week, TPC/g exceeded the acceptable limit (>10⁶) indicating the level of pasteurization/blanching time is not sufficient. Coconut cream was unacceptable due to layer separation and development of off odour and smell. Scrapped coconut and coconut chips were accepted for 4 weeks and over 8 weeks respectively. Results of the storage studies indicate the shelf life of the frozen coconut products are 8 weeks. Pasteurization for 70°C for 1.5 minutes is not sufficient to reduce the initial microbial load and to inactivate the enzymes. The processed coconut chips can successfully be packed in triple laminates for two months.

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Corrosion stability of an aluminium alloy used in making of some cooking pans in Sri Lanka

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In addition to aluminium, aluminium alloys commonly used for making of some cooking pans in Sri Lanka contain of Si, Fe, Cu, Mn, Mg, Cr, Zn and Ti as minor elements. In the present work, the stability of one such alloy against corrosion, at ambient temperature in several aqueous media in the pH range of 5.0 to 6.5 that closely resembles the physicochemical status of liquid foods cooked using these vessels were investigated. The electrochemical techniques; immersion test, open circuit potential measurements and potentiodynamic polarization techniques were used to determine the corrosion parameters and the rate of corrosion of the alloy in the selected experimental conditions.

The results of the immersion tests indicated that, the rates of corrosion of the alloy in several aqueous media; tap water from municipal water supply, citric acid and acetic acid dissolved in tap water and pH adjusted to 5.0 did not exceed 0.7 mm yr\(^{-1}\). The open circuit potentials corresponding to the alloy in all above solutions increased positively with time indicating the formation of passive oxide films on the alloys resulting a decrease in the rate of corrosion with time. Potentiodynamic polarization studies showed that in the above aqueous media the corrosion potentials fall in the ranges of (-362 to -739 mV) vs. the silver/silver chloride electrode and corrosion currents fall in the range of (~10.00 to ~24.24) $\mu$A cm\(^{-2}\).

The immersion test results indicated that, the alloy can undergo corrosion with rates in the range of about 1.4 to about 2.1 mm yr\(^{-1}\) in solutions of tap water, gallic acid and tartaric acid containing sodium chloride [2%(w/v) NaCl]. The highest rates of corrosion of about 2.1 mm yr\(^{-1}\) for the alloy were observed in tartaric acid solution containing 2 % (w/v) NaCl. The open circuit potentials for these solutions increased negatively with time indicating adsorption of negatively charged chloride ions on the surface of the alloys resulting in an increase in the rate of corrosion with time. The corrosion potentials and corrosion current found from the potentiodynamic studies for the alloy containing 2%(w/v) sodium chloride solution of municipal tap water, gallic acid and tartaric acid at pH 5.0 were in the ranges of about -693 to about -760 mV vs. Ag/AgCl electrode and ~ 59.26 to ~79.43 $\mu$A cm\(^{-2}\) respectively.

The results indicated that the alloy can undergo corrosion significantly if it is used in aqueous media containing gallic acid or tartaric acid at pH 5 or 2 %( w/v) NaCl in tap water, gallic or tartaric acid solutions at pH 5 containing 2 % (w/v) NaCl in the ranges studied.

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Development of three simple voltammetric techniques for detection of theophylline

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The potential of employing the three voltammetric techniques; linear sweep voltammetry (LSV), differential pulse voltammetry (DPV) and square wave voltammetry (SWV) using pyrolytic graphite working electrode for detection of theophylline (TP), a common drug used for treatment of respiratory diseases was investigated. Phosphate buffer at the concentration of $2.0 \times 10^{-2}$ mol dm$^{-3}$ and at the pH of 6.6 were found to be the best electrolytic medium for all three voltammetric techniques. TP was found to undergo an irreversible oxidation reaction producing concentration dependent reproducible anodic peak currents at the peak potentials of +0.995 V, +0.772 V and +0.785 V with respect to Ag(s) / AgCl(s) / Cl$^-$(aq) reference electrode (+0.197 V vs. NHE) for the three techniques, LSV, DPV and SWV, respectively. The optimum scanning rate of working electrode potential for LSV was 100 mV s$^{-1}$. The optimum scanning rates of working electrode potential and pulse height for DPV were 25 mV s$^{-1}$ and 140 mV, respectively. The optimum pulse height and frequency for SWV were 110 mV and 50 Hz, respectively.

Under optimum conditions, there were good linear relationships between anodic peak current and TP concentration for the three techniques. The linear concentration ranges for LSV, DPV and SWV were from $3.0 \times 10^{-4}$ mol dm$^{-3}$ to $1.3 \times 10^{-3}$ mol dm$^{-3}$, $7.0 \times 10^{-5}$ mol dm$^{-3}$ to $8.0 \times 10^{-4}$ mol dm$^{-3}$ and $5.0 \times 10^{-5}$ mol dm$^{-3}$ to $1.1 \times 10^{-3}$ mol dm$^{-3}$, respectively. The limit of detection observed with LSV, DPV and SWV were $2.5 \times 10^{-4}$ mol dm$^{-3}$, $6.0 \times 10^{-5}$ mol dm$^{-3}$ and $4.0 \times 10^{-5}$ mol dm$^{-3}$, respectively. The results obtained during an analysis of a commercial TP drug, theophylline sustained release uncoated tablets with the three techniques, LSV, DPV and SWV were found to exhibit percentage deviations of 4.8 %, 3.1 % and 2.7 %, respectively from the value given on the tablet. All three techniques have potentials for detecting TP in the therapeutic range of 10 to 20 mg dm$^{-3}$.

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An evaluation of lead levels in paints sold in the Sri Lankan market

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An investigation has been carried out to ascertain and evaluate lead levels in different solvent based and water based household paints sold in the Sri Lankan market. Unlike in developed countries, in developing countries like Sri Lanka, relatively little or no attention has been devoted to the potential for lead exposure which is considered to be a major health hazard. Lead has been used in paints, gasoline, water pipes and many other products. At present lead based paint is one of the most significant sources of lead exposure. There are two common basic types of lead pigments known as white lead (Pb(OH)$_2$.2PbCO$_3$) and red lead (Pb$_3$O$_4$), which have been widely used in the paint and coating industry. Lead dust can form when lead based paint is scraped, sanded, or heated. But later people realised that exposure to lead dust released from lead based paints caused lead poisoning in children as well as in adults. Lead is a highly toxic, heavy metal. Its adverse effects on health include hyperactivity, low intelligence quotient (IQ) scores, hearing loss, behavioral disorders, kidney toxicity and anaemia.

In this study five brands of white coloured enamel paints and seven brands of white coloured emulsion paints sold in the Sri Lankan market as household coatings were investigated over a time period of six months in 2007. Experimental results indicated that the levels of lead in the enamel paints ranged from 5.7±1.7 mg kg$^{-1}$ to 2452.3±109.1 mg kg$^{-1}$ and it was from 4.1±0.3 mg kg$^{-1}$ to 688.2±16.3 mg kg$^{-1}$ in emulsion paint sample analysed. Out of the five enamel paint and seven emulsion paint brands analysed two enamel paint brands and one emulsion paint brand showed the presence of considerably high amounts of lead and thus those products cannot be recommended for applications, since they have a potential risk of causing health hazards pertaining to lead poisoning especially in children. Therefore, experimental results revealed that high levels of lead pigments and lead additives are still used by some paint and coating manufacturers in Sri Lanka with increased risk of exposure to people, for whom domestic sources of lead exposure is more important than exposure through leaded petrol.

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Comparison of the \textit{in vivo} antioxidant activity of traditional coconut oil, virgin coconut oil and soya oil

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When the nutritional quality of cooking oils is considered, it is extremely important to evaluate the contribution of cooking oils to the antioxidant activity in blood. In the present study, the \textit{in vivo} antioxidant potentials of three cooking oils are compared. Male Wistar rats were fed with a special diet containing traditional coconut oil (TCO, prepared by boiling coconut milk), virgin coconut oil (VCO) and soya oil (SO). The effect of the consumption of these oils on the total antioxidant activity in blood serum was analyzed and compared. The decolorization of ABTS$^{**}$ (radical cation of 2,2'-azinobis-(3-ethylbenzothiazoline-6-sulfonic acid) was used as a measure of antioxidant activity and the antioxidant activity was expressed as trolox equivalent antioxidant capacity (TEAC). The results are summarized in Table 1.

Table 1. Variation of TEAC in blood serum

<table>
<thead>
<tr>
<th>Sample name</th>
<th>Baseline</th>
<th>28 days</th>
<th>56 days</th>
<th>84 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO</td>
<td>34.9 ± 0.2$^a$</td>
<td>33.0 ± 0.3$^b$</td>
<td>35.5 ± 0.5$^{ac}$</td>
<td>36.1 ± 1.0$^c$</td>
</tr>
<tr>
<td>TCO</td>
<td>41.9 ± 0.7$^a$</td>
<td>41.1 ± 0.2$^{ab}$</td>
<td>47.1 ± 0.8$^c$</td>
<td>47.4 ± 0.3$^c$</td>
</tr>
<tr>
<td>VCO</td>
<td>39.2 ± 4.4$^a$</td>
<td>34.8 ± 0.2$^b$</td>
<td>36.1 ± 0.9$^{ab}$</td>
<td>37.5 ± 1.2$^a$</td>
</tr>
</tbody>
</table>

Values are means (n = 4) ± SD (n = 4), within the same raw different letters are significantly different at P<0.05 (ANOVA).

The results indicate that there is a noticeable improvement of the antioxidant capacity especially during the 28 – 84 day period and TCO shows the highest increment indicating that a better improvement of the antioxidant capacity in blood is resulted by the consumption of TCO compared with the consumption of VCO or SO. Higher antioxidant activity of TCO may be attributed to the higher polyphenol contents of TCO compared with those of VCO and SO.

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Preparation of Coconut oil blends and the evaluation of their health effects

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Coconut oil prepared by pressing copra (copra oil, CO) is the major cooking oil in Sri Lanka. However, copra oil contains only less than 1.5 % of essential fatty acids. The objective of the project is to improve the quality of copra oil by blending copra oil with traditional Sri Lankan seed oils containing high percentages of polyunsaturated fatty acids. Oils of the seeds of Brassica juncea (Aba), Madhuca nerifolia (Mee) and Sessamum indicum (Thala) were used to prepare oil blends. The organoleptic acceptability of the prepared blends was checked by a panel and the oil blends selected by the panel were selected for the evaluation of health effects. The acceptable blends of coconut oil were aba oil (AO) (40%), thala oil (TO) (50%) and mee oil (MO) (60%) and by volume.

Male Wistar rats were fed with a special diet containing these oil blends, coconut oil (CO), and soya oil (control) and their serum levels of total cholesterol (TC), HDL, LDL, and triglycerides (TG) were determined. The results are summarized in Table 1.

<table>
<thead>
<tr>
<th>Type of oil blend</th>
<th>TC (mg/dL) ± S.E</th>
<th>HDL (mg/dL) ± S.E</th>
<th>LDL (mg/dL) ± S.E</th>
<th>TG (mg/dL) ± S.E</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO (100%)</td>
<td>162.0 ± 1.0</td>
<td>48.0 ± 1.0</td>
<td>114.0 ± 1.0</td>
<td>152.0 ± 2.0</td>
</tr>
<tr>
<td>AO (40%) + CO (60%)</td>
<td>128.0 ± 2.0</td>
<td>62.0 ± 3.0</td>
<td>66.0 ± 1.0</td>
<td>96.0 ± 2.0</td>
</tr>
<tr>
<td>TO (50%) + CO (50%)</td>
<td>131.0 ± 1.0</td>
<td>55.0 ± 2.0</td>
<td>76.0 ± 1.0</td>
<td>109.0 ± 0.5</td>
</tr>
<tr>
<td>MO (60%) + CO (40%)</td>
<td>141.5 ± 1.2</td>
<td>52.0 ± 1.0</td>
<td>89.0 ± 1.0</td>
<td>135.0 ± 1.0</td>
</tr>
<tr>
<td>Soya oil (control)</td>
<td>121.0 ± 1.0</td>
<td>65.0 ± 1.0</td>
<td>55.0 ± 1.0</td>
<td>92.0 ± 1.0</td>
</tr>
</tbody>
</table>

Each data point represents the mean of five replicates ± S.E; Different superscript letters in same column denote significant difference at 5% level by one way ANOVA.

The results indicate that there is a remarkable decrease in the TC, LDL and TG levels and an increase in HDL levels in blood serum due to consumption of oil blends compared to the consumption of CO. The beneficial effects of the oil blend with AO (40%) + CO (60%) are closely comparable with those of soya oil. Blending coconut oil with given oils improves beneficial health effects and provide essential fatty acids without significantly altering the organoleptic quality of coconut oil.

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High accuracy theoretical calculations of NLO properties of conjugated organic systems using Hartree–Fock (HF), Møller-Plesset perturbation theory (MP2) and Density Functional Theory (DFT): A comparative investigation

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The advancement of experimental techniques and evolution of quantum chemical theoretical procedures lead to the dramatic development of materials with nonlinear optical properties (NLO) during the last decade. Therefore, the hyperpolarizability which is the measure of NLO activity of various systems is theoretically investigated because compounds with large NLO response are candidates in photonic technologies. We report a comparative investigation of the first static hyperpolarizabilities (β) of fluorenyl derivatives with a number of donor-acceptor (D-A) moieties (9 molecules) on either side of the fluorenyl ring system enhancing the π-electronic charge distribution through the π-conjugation. The first static hyperpolarizabilities (β) of fluorenyl derivatives were obtained by Møller-Plesset perturbation theory (MP2) and the density functional theory (DFT) and compared the values with the published data using Hartree–Fock (HF) method. Fully optimized molecular geometries were obtained using HF, MP2 and B3LYP (DFT) methods employing 6-31G basis set. Then the β values were calculated for each molecule with the same level of theory using GAUSSIAN 98W. It can be seen that there is a two fold increase in MP2 hyperpolarizability values compared to the HF method and three fold increase in hyperpolarizability values of DFT method compared to the HF method. When comparing the DFT and HF methods, DFT includes some component of electron correlation for much the same computational cost as HF methods. This means that it is a highly efficient and accurate way of performing a advanced calculation for the fluorenyl system. This shows that this system can be a potential NLO material which can be synthesized in a standard laboratory.

<table>
<thead>
<tr>
<th>HYPERPOLARIZABILITY (β)</th>
<th>Increase</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HF (10⁻³⁰ esu)</td>
<td>MP2 (10⁻³⁰ esu)</td>
<td>DFT (10⁻³⁰ esu)</td>
<td>Increase in MP2 compared to HF</td>
<td>Increase in DFT compared to HF</td>
<td>Increase in DFT compared to MP2</td>
</tr>
<tr>
<td>30.19</td>
<td>61.21</td>
<td>91.56</td>
<td>31.02</td>
<td>61.37</td>
<td>30.34</td>
</tr>
<tr>
<td>37.51</td>
<td>82.14</td>
<td>128.1</td>
<td>44.62</td>
<td>90.57</td>
<td>45.95</td>
</tr>
<tr>
<td>39.77</td>
<td>88.80</td>
<td>140.9</td>
<td>49.03</td>
<td>101.1</td>
<td>52.06</td>
</tr>
<tr>
<td>42.94</td>
<td>91.70</td>
<td>143.7</td>
<td>48.76</td>
<td>100.8</td>
<td>52.03</td>
</tr>
<tr>
<td>20.42</td>
<td>38.77</td>
<td>65.91</td>
<td>18.35</td>
<td>45.49</td>
<td>27.14</td>
</tr>
<tr>
<td>52.98</td>
<td>105.4</td>
<td>144.8</td>
<td>52.46</td>
<td>91.81</td>
<td>39.35</td>
</tr>
<tr>
<td>81.45</td>
<td>153.2</td>
<td>242.5</td>
<td>71.71</td>
<td>161.0</td>
<td>89.30</td>
</tr>
<tr>
<td>130.4</td>
<td>253.7</td>
<td>765.9</td>
<td>123.3</td>
<td>635.5</td>
<td>512.2</td>
</tr>
</tbody>
</table>

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Shelf life of leafy vegetables treated with natural essential oils

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Fresh product of vegetables typically contains a complex mix of microorganisms. To prolong the shelf life of vegetables, the growth of microbial population must be controlled and washing and removal of damaged tissues are employed to reduce initial high counts. Clean sanitations are essential because storage life is shorter with high initial microbial loads. Chemical sanitations have a negative impact. Naturally occurring antimicrobial product healthier for environment and humans. Essential oils have antimicrobial properties. We investigated the in vitro antimicrobial activity of Cinnamon leaf oils (Cinnamom zeylanicum) on the native micro flora of “Gotukola” (Centiella asiatica). Fresh Gotukola samples were selected with uniformity of color, size and physiological damage were discarded. Leaves were washed 3 times with tap water and allowed to remove surface moisture. Leaves were hand sprayed on both sides with essential oils at minimum inhibitory concentration (MIC) 0.06 ml/100 ml v/v that is the concentration that produced a 90% in vitro inhibition of the native micro flora of Gotukola. In Control samples leaves were sprayed with tap water. After spraying 50g of the leaves were placed in low-density polyethylene (LDPE, 150 gauge) bags of 20 X 30 cm² surface area. The bags were sealed and stored at 5°C with 97 % RH. At 3, 5 &7 days of storage samples were taken for determination of microbiological test include the total plate count (TPC), coliforms, E-coli and Salmonella, nutritional value (fiber, moisture, ash & ascorbic acid) & sensory properties. For determination of microbiological tests International Standard were used. Moisture, Ash, Fiber & Ascorbic acid content of the leaves were determined according to the standard methods. Leaves were evaluated for their sensory properties color, appearance, taste, and aroma, overall acceptability by providing samples and a questionnaire to six trained panelists. There was no effect due to essential oil treatment on nutritional value of Gotukola samples when compare the treated samples and control samples. Ascorbic acid content of the sample decrease with the storage time. TPC was low in samples treated with essential oils than control samples. Initial TPC of samples before essential oil treatment was $3.67 \times 10^2$ cfu/g. Seven days after storages at 5°C in control sample & treated sample TPC were $2.45 \times 10^2$ & $1.48 \times 10^2$ cfu/g respectively. Coliform count was also low in samples treated with essential oils ($40 \times 10^1$ cfu/g) than control samples ($110 \times 10^1$ cfu/g). The Salmonella count and E. coli count of all samples were nil. On the sensory attributes of the samples the panelists did not find difference among controls & treated samples. Throughout the storage time, no evidence of softening or rot was found on any of the samples. Therefore, we can conclude that cinnamon leaf oil can be used as naturally occurring sanitizing compound in leafy vegetables.

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Investigation of the effect of structure of surfactants on binding to iron oxide nanoparticles

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The development of nanometer-sized colloidal particles has been intensively studied, due to their considerable technological and fundamental scientific interest. The surface modification of these colloidal nanoparticles and the related surfactants are very important to facilitate their applications to biotechnology, catalysis and nanocomposites. In particular, various metal nanoparticles have been extensively utilized as catalysts for many organic transformations, and stabilizing ligands (surfactants) are known to influence the catalytic activity and selectivity of the nanoparticles. In order to recognize their potential applications in industry and in biotechnology it is critical to understand the surface chemistry of colloidal nanoparticles. Magnetic nanoparticles made from iron oxide, in particular, have attracted extensive interest due to their potential applications in many fields such as in multi-tera bit storage device, catalysis, sensors, and a platform for high-sensitivity biomolecular magnetic resonance imaging (MRI) for medical diagnosis and therapeutics.

In the current study, we first investigated the synthesis of iron oxide nanoparticles using a novel method. We then investigated the coordination ability of so synthesized nanoparticles towards various surfactants to understand how the structures of surfactants relate to its binding abilities with iron oxide nanoparticles using FT-IR spectroscopy. Although large number of surfactants have been used to stabilize iron oxide nanoparticles for various applications these surfactants have not been utilized as stabilizing surfactants for iron oxide nanoparticles. For this investigation we used six surfactants, stearic acid, palmitic acid, sodium dodecyl sulphonic acid (SDS), 4-aminobenzoic acid, anthraquinone-2-sulphonic acid, and sulphanilic acid. FT-IR spectra, obtained for iron oxide nanoparticles coated with above six surfactants, reveal surfactants having long hydrocarbon chain followed by the coordination site such as stearic acid, palmitic acid, sodium dodecyl sulphonic acid (SDS), have been coordinated to iron oxide nanoparticles. While, 4-aminobenzoic acid, anthraquinone-2-sulphonic acid, and sulphanilic acid has not been coordinated. Therefore, it is evident that bulky molecules, that have sterically hindered groups close to the coordination site, are prevented from attaching to iron oxide nanoparticles. From above observations it is clear that only those molecules with flexible and less sterically hindered structures can bind to iron oxide nanoparticles.

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Influence of maturity variations on proximate chemical compositions and fatty acid profiles of Oreochromis mosambicus Peter (Tilapia)

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The influence of maturity variations on the proximate chemical composition and the fatty acid profile of Oreochromis mosambicus (Tilapia) were studied. The maturity was grouped into six stages by weight (g): length (cm) relations. The per cent of ash and moisture contents were determined as mentioned in the Official methods of Analyses of the Association of Official Analytical chemists' (AOAC, 1984), whereas the oils were extracted according to the procedure of Folch et al., (1957). The fatty acid methyl esters (FAME) were prepared and the fatty acid profile was analyzed as mentioned in the Official methods of the American Oil Chemists' Society (Ce1b-89), (AOCS, 1992).

Table: 1 The proximate chemical composition (Mean ± SD, n = 4, wet weight basis)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>78.68 ± 0.43</td>
<td>79.18 ± 0.29</td>
<td>82.01 ± 0.68</td>
<td>81.98 ± 2.46</td>
<td>79.60 ± 1.76</td>
<td>80.12 ± 0.70</td>
</tr>
<tr>
<td>B</td>
<td>2.94 ± 0.10</td>
<td>1.25 ± 0.03</td>
<td>0.62 ± 0.02</td>
<td>1.85 ± 0.05</td>
<td>1.63 ± 0.11</td>
<td>0.75 ± 0.05</td>
</tr>
<tr>
<td>C</td>
<td>0.88 ± 0.03</td>
<td>0.82 ± 0.04</td>
<td>1.15 ± 0.09</td>
<td>1.32 ± 0.07</td>
<td>1.04 ± 0.06</td>
<td>1.22 ± 0.09</td>
</tr>
</tbody>
</table>

Maturity stages: A - Moisture content, B - Lipid content, C - Ash content

The proximate compositions vary as shown in Table 1. The per cent of total Omega-6 fatty acid (FA) content of Stage-1 (5.92), Stage-2 (5.89) and Stage-3 (5.14) significantly varies (p ≤0.05) from Stage-6 (10.44). The Stages 1, 2 and 3 were almost same in their Omega-6 FA content. Stage-6 contains the per cent of maximum Omega-6 FA (10.44). The per cent of ash and lipid contents were influenced by maturity variation. Except omega-6 and the ratio between omega-3 and omega-6, other fatty acids were not influenced as hypothesized. The study shows a variation of omega-6 FA in Stages 1 to 6, with minimal variation between Stages 1 to 3. The highest level of omega-6 FA was seen in Stage-6. A further study with the known age of fish is warranted.

Financial assistance by National Science Foundation (grant no: RG/AG/02/2005) is acknowledged.

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Kinetic study of proline dehydrogenase from *Saccharomyces cerevisiae* (yeast)

Proline dehydrogenase is the first enzyme in the proline catabolic pathway which converts proline to $\Delta^1$-pyrroline-5-carboxylate (P5C). Function of this enzyme is very important in regulating proline levels in all organisms. Proline plays a central role in metabolism and is recognized as an important amino acid in bioenergetics, osmoprotectant, cellular redox control, apoptosis and cancer.

In bacteria, proline dehydrogenase is a part of a multifunctional enzyme called proline utilization A (PutA). PutA consists of a proline dehydrogenase domain and a $\Delta^1$-pyrroline-5-carboxylate dehydrogenase domain which catalyze the two step conversion of proline to glutamate. In addition to its enzymatic activities PutA is an autorepressor of PutA gene. In contrast, eukaryotic proline dehydrogenase is a monofunctional enzyme.

Although prokaryotic Proline dehydrogenase (PutA) is exclusively studied, little information is known for the eukaryotic enzyme. Therefore, our goal was to purify and characterize the eukaryotic proline dehydrogenase. In our work, we have over-expressed the eukaryotic proline dehydrogenase of yeast (Put1p) in *E. coli* and successfully purified the enzyme. Kinetic study of the purified enzyme revealed a $K_M$ of 35.7mM and that D-proline is a mix type inhibitor of proline dehydrogenase. Kinetic analysis of the purified enzyme will be discussed.

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Preliminary characterization of phosphatase activity in the crude pitcher fluid of *Nepenthes distillatoria* (bandura)

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Carnivorous pitcher plants of the genus *Nepenthes* acquire substantial amounts of nutrients from the insects captured. A mixture of hydrolytic enzymes is believed to be responsible for efficient digestion of insect carcasses inside the pitcher fluid. In this study we partially characterized phosphatase activity detected in the crude pitcher fluid of *N. distillatoria*, a plant species endemic to Sri Lanka.

A simple assay procedure was developed using *P*-nitrophenyl phosphate (pNPP) as the substrate to determine the acid phosphatase activity in the crude pitcher juice. The reaction mixture contained 100 µl 0.5 mM pNPP, 100 µl 0.5 M sodium acetate buffer at pH 4.0, and 50 µl of crude *Nepenthes* fluid. After incubation at 37°C for 2.5 hours, 1 ml of 0.5 M NaOH was added to inhibit the reaction and color development and absorbance was measured at 405 nm. Optimum pH for phosphatase activity was determined by incubating the reaction mixture at different pHs ranging from pH 2.0 to 10.0. Optimum temperature was determined using the same assay procedure at pH 4.0 and at different temperatures from 30°C to 60°C. Thermal and pH stability of phosphatase activity was determined by incubating the crude pitcher fluid at different temperatures and pHs for a period of one month. Aliquots were removed at different time intervals and the percentage remaining activity of each aliquot was determined. Phosphatases in the crude pitcher fluid were partially purified using a DEAE cellulose column.

A significant phosphatase activity in the crude pitcher fluid was observed. Two pH optima were observed at pH 2.5 and pH 4.0. Optimum temperature for phosphatase activity was 55°C. The phosphatase/s in crude juice is not thermally stable as acid proteinases reported previously. More than 50% of activity was lost after 14 days at room temperature and within a day at 50°C. At 37°C and 45°C, 50% activity was lost within 6 and 3 days, respectively. However the enzyme was highly stable at low pH. More than 95% of activity was remaining after a month at pH 2.0, 4.0, 5.0, and 6.0. At pH as high as 9.0 and 10.0, approximately 50% of enzyme activity was retained even after a month. DEAE cellulose chromatography resulted in two sharp peaks at NaCl concentrations 0.10 M and 0.18 M, indicating the presence of two phosphatases in the crude juice. Studies on purification and characterization of these enzymes are in progress.

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Designing of a water quality index for weras ganga

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A Water Quality Index (WQI) is defined as a rating system reflecting the composite influence of a number of individual water quality determinants on the overall quality of a given water body. The composite influence is obtained via an indexing model; an assortment of equations specifying necessary mathematical treatment. Such a model would inescapably have to cater for the unique consequences within the site of concern, whereas no exact Water Quality Indexing Model had been developed directly concerning the context of Sri Lanka. Thus, the focus of this research was to specifically design a WQI within the perspective of Sri Lanka.

With due reasoning, Weras Ganga; a unique ecosystem within the Bolgoda Wetlands, was selected for the study. After extensive analysis of general variables, nutrients, organic matter, major ions, trace elements and microbiological indicators pertaining to water quality at site, efforts were made to produce a WQI for Weras Ganga via a mathematical model accomplished by performing apt modifications on a Water Quality Indexing Model previously adopted by the Canadian Council of Ministers of the Environment (CCME). The model principally focused on three factors in respect to water quality; which are,

1. The number of variables whose objectives are not met (Scope) \([F_1]\)
2. The frequency with which the objectives are not met (Frequency) \([F_2]\) and
3. The amount by which the objectives are not met (Amplitude) \([F_3]\).

Finally, the ultimate WQI was calculated via above factors using the formula given below.

\[
WQI = 100 - \left( \frac{F_1^2 + F_2^2 + F_3^2}{1.732} \right)
\]

Eventually, the General WQI for Weras Ganga was found to be 27.01, which inferred that the Weras Ganga waters are at a plight of high deterioration. In conclusion, a precise interpretation was sought, with the ultimate objective; “to attain an insight concerning the prevailing plight of the quality of Weras Ganga waters and to provide or at least recommend measures acceptable to all parties, who entail the waters of Weras Ganga to be of consumable quality”.

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Detection and preliminary characterization of glycosidase/s from *Nepenthes distillatoria*

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The principal nutritional requirements of carnivorous plants are largely held in the prey in organic form. In order to break complex molecules down to their simpler, absorbable components most carnivorous plants secrete hydrolytic enzymes. *Nepenthes distillatoria* is one such carnivorous plant endemic to Sri Lanka. In this study, we partially characterized glycosidase activity detected in the crude pitcher fluid of *N. distillatoria*.

Crude juice of pitchers of *N. distillatoria* was collected from Hakurugala forest patch at Ruwanwella, filtered and stored at -20°C until use. Preliminary investigation for glycosidase activity was conducted by incubating a 2.5% glycogen solution with 100 μl of pitcher juice in sodium acetate buffer at pH 5.2. The reaction mixture was incubated at 37°C for 90 minutes. The reaction was terminated by the addition of 1% 2, 4 - dinitrosalicylic acid followed by heating up to 100°C for 10 minutes. Then a solution 40% K-Na tartarate was added to stabilize the products. The amount of glucose produced by the digestion of glycogen substrate was determined by measuring the absorbance at 540 nm. Optimum pH and temperature for glycosidase activity were determined by incubating the reaction mixture at different pHs and at different temperatures. Crude pitcher fluid was incubated at different pHs and temperatures separately over a period of two weeks. Aliquots were removed at different time intervals and the remaining glycosidase activity of each aliquot was determined by carrying out the standard assay procedure.

A low, but detectable glycosidase activity was observed in the crude *Nepenthes* pitcher juice. The optimum pH for glycosidase activity was pH 5.5. The optimum reaction temperature was obtained as approximately 40°C. The glycosidase activity in the pitcher juice is not stable for more than a week even at 4°C. Moreover, glycosidase activity in crude juice was not stable over a broad pH range as anticipated. However, they are stable when stored in pH 2.0 at 4°C. At basic pHs beyond pH 8.0, complete loss of activity was observed within a day. This observation is in accordance with the pH of the crude juice, which is extremely acidic in nature. Further studies are necessary to precisely determine the nature of these enzymes.

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Computer simulation study of structure and stability of CO$_2$-N$_2$ dimers

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CO$_2$-N$_2$ dimers have been investigated using the realistic pair potential. Lennard-Jones potential was used to represent the attractive forces and repulsive forces while electrostatic interaction was taken into account through quadrupole - quadrupole interactions. We first confirmed our simulation method by modeling the N$_2$-N$_2$ and CO$_2$-CO$_2$ neat dimers with comparison of the results with literature. Potential parameters for CO$_2$-N$_2$ dimer was generated by using the Lorentz-Berthelot (LB) mixing rules.

Three stable dimer structures have been obtained for the nitrogen-carbon dioxide dimer in excellent agreement with the dimer configurations obtained in the experimental Infrared spectroscopy. Two T-shaped structures and canted parallel structures are the observed configurations as given in the following Figure. The energies and equilibrium bond distances of these three configurations are reported. Since in our study, we used the realistic potential rather a non-realistic potential and the three structures obtained are similar to the experimentally observed structures, we report that the realistic pair potential we used in this calculation is more suitable to model the N$_2$-CO$_2$ system for further simulation studies.

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**Figure.** Three lowest energy structures of CO$_2$-N$_2$ dimers. (a) canted-parallel structure, (b) T-shaped 1 structure (N pointing to C in CO$_2$ molecule), (c) T-shape 2 structure (O pointing to the center of N$_2$ molecule)

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A new butyrolactone from an endophytic fungal strain isolated from marine red alga

Laurencia ceylanica

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As a continuation of our work on endophytic fungi from seaweeds, a fungal strain isolated from red alga, Laurencia ceylanica, was cultivated in bulk and extracted with EtOAc to afford a gummy extract. Above extract was subjected to column chromatography followed by PTLC to give a new compound (LC-1) along with 3 known compounds butyrolactone-1 (LC-2), 6-hydroxy mellin (LC-3) and (3R, 4R)-6, 7-dimethoxy-4-hydroxymellin (LC-4).\textsuperscript{15}C NMR and DEPT spectra of LC-1 showed 20 carbon signals including one aldehyde, one methoxy, and ten quaternary carbons. Its \textsuperscript{1}H NMR spectrum showed signals due to seven aromatic protons, one methylene group, one aldehyde proton and one methoxy group. The positive CI MS of LC-1 showed its molecular ion peaks at m/z 385.0 corresponding to \([M + H]^+\) and the molecular formula was deduced to be \(C_{20}H_{16}O_8\). Comparison of the NMR data of LC-1 with butyrolactone-1 (LC-2) isolated from the same extract indicated them to be compounds with similar skeletons. Further analysis, indicated that the isoprenyl group in butyrolactone-1 is replaced by an aldehyde group in LC-1. Hence, the structure of LC-1 was confirmed a new natural product 3-hydroxy-4-(4-hydroxyphenyl)-5-methoxycarbonyl-5-(4-hydroxy-3-formylbenzyl)-2,5-dihydro-2-furanone. Isolates LC-1 and LC-2 showed significant antioxidant activities having IC\textsubscript{50} (\(\mu\)M) 88.2±0.30 and 132±3.77 respectively, when subjected to free radical scavenging assay.
Liquid crystal (LC) behavior of cinnamyl 2, 3, 4, 6-tetra-O-acetyl-α-D-glucopyranoside

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Carbohydrates are a new, but promising source for liquid crystals. But they are different from classical monophilic liquid crystals. They have many interesting non-technical applications like being used as surfactants, emulsifiers, membrane builders’ etc. carbohydrate LCs mainly consist of a polar sugar moiety and a non polar part. Thus, they possess an amphipathic property which imparts the liquid crystal behavior and surfactant properties to carbohydrate derivatives. In this paper, starting from glucose and cinnamyl alcohol, novel aryl glycosides has been synthesized. It was done by the selective acylation of D-glucose with an acylating agent, acetic anhydride followed by glycosilation with cinnamyl alcohol and followed by the investigation of liquid crystal properties of both the acetylated and the deacetylated products. These products have been structurally elucidated using standard spectroscopic techniques like hydrogen (1H) NMR, carbon-13 (13C) NMR, Mass spectroscopy and FTIR. Their thermotropic and lyotropic liquid crystalline properties were investigated using polarizing microscopy, differential scanning calorimetry and X-ray diffraction. Both thermotropic as well as lyotropic polymorphism was found for cinnamyl 2,3,4,6-tetra-O-acetyl-α-D-glucopyranoside. The compound displayed thermotropic hexagonal columnar/ smectic A phase and the investigation of the lyotropic phase behaviour led to the observation of hexagonal columnar Phase. The results of the single-crystal X-ray analysis provided for a better understanding of crystal formation and stability.

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Aurasperone - A from endophytic fungus strain SW11 isolated from brown alga Sargassum wightii

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As a continuation of our research work on endophytic fungi from seaweeds, brown alga Sargassum wightii Greville was collected from Tangalle and an endophytic fungal strain was isolated. The isolated fungus (SW11) was cultured in large scale and extracted with EtOAc to give the EtOAc extract as a brownish yellow gum. It was subjected to normal column chromatography using increasing amount of MeOH in dichloromethane followed by repeated reverse phase column chromatography on RP-18 to give a dark yellow compound (SWR-1) as a minor compound. SWR-1 showed molecular mass at m/z 570.0 and NMR spectral analysis confirmed it to be aurasperone-A, which has been previously reported from Aspergillus niger. SWR-1 was subjected to luminal - based chemiluminescence (CL) assay. Our results showed that SWR-1 (IC₅₀ >100 µg/ml) did not show a potential suppressive effect on whole blood. However, it showed potential suppressive effect (IC₅₀ = 34.1±11.7 µg/mL) on polymorph nuclear cells (PMNs) assay.

![Aurasperone-A](attachment:image.png)
Synthesis of glucopyranoside carbohydrate derived liquid crystal

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Glycolipids are amphoteric liquid crystals forming lyotropic liquid crystals in aqueous solutions and thermotropic liquid crystals in their dry form as a result of microphase separation of the hydrophilic and hydrophobic parts in the molecules. In this study, glycolipid was synthesized by introducing β-sitosterol aglycone to peracetylated D-glucose followed by deprotection via alkaline treatment. FTIR, $^1$H-NMR, $^{13}$C-NMR, optical birefringence, differential scanning calorimetry and XRD techniques were employed to characterize the glycolipid and its phase structure. The product was shown to form thermotropic hexagonal columnar/smectic phase upon cooling the isotropic liquid.

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Four new butanolide derivatives from the genus *Hortonia*

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*Hortonia* is a genus endemic to Sri Lanka, considered to have originated in Gondwanaland about 100-120 million years ago. The latest revision of the family Monimiaceae by Dassanayake lists only three distinct species (*H. floribunda* Wight ex Arn., *H. angustifolia* (Thw.) Trimen, and *H. ovalifolia* Wight) in Sri Lanka. Having observed identity in the TLC profile of the CH\textsubscript{2}Cl\textsubscript{2} extracts of the leaves of all three species, a phytochemical study was undertaken to resolve the speciation of *Hortonia*. Previously, we have reported the isolation of two new butenolides from the leaves of all three species (*H. angustifolia*, *H. floribunda* and *H. ovalifolia*). In the course of our further investigation of the leaves of these three plants, we have isolated three new butanolides, 1-3, and a new ring-opened butanolide, 4, whose structures were determined as (2\textit{E},3\textit{R},4\textit{R},9'\textit{Z})-2-(dodec-9'-en-11'-ynylidene)-3-hydroxy-4-methylbutanolide (1), (2\textit{E},3\textit{R},4\textit{R})-2-(dodeca-9',11'-diynylidene)-3-hydroxy-4-methylbutanolide (2), (2\textit{E},3\textit{R},4\textit{R},9'\textit{E})-2-(dodeca-9',11'-dienylidene)-3-hydroxy-4-methylbutanolide (3) and one new ring-opened butanolide, methyl (2\textit{Z},11\textit{Z},1'\textit{R},2'\textit{R})-2-(1',2'-dihydroxypropyl)tetradeca-2,11-dien-13-ynoate (4) by \textsuperscript{1}H NMR, \textsuperscript{13}C NMR, HOMOCODY, HMBC, HMQC, DEPT and HRESIMS analysis. The stereochemistry of the two OH groups at 1' and 2' carbons in 4 were determined by its conversion to the corresponding acetonide 5 followed by \textsuperscript{1}H NMR analysis.
Spectroscopic evidence for the pH sensitivity and anion trapping capability of N,N-ethylenebis(acetylacetoneiminato)copper(II) complex

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A shiny crystalline purple colour N,N-ethylenebis(acetylacetoneiminato)copper(II) complex synthesized by template synthesis shows some interesting acid-base properties and capability of binding anions. Single crystal X-ray crystallographic, XRD, UV, IR and CV data were used to characterize the compound. Interestingly, the complex is purple at pH > 7 and colourless in pH < 2. Anions like SCN\(^-\), I\(^-\), Br\(^-\), Cl\(^-\) binds to this complex when it is in acidic medium turning the colour of the solution to yellow. The intensity of yellow colour varies in the order Cl\(^-\) < Br\(^-\) < SCN\(^-\) < I\(^-\). The colour change at pH < 2 may be due to the protonation of the ligand environment coordinated to the Cu\(^{2+}\) center. The UV-visible spectrum of the complex at pH > 7 shows a band at 540 nm. This band disappears and a new band appears around 820 nm giving an isobestic point at 680 nm with the addition of H\(^+\) ions into an ethanolic solution of the compound. Interestingly, the band around 540 nm reappears and the solution colour turns to purple again with the addition of OH\(^-\) ions into the same solution. Stepwise addition of SCN\(^-\) and Br\(^-\) to the solution separately at pH < 2 shows an appearance of a new band at 795 nm and 790 nm respectively with the disappearance of the band at 540 nm. This red shift of the d-d band together with the intensity decrease at pH < 2 may be due to the protonation of the ligand environment bonded to the Cu\(^{2+}\) center by decreasing the crystal field stabilization energy (CFSE) of the complex and increasing the symmetry of the system. The blue shift of the d-d band together with the intensity increase with the addition of various anions to the solution at pH < 2 may be due to the CFSE change with the coordination of anions to Cu\(^{2+}\) center and decreasing the symmetry of the system.

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Relationship between organoleptically categorized Sri Lankan black tea (*Camellia sinensis*, L.) with objective assessment of liquor colour and polyphenol composition

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Colour difference of tea infusions is one of the parameters used by professional tea Tasters to distinguish high, mid and low grown Sri Lankan Black tea. Since this is based on subjective assessment, we examined whether there is a relationship between objective assessment of colour and polyphenol content of tea infusion of different agro-climatic regions with this visual sensory quality. Broken Orange Pekoe Fannings (BOPF) grade black tea samples were collected randomly from four tea factories belonging to each agro-climatic region: high grown (>1200 m, average mean sea level); mid grown (1200–600 m, amsl) and low grown (<600 m, amsl). Infused liquor was made, colour was determined using an automatic colour difference meter and polyphenol content was assessed using HPLC with set wave length at 278 nm, coupled with Phenyl-Hexyl bonded C18-Reverse phase column, linear acetonitrile gradient elution and inbuilt UV/Visible Spectrophotometer detector. Tea liquor samples were then subjected to sensory assessment by a panel of professional tea Tasters.

The Spearman’s linear correlation analysis showed that, there were significant correlations (ps0.05) between the infused liquor colour sensory assessment of professional tea Tasters (score of 0–15) with the colour difference meter readings: \( \Delta L \)-light-dark (+100 to -100), \( \Delta a \)-red-green (+60 to -60), \( \Delta b \)-yellow-blue (+60 to -60) and \( \Delta E \)-total colour difference \( \sqrt{((\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2)} \) and polyphenol contents: total catechins (TC), total polyphenols (TPP), theaflavins (TF), thearubigins (TR) and TR/TF ratio in black tea infusion made from different agro-climatic elevations in Sri Lanka. The values of \( \Delta L \), \( \Delta a \), TR and TR/TF ratio positively correlated to the sensory colour assessment suggesting that the method could support to categorize black tea in to different agro-climatic regions. Significantly negative correlations of \( \Delta b \), \( \Delta E \), TC and TF values with sensory colour analysis were shown in high grown followed by mid grown and low grown teas. The content of TPP did not show a relationship with the sensory analysis. The overall results suggest that instrumentally determined colour or estimation of polyphenol content may be used to support sensory quality assessment of black tea.

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Synthesis and characterization of meso-5-(4-hydroxyphenyl)-10,15,20-tris(4-methoxyphenyl)porphyrin and its use as a photosensitizer in nanocrystalline zinc oxide solar cell

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Meso-5-(4-hydroxyphenyl)-10,15,20-tris(4-methoxyphenyl)porphyrin \( \text{[H}_2\text{HPTrMPP]} \) was synthesized starting from pyrrole, \( p \)-hydroxybenzaldehyde and \( p \)-methoxybenzaldehyde in propanoic acid medium and the product was separated by the column chromatography using \( \text{CHCl}_3: \text{CH}_3\text{OH} \) (95:5V/V) as the eluant; violet coloured product was obtained upon the rotary evaporation of the solvent. The product had intense Soret absorption band centered at 419 nm and four Q bands of lower intensity in the range 510 nm to 700 nm in the UV-visible absorption spectroscopy. The product was also characterized by \( ^1\text{H}-\text{NMR} \) and FT-IR spectroscopic techniques and by cyclic voltammetry; all of which supported to identify the product to be \( \text{H}_2\text{HPTrMPP} \). \( \text{H}_2\text{HPTrMPP} \) was then metallated with \( \text{Zn}^{2+} \) to yield \( \text{ZnHPTrMPP} \).

The UV-visible absorption spectrum of \( \text{ZnHPTrMPP} \) had the typical Soret absorption band centred at 419 nm but the four bands in Q-band reduced to two as expected. Also in \( ^1\text{H}-\text{NMR} \) of the metallated product, the signals due to N-H which was observed in \( \text{H}_2\text{HPTrMPP} \) disappeared.

Nanoparticles of ZnO was prepared by the sol-gel process using zinc acetate dihydrate with NaOH in methanol at 55 °C. Cetyltrimethylammonium bromide(CTAB) was used as the particle growth controller. The precipitate obtained was separated by filtration, washed several times with methanol and then with distilled water and the thick viscous solution was autoclaved at 60 °C. The X-ray diffractometry confirmed the purity of ZnO and the particle size calculated using the Debye-Scherer equation was around 9 -18 nm.

Several (11 in number) solar cells of the configuration ITO/ZnO/ZnHPTrMPP/I\(_2\), I\(_{-}\) in water or dimethyl sulphoxide/Pt-ITO were prepared by utilizing both doctor blading and dip coating methods to deposit ZnO on ITO and their performances, i.e., Open Circuit Voltage \( V_{\text{oc}} \), Short-circuit current \( I_{\text{sc}} \) and the Fill Factor FF, were determined. The cells with best performance has \( V_{\text{oc}} \) of 0.7 V, \( I_{\text{sc}} \) of 136 A and FF of 0.41. The energy level diagram was constructed using experimental results obtained in spectroscopic and electrochemical studies carried out in this work and the thermodynamic feasibility of the cell performance confirmed.

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Estimation of copper content in Sri Lankan black tea

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Copper is an inorganic element present in tea. The inherent copper content in tea can vary with the variation of soil characteristics in different agro-climatic elevations. The application of copper based fungicides mainly to control blister blight leaf disease may affect the copper content in tea. Fungicide application is practiced under wet and humid climatic conditions, in which the disease is more prevalent and thus the addition of copper to tea can also vary in different geographical regions. The aim of this study was to estimate the variation of copper content in black tea from different geographical regions under three main agro-climatic elevations; high grown (>1200 m, Average Mean Sea Level), mid grown (600 m-1200 m, AMSL) and low grown (<600 m, AMSL) in Sri Lanka.

The identified seven geographical regions were High/West, High/Nuwara-Eliya, High/Uva, High/Udupussellwa, Mid/West, Mid/Uva and Low, and black tea samples were collected from five selected factories in each region from four different tea grades; BOP, BOPF, Pekoe and Dust. Samples were dry-ashed at 450 °C for 12 hours, followed by an acid extraction. Each extracted sample was analyzed using ultraviolet-visible spectrophotometry at 400 nm as copper-diethylthiocarbamate complex in carbontetrachloride and using flame Atomic Absorption Spectrophotometry (AAS) by standard addition method.

There was no significant variation of copper content in different regions (p≤0.05). A significant variation in different grades was observed from AAS method (p≤0.05). The lowest copper content (34.2 mg/kg) was reported in low grown tea, while the highest content (53.7 mg/kg) was in mid grown tea. Dust grade had the highest amount (59.7 mg/kg) of copper. There was a positive correlation (R²=0.712) between two spectroscopic methods. As the variation of copper content in black tea from different regions was not significant, the variation in soil characters may have a very little effect on it. The variation in different grades may be due to the plucking method, possible chemical reactions during manufacture and metallic contaminants. Both spectroscopic methods can be applied to estimate the copper content in black tea. The copper content in Sri Lankan black tea lies within the limits of standards of many international bodies and therefore, can be accepted as in good export quality.

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Studies in simulated rice field environment: II. Investigation of kinetics of propanil degradation using electrochemical methods

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Propanil is a fast moving herbicide used in rice cultivation. Although propanil is electroinactive, its principal degraded product, 3,4-dichloroaniline (3,4-DCA), is electroactive. Detailed electrochemical investigation of 3,4-DCA in aqueous medium reveals that it shows two reduction and two oxidation peaks at +0.10 V, –0.10 V, +0.35 V and +0.75 V, Vs saturated Calomel Electrode (SCE) respectively. The most intense peak appears at +0.75 V, which is diffusion-controlled according to peak current- potential scan rate studies, and hence it is suitable for quantitative analysis. Consequently, direct detection of 3,4-DCA in the environment can be extended for investigation of the fate of propanil.

Application of propanil, with the recommended dose for rice cultivation, in three beds of equal dimensions (1.0 m in length × 1.0 m in width × 0.5 m in depth) prepared in a polytunnel, an effective simulated environment, can be used for fate studies. Determination of the concentrations of 3,4-DCA through the entire rice cultivation cycle of 4 months indicated that the concentration of 3,4-DCA initially increased up to 4 days followed by decreased up to 10 days, and finally reaching a constant concentration.

Kinetic studies performed for initial degradation of propanil, assuming that the degradation of propanil forming 3,4-DCA is the major conversion step, indicated that the degradation process is of first order with respect to propanil with the rate constant of 5.0 x 10^{-6} s^{-1}. The linear fit of the integrated rate equation for first order kinetics shows a regression coefficient close to one, as compared to more deviated values for the rate laws of other orders. However, further refinement of this kinetic model can be achieved by considering the quantity of propanil lost during spraying, due to volatilization, and plant and soil absorption.

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QuEChERS method to analyze pesticide residues in tea

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Tea is the most demanded and profit generating commodity among all export items of agriculture in Sri Lanka, due its higher quality. However, a problem associated with pesticide residues in Ceylon tea, which interferes with its quality, has been identified several years ago. Therefore, analysis of pesticide residues in tea has become critical in exporting to maintain its quality. The methods available for analyzing pesticide residues have some constraints, such as the longer time taken, higher solvent cost, use of chlorinated solvents, high wastage and the need for skilled manpower. Therefore, this study was conducted with the objective to validate the method, dubbed the quick, easy, cheap, effective, rugged and safe (QuEChERS) to analyze pesticide residues in tea.

Experiments were performed to validate the modified QuEChERS method to analyze pesticide residues [i.e. Organochlorine and Organophosphate] in tea. Tea samples were treated with three different levels of know concentrations (0.05, 0.25 and 0.50 mg/kg) of Organochlorine (Aldrin, HCH’s, Endrin, Endosulphan, DDT, Heptachlor and PCNB was used as internal standard) and Organophosphate (Diazinon, Fenthion, Malathion, Parathion, Phenthoate,) pesticide standard solutions (spiking) and these samples were analyzed by the QuEChERS multiresidue method. Extraction of pesticide residues from the spiked tea samples was done using 50 mL of Ethyl acetate (ETOAc). Samples were dehydrated with 10 g of Anhydrous Na₂SO₄ and then neutralized using 1.6 g of NaHCO₃ and centrifuged. After centrifugation 10 mL of the ETOAc extract underwent a cleanup step (in a technique known as dispersive solid-phase extraction) in which the removal of impurities and trace amounts of water were performed using 0.25 g of Primary Secondary Amine (PSA) and 1.5 g of MgSO₄. Then the extract was concentrated and analyzed by to GC-ECD or NPD. The recovery of each spiked pesticide was calculated. The statistical analysis was done using “Two Factor-Factorial CRD”

Recoveries of each pesticide obtained using the modified QuEChERS method is high and was greater than 85% for Organochlorine pesticides for all three spiking levels. However, less than 30% recovery was shown for Organophosphate pesticides because of the problem associated with Caffeine. The modified QuEChERS method is recommended for analysis of Organochlorine pesticide residues in tea whereas in the analysis of Organophosphate pesticides the Caffeine interferes with the recoveries. As further studies, removal of Caffeine by available removal methods and then validating the method for analysis of Organophosphate residues of tea could be suggested.

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Modeling acid - base properties of montmorillonite-water Interface

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Montmorillonite is a member of smectite group, i.e. 2:1 layer silicate, with two silicate tetrahedral sheets joined to a central octahedral sheet. The clay exhibits variable and permanent charge characteristics. In this work, the interaction mechanisms of protons with montmorillonite were examined using electric double layer theory. In this context, specific surface area was determined by methylene blue (MB) method. The MB replacement point indicates the saturation of surface sites, accordingly the surface area was obtained as 416±5 m\textsuperscript{2}g\textsuperscript{-1}. When compared to hydrous metal oxides, the proton titration curves of montmorillonite exhibit unusual features, viz. no any common intersection point that corresponds to pH\textsubscript{pzc}. In montmorillonite there are two site types; amphoteric site (>XOH) along edges and fixed (negative) sites (>Y\textsuperscript{-}) along basal planes. Protons interact with both site types; thus the resultant titration curves exhibit peculiar behavior when compared to in metal hydroxides. Proton interactions on montmorillonite were modeled by 2-pK approach. Proton affinity constants and site density values were estimated by a numerical optimization and found to be: 

\[ \text{\textsuperscript{>Y} + H^+ \rightarrow \text{\textsuperscript{>YH}}, K_Y = 9.28}; \text{\textsuperscript{>XOH} + H^+ \rightarrow \text{\textsuperscript{>XOH\textsuperscript{+}}}}, \log K_{\text{\textsuperscript{+}}} = 5.89; \text{\textsuperscript{>XOH} \rightarrow \text{\textsuperscript{>XO} + H}}, \log K_2 = 6.12 \text{ and } \text{\textsuperscript{>XOH}=1.38\times10^{-4}} \text{ mol dm}^{-3}, \text{\textsuperscript{>Y}=2.28\times10^{-4}} \text{ mol dm}^{-3} \text{ respectively. Calculations suggest that pH}_{\text{pzc}} = \sim6 \text{ along edge sites. Therefore, montmorillonite surface is dominantly negative when pH} > \sim6. Surface titration curves of 0.100 and 0.010 mol dm\textsuperscript{-3} NaNO\textsubscript{3} are fitted well with 2-pK diffuse layer model whereas the titration curve obtained in 0.001 mol dm\textsuperscript{-3} NaNO\textsubscript{3} shows least fitting quality.\]

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Evaluation of physico-chemical and sensory properties of coconut residue flour

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A study was conducted to evaluate physico-chemical and grinding characteristics of coconut residue flour. Coconut residue flour is the byproduct of dry process of virgin coconut oil. The powder is off white in colour and has a good smell. Proximate composition of coconut residue flour was moisture 3.2%, ash 7.3%, protein 22.4%, sugar 20.2%, fat 10.2%, crude fibre 16.3% while that of wheat flour was moisture 7.0%, ash 0.6%, Crude protein 14.5%, Total sugar 2.3%, crude fat 1.23%. The results indicated that coconut flour contains higher protein and crude fibre contents than the wheat flour. Coconut flour has a higher water absorption capacity (6.9 g/g – 7.57 g/g) when compared with that of wheat flour (2.35-2.87g/g). The water absorption capacity did not change with time significantly. Oil absorption capacity of coconut flour is similar to that of wheat flour (1.98-2.36 g/g) and it did not change with time.

The coconut residue was ground using three types of mills into a fine powder to find out the suitable grinding system for coconut residue. The selected mills were local flour mill (LFM), mill fabricated at CRI (CRI M), and hammer mill (HM). The size distribution of the flour was determined and found that the LFM gave larger particle sizes (70.57% retained in 425μm sieve) while CRIM and HM retained 24.54% and 25.30% in 425μm respectively indicating that they produced finer particles. LFM was not efficient for grinding the coconut residue due to its high fibre content. However, CRIM and HM gave better particle size distribution. HM was the best having approximately 75% of the particles distributed in 300-150μm range. The mills used in the study did not produce satisfactory milling properties, hence need further investigations.

The chemical composition did not vary with different particle sizes. However, moisture content of all the fractions was higher than the whole coconut flour due to its hygroscopic nature. The other components are within the range of original powder indicating that the composition does not vary with the size of the particles.

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Removal of fluoride by magnetic $\gamma$-Fe$_2$O$_3$ nanoparticles

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Magnetic $\gamma$-Fe$_2$O$_3$ nanoparticles were synthesized by modified co-precipitation method and XRD patterns well matched with $\gamma$-Fe$_2$O$_3$ structure. SEM images and particles size measurement confirmed that the synthesized $\gamma$-Fe$_2$O$_3$ is in 50 – 200 nm range. These $\gamma$-Fe$_2$O$_3$ particles were employed as absorbent to remove fluoride in water. The fluoride adsorption was found to be strongly pH dependent and the adsorption capacity varied with a pH of the medium. Optimum Fluoride adsorption was measured at pH 4 and no dependence on the background electrolyte was observed indicating that the fluoride adsorption occurs in inner-sphere mechanism. The fluoride adsorption decreased when the pH of the medium was above the zero point charge of $\gamma$-Fe$_2$O$_3$ (pH$_{zpc}$=8.13) indicating the transformation of the positively charged surface to a negatively charge surface and higher OH$^-$ concentration. Fluoride uptake rate was very fast in the first 15 minutes and almost 90% adsorption was observed and thereafter, the adsorption rate decreased slowly due to desorption of weakly bonded Fluoride and competition between F$^-$ and OH$^-$ ions in medium. Adsorption isotherm data at pH 4 followed Langmuir model suggesting the multilayer formation after the $\gamma$-Fe$_2$O$_3$ particles were covered by monolayer and this further reveals a direct chemical bond formation.

Complement experiments of the Diffuse reflectance FT-IR spectroscopy (DRIFT) studies showed evidence for inner-sphere bonding mechanism between fluoride and $\gamma$-Fe$_2$O$_3$ particles; negative adsorption peaks observed at around 1630 cm$^{-1}$ and 3400 cm$^{-1}$ indicated the formation of direct Fe-F bond by the removal of surface OH groups.

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Phytoextraction of heavy metals in semi-aquatic environments using selected *Colocasia* sp. and *Wedelia* sp.

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This particular study focuses on remediation of heavy metal (Cd²⁺ and Pb²⁺) contaminated semi-aquatic environments using two plant species, a *Colocasia* sp. and a *Wedelia* sp. which are two common local plants growing under semiaquatic conditions.

The main research work involved two experimental setups; the pot experimental setup and the hydroponic solution experimental setup (only for *Colocasia* sp.).

In pot experimental setup a series of plants were allowed to grow for a certain period of time in pots containing varying concentrations of the analyte in soil. Then the plant materials (aerial parts and below ground parts separately) and the corresponding soil samples were digested and analyzed using flame atomic absorption spectrometer (FAAS).

In hydroponic solution experimental setup, plants of similar nature were placed in conical flasks containing varying concentrations of the analyte in a hydroponic solution and observed for two weeks. Then the plant materials and the solutions were digested and analyzed using FAAS.

The two experimental plants *Wedelia* sp. and *Colocasia* sp. have not proven to be suitable candidates for Cd²⁺ phytoextraction. The maximum tolerable Cd²⁺ concentration for *Wedelia* sp. was 450 mg per 1kg of dry soil while that for Pb²⁺ was 1500 mg kg⁻¹ (after 60 days in soil). This shows that the toxicity of Cd²⁺ on the *Wedelia* sp. is higher than the Pb²⁺ toxicity on the same plant. At 450 mg kg⁻¹ concentration in soil, phytoextracted concentration of Cd²⁺ was 8.1(±0.4) mg kg⁻¹ while that for Pb²⁺ was 128.9(±4.6) mg kg⁻¹. The maximum Cd²⁺ concentration which was tolerated by the *Colocasia* sp. was less than 10ppm and survived less than a week in hydroponic solution.

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Bioaccumulation capacity assessment for lead uptake by Azolla sp

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Heavy metals pollution represents an important environmental problem due to toxic effects of metals and their accumulation throughout the food chain leading to serious ecological and health problems. Unlike organic pollutants, heavy metals are not degraded through biological processes. Traditional technologies for the removal of heavy metal are often ineffective and/or very expensive when used for the removal of heavy metal ions to very low concentrations. Plants based bioremediation technologies have recent attention as strategies to clean up contaminated soil and water.

The objectives of the research presented in this paper were to determine

- the effect of the strength of the ambient nutrient solution for uptake of Lead by Azolla sp – Nutrient analysis.
- the capacity for Lead uptake by Azolla sp – Capacity assessment.

In the nutrient analysis, plants were exposed to nutrient solution at different strength and with varying Pb concentration. To estimate the capacity for lead uptake by Azolla sp, the plants were exposed to different concentration of Pb at 10% Hoagland nutrient solution. Pb uptake was analyzed in the plant bio mass using Atomic absorption spectrometer.

In nutrient enriched environments, the bio-availability fraction of metals may be reduced as a result of binding to nutrient anions. The uptake of heavy metals in plants may be affected by competition, since nutrient captions compete with metals for uptake sites. In the present study, at 10% nutrient, Azolla sp showed toxic symptoms due to high uptake of Pb with increasing concentration of Pb. In capacity assessment, Relative Growth decreased significantly with increasing concentration of Pb. However, Pb uptake increased significantly with increasing concentration of Pb. Azolla sp. showed highest absorption (11000 mg/kg) at 12 ppm of Pb solution.

Bio Concentration Factor (BCF) is the ratio of metal concentration in the dry plant biomass to initial concentration of metal in the feed solution which evaluates the ability of plants to accumulate heavy metal. At low Pb concentration (1.5-3.5 ppm) the BCF was a little under 1000. It was more than 1000 at around 5-7.5 ppm Pb. For Phytoremediation, a good accumulator should accumulate the elements with a BCF >1000 in its tissue.

High concentration of available nutrients mitigates Pb toxicity on Azolla sp. Pb uptake is high at low nutrient concentrations in the ambient solution. Above results indicate that Azolla is a potential candidate for removal of Pb at low concentrations (5-7.5 ppm) in waterways polluted with effluents.

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Chromium removal by non-living biomass of *Cabomba* sp. - A kinetic and equilibrium study

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Chromium is found in effluents from electroplating, leather tanning and textile industries, chiefly as Cr(VI), which is toxic and mutagenic for most organisms. Consequently, removal of Cr(VI) from industrial wastewater is of great importance.

Several chemical procedures based on reduction and precipitation and ion exchange processes are known, though with limitations due to handling of large volumes of aqueous solutions of colloidal chromium hydroxide and high cost. Removal of Cr(VI) from water using adsorption by activated carbons, prepared from different sources, is considered cheap.

Previously, we reported the study of use of non-living biomass of *Cabomba* sp. to remove chromium from aqueous solution. We present here, the kinetic and equilibrium studies on biosorption of Cr(VI) by non-living biomass of *Cabomba* sp.

Kinetic studies were carried out to determine the time required for Cr(VI) binding process to reach equilibrium. The dry mass was exposed, in triplicate, to varying Cr(VI) solution. Upon equilibration, solutions were filtered and the filtrate was analyzed for chromium by Atomic Absorption Spectrometer.

This work shows that biosorption is a complex process involving first and second order kinetics. Results from adsorption studies indicated that uptake of Cr increased with increasing concentration of test solution. The system obeys chemisorption and Freundlich isotherm relationship for Cr adsorption by *Cabomba* sp.

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Moss (*Barbula* sp.) as a bioindicator to monitor heavy metal air pollution: Comparison of native moss and moss bag technique

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Biomonitoring techniques using moss (*Barbula* sp.) as a bioindicator have been used to examine heavy metal deposition in local areas and around point sources. We sought to determine the efficacy of moss bag technique and native moss method against bulk deposition to determine heavy metal air pollution. Atmospheric heavy metal deposition was determined around the industrial area of Sapugaskanda which includes an oil refinery, an industrial zone and three power plants; Sedawatte which has the influence of Kalanitissa power plant and Dalugama University premises which close to the A1 road. Heavy metals (Pb, Ni, Cu, Cd and Cr) were determined by Atomic Absorption Spectroscopy (AAS) during six months of period from October 2007 to March 2008.

Heavy metal concentrations measured in three sampling sites during six months of period is given in μg/g dry weight of moss sample in native moss and moss bag technique. Concentration of heavy metals in bulk collector is expressed in μg/cm² area of the funnel. Dry weight of moss in unit area was used to bring these results into a common unit. A hypothesis was developed according to the equality of population variance of results in two methods and the corresponding significant levels (α value-probability of making a decision to reject the null hypothesis when the null hypothesis is actually true) were obtained from the F distribution table to compare native moss method and moss bag technique with bulk deposition method. The results indicate that the moss bag technique is most suitable to monitor heavy metal air pollution than the native moss method when compared with the bulk deposition method.

<table>
<thead>
<tr>
<th>Metal</th>
<th>Comparison between two methods</th>
<th>α value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pb</td>
<td>Native moss (<em>Barbula</em> sp.2) - Bulk deposition</td>
<td>0.0004</td>
</tr>
<tr>
<td></td>
<td>Moss bag (<em>Barbula</em> sp.2) - Bulk deposition</td>
<td>0.0003</td>
</tr>
<tr>
<td>Ni</td>
<td>Native moss (<em>Barbula</em> sp.2) - Bulk deposition</td>
<td>0.3663</td>
</tr>
<tr>
<td></td>
<td>Moss bag (<em>Barbula</em> sp.2) - Bulk deposition</td>
<td>0.1435</td>
</tr>
<tr>
<td>Cu</td>
<td>Native moss (<em>Barbula</em> sp.2) - Bulk deposition</td>
<td>0.1679</td>
</tr>
<tr>
<td></td>
<td>Moss bag (<em>Barbula</em> sp.2) - Bulk deposition</td>
<td>0.0267</td>
</tr>
<tr>
<td>Cr</td>
<td>Native moss (<em>Barbula</em> sp.1) - Bulk deposition</td>
<td>0.2379</td>
</tr>
<tr>
<td></td>
<td>Moss bag (<em>Barbula</em> sp.1) - Bulk deposition</td>
<td>0.1629</td>
</tr>
<tr>
<td>Cd</td>
<td>Native moss (<em>Barbula</em> sp.1) - Bulk deposition</td>
<td>0.0978</td>
</tr>
<tr>
<td></td>
<td>Moss bag (<em>Barbula</em> sp.1) - Bulk deposition</td>
<td>0.0257</td>
</tr>
</tbody>
</table>

Table 1 Statistical results for two methods compared with bulk deposition

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Synthesis, characterization, and metal adsorption of Tannin Phenol Formaldehyde Resins obtained from flower buds of *Terminalia turbula*.

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Tannin was extracted using different solvent/solvent systems from flower buds of *Terminalia turbula*. They were polymerized with phenol and formaldehyde to form Tannin Phenol Formaldehyde (TPF) resins of different molecular structure. The resins obtained were sulfonated using concentrated H$_2$SO$_4$ acid and were converted to Na$^+$ form. The resins obtained were characterized by using FTIR Spectroscopy. Ion exchange capacity of both TPF and sulfonated TPF were estimated for bivalent cations Zn$^{2+}$, Pb$^{2+}$, Ca$^{2+}$, Mg$^{2+}$ and Cu$^{2+}$ using their Na$^+$ forms in burette type exchange columns. FTIR results show the successful formation of TPF, sulfonation of them and complexation with the metal ions.

The ion exchange capacities of TPF resins formed were weak due to weak acidic character of phenolic groups attached to the resins. The sulfonation increased the ion exchange capacity of the resin significantly. The resin that contains tannin: phenol ratio 1:0.5 gave the highest exchange capacity (e.g. 0.105 Cmmol/g for Pb$^{2+}$). The capacity was increased by nearly three times in its sulfonated form (e.g. 0.305 Cmmol/g for Pb$^{2+}$). As the capacities obtained for sulfonated TPF resins are about fifty percent of capacities of commercially available resins, it can be concluded that they can be used as ion exchange resins made using locally available renewable resources.

Financial assistance by NSF (Grant No: RG/2006/EB/04) is highly acknowledged.

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Quality improvement of locally available calcite for paint industry

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Calcite (CaCO₃) is one of the commonly used extenders in paint industry. Though calcite is readily available in Sri Lanka imported calcite is preferred over the local form since it gives a better gloss finish in paint productions.

This study focuses on investigation of improvement of quality of local calcite to promote use of locally available calcite in Sri Lankan paint industries. Initially the crystal structure, particle size and percentage purity of the local and imported calcite, which are commonly available in Sri Lanka, were studied.

The samples were characterized using Powder X-ray Diffraction(PXRD), Fourier Transform Infra Red spectroscopy(FTIR), Chemical Analysis and Light Scattering, Particle Size Analysis Techniques.

PXRD confirmed that both imported and local mineral have the same crystal structure which is similar to that is reported for pure calcite in ICDC (database of inorganic crystal structures) database. This observation suggests that there is no solid solution formation with MgCO₃ or other mineral in the locally available calcite forms. However, chemical analysis confirmed that there is a small percentage of MgCO₃ in the local calcite compared to the imported material, which was under the detection limit of PXRD. The particle size distributions of both types of calcite were studied using particle size analyzer and light scattering experiments. These techniques provided consistent particle size distribution, where the local form contained a wide range of particle size distribution (0.4 µm – 9 µm) compared to the imported form, which has approximate particle size of 3 µm.

Attempts were also made to remove impurities in local calcite using sodium lauryl sulphate, and the method successfully removed most of the impurities present in the sample.

Further attempts were made to coat the local calcite, with commercial dispersion agent (Tamol), which gave an improved gloss finish to the local calcite.

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Study of antinociceptive and sedation activity of a novel class of vesicular monoamine transporter inhibitors in rats

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The pharmacological characteristics of a novel vesicular monoamine transporter (VMAT) inhibitor, '4-phenyl-1-(2-phenyl-allyl)pyridinium bromide', has been explored in this study to understand the in vivo mechanisms of action of APP-MPP⁺ conjugates. A convergence synthesis of 4-phenylpyridine and α-(bromo)methylstyrene was carried out and finally combined to yield the APP-MPP⁺ conjugated inhibitor.

Male albino rats were orally administered with different doses (12.5, 25, 50 mg/kg) of the drug and the reaction times on hot-plate and tail flick tests were recorded. In the hot-plate test significant (p < 0.01) increment in the reaction time of rats at 1 h and 2 h was evident, while the tail-flick test failed to induce a significant prolongation. The antinociceptive effect (analgesic) was dose dependent, with an EC₅₀ value of 23.5 mg/kg. In the hole-board test, the mid dose of the drug significantly impaired the number of crossings (by 48%, p < 0.005), rearings (by 25%, p < 0.02), head dippings (by 40%, p < 0.02) and the dipping time (by 64%, p < 0.005). These effects were also dose dependent. These effects were genuine and not false positive results arising from impairment of muscle strength and coordination (as judged by bar and bridge tests respectively), or hypothermia (as judged by rectal temperatures). Membrane stabilization effect was absent under the doses tested (0.01, 0.02, 0.04 mg/mL). The drug induced antinociception was not blocked by atropine, but was blocked by metoclopramide, indicating a D₂ receptor mediation of action. These results correlate with previous findings that APP-MPP⁺ conjugates are monoamine transporter inhibitors. This possibly indicates the inhibition of the dopamine transporter (DAT) and to an increase of dopamine in the synaptic cleft, inducing analgesia. Even the high dose of the drug was well tolerated. Since this compound has promising sedative and analgesic potentials, it is concluded that APP-MPP⁺ compounds could be developed in to a novel class of drugs to effectively treat various neurological and physiological disorders, provided that neurotoxicity is ruled out.

Financial assistance by the National Science Foundation (grant No. RG/2005/FR/08) & Departments of Chemistry and Zoology, University of Colombo is acknowledged.

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Comparative study on analysis of sucrose content in food

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Sucrose is one of the commonly use sweetener in various food and often used in milk based food products such as ice cream. Most of ice cream products contain approximately 13 % of sucrose by w/w. Sucrose is an easily assimilated macronutrient that provides a quick source of energy to the body, provoking a rapid rise in blood glucose upon ingestion.

Overconsumption of sucrose has been linked with some adverse health effects. When a large amount of foods that contain a high percentage of sucrose is consumed, beneficial nutrients can be displaced from the diet, which can contribute to an increased risk for chronic disease. It has been suggested that sucrose-containing drinks may be linked to the development of obesity and insulin resistance.

Therefore, it is essential to determine sucrose content in foods before using for human consumption. Fehling’s method, Ferricyanide method and Dinitro salicylic (DNS) based spectrometric method are used as common analytical methods to determine sucrose content in various foods. Fehling’s method and Ferricyanide method is suitable for the food sources if they do not have any colour. The accuracy of the results also vary from individuals depend on the ability to detect the end point of the titration. In this article, we have reported the use of these three methods for comparative study to determine sucrose content in food taking ice cream as a source.

Our results show that all three methods produced close results in ice cream samples tested so far. Out of three methods which were applied in this study, spectrophotometric method is a simple, an economical and a fast method. Results obtained by titrmetry and spectrophotometry perfectly agreed with the actual content of sucrose in ice cream samples. The actual sucrose content of ice cream samples were conformed by consulting manufacture. Results are tabulated in table 1.

<table>
<thead>
<tr>
<th>Ice cream</th>
<th>%Sucrose by Fehling's reagent</th>
<th>%Sucrose by DNS based Spectroscopic Method</th>
<th>%Sucrose by Ferricyanide method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vanilla flavored</td>
<td>12.92</td>
<td>13.06</td>
<td>13.04</td>
</tr>
<tr>
<td>Strawberry flavored</td>
<td>_____</td>
<td>14.10</td>
<td>13.94</td>
</tr>
</tbody>
</table>

Table 1: Percentage of sucrose in ice cream samples.

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Cloning of STH2 gene, to transform Bg 360 and Bg 250 Sri Lankan rice varieties

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Arabidopsis STH2 is identified as a positive regulator of light signaling pathway. It is a protein that containing tandem repeated of Zn$^{+2}$ binding B-boxes and interacts with bZIP transcription factor HY5. The HY5 which acts downstream of the several photoreceptors, is a positive regulator of light signaling pathway. In the dark HY5 activity is negatively regulated by COP/DET/FUS mediated degradation of the HY5 protein. The STH2 protein in Arabidopsis activates transcription and positively regulated light mediated development in plants by interacting with HY5 and COP1. The HY5 promotes the expression of light regulated genes such as ribulose-1, 5-bisphosphate carboxylase/oxygenase (Rubisco), which catalyses an important step in photosynthesis. Therefore the STH2 might act as a cofactor for HY5 that activate transcription of photosynthesis genes resulting high productivity in crop plants. To test this hypothesis we are intended to over express the STH2 gene in Sri Lankan rice varieties. In order to transform the rice plants with STH2 gene, in this study we have taken an attempt to clone the STH2 gene from its BAC clone F10A5 to pCAMBIA 1303 binary vector. The F10A5 clone was digested with Mfe1 and Xho1 restriction enzymes. The STH2 gene (9.5 kb DNA fragment) was cloned into pBSK+ vector. The STH2 pBSSK+ clone was then digested with Pst1 and Kpn1 and the STH2 gene (7.5 kb DNA fragment) was cloned into the pCAMBIA 1303 binary vector. This recombinant plasmid construct will be used to transform Agrobacterium GV3101 in order to carry out the Agrobacterium mediated transformation of the two rice varieties.

Acknowledgement:
We acknowledge the financial support from NSF grant RG/2007/BT/09

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Investigation to increase the sensitivity of vanadomolybdophosphoric acid method used for colorimetric determination of phosphate

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The determination of phosphate by the vanadomolybdophosphoric acid colorimetric method is very selective. However, the sensitivity of the method is very low, as such there is a need to increase sensitivity.

Since it is very selective, sensitivity of this method was found to be increased with use of N-benzoylphenylhydroxylamine. It has now been observed that the addition of NBPHA to vanadomolybdophosphoric acid forms an intensely colored complex possessing an absorption maxima at 444 nm.

This system obeys Beer’s law at 444 nm up to the concentration of phosphorus 2.0 mg dm$^{-3}$. The molar absorptivity at 444 nm was $8.0 \times 10^3$ cm$^{-1}$ mol$^{-1}$ dm$^3$. The minimum detection limit lies in the region to 0.015 mg dm$^{-3}$.

Considerable amounts of cations and anions including a 25 fold molar excess of nitrate, a 34 fold molar excess of nitrite, a 37 fold molar excess of fluoride, a 24 fold molar excess of sulphate, a 0.4 fold molar excess of iron(II), a 2.2 fold molar excess iron(III), a 103 fold molar excess of calcium and a 172 fold molar excess of magnesium could be tolerated. Interference from iron(II) could be overcome up to a 2.2 fold molar excess of iron(II) by converting iron(II) to iron(III) using hydrogen peroxide.

The proposed method was successfully applied to determine the phosphate content (less than 2.0 mg dm$^{-3}$) in a sample of potable water.

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Characterization of biological activity of *Flueggea leucopyrus* Willd. (katupila)

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*Flueggea leucopyrus* Willd. is a medicinal plant used for the treatment of many diseases including cancer in the Ayurvedic system of medicine. The present study was carried out to investigate the cytotoxic and antioxidant properties of the aqueous extracts of leaves and stem of the plant. Brine shrimp bioassay was used to study the cytotoxic properties of the plant. The crude extracts of leaves and stem did not show cytotoxic activity (IC₅₀ >30 μg ml⁻¹) in the brine shrimp bioassay.

The aqueous extracts of leaves and stem were investigated for their total phenolic content and antioxidant properties. The leaves and stem extract contained a total phenolic content of 18.12% and 12.08% w/w of gallic acid equivalents respectively. The free radical scavenging activity (DPPH assay) of aqueous extracts of leaves and stem were investigated and compared with ascorbic acid which was used as a reference standard. The DPPH free radical scavenging activity of the leaves and stem extracts showed IC₅₀ values of 8.08 and 17.56 μg ml⁻¹ respectively. The IC₅₀ value of ascorbic acid was 5.29 μg ml⁻¹. The Nitric oxide radical scavenging activity of the aqueous extract of the leaves and stem were also studied. The leaves showed concentration dependent NO radical scavenging activity at concentrations less than 5 μg ml⁻¹, giving IC₅₀ value between 1.7-2.1 μg ml⁻¹. The stem extract did not show any dose dependent relationship towards NO radical scavenging activity. According to the phytochemical screening results, alkaloids, leucoanthocyanins and tannins of the pyrogallol type are present in both the leaves and stem of the plant. The results obtained in the present study indicate that aqueous extracts of the aerial parts of *Flueggea leucopyrus* Willd. is a potential source of natural antioxidants. Antioxidants have also been reviewed for their possible role in the prevention of cancer. Hence the results obtained from this study could be used in the rationalization of ethnomedical use of the plant.

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Anti-oxidative activity of Pleurotus cystidiosus

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Antioxidants have been isolated from plants and fungi and they are mostly polyphenols and flavonoids. Ji-Kai Liu and his coworkers have reported the DPPH radical scavenging activities of ten natural \( p \)-Terphenyl derivatives obtained from three mushrooms indigenous to China. Curtisians A-D isolated from Paxillus crutissii have shown 10-20 times more antioxidant activities than that of vitamin E against lipid peroxidation. Betulinan A and B obtained from Lenzites betulina and hispidine derivatives obtained from Phellinus linteus mycelial culture broth have reported to have strong antioxidant activities. Pleuran (\( \beta \)-1,3-D glucan) isolated from Pleurotus ostreatus has also shown antioxidant activity. This study was carried out to investigate the antioxidant activities of the edible mushroom Pleurotus cystidiosus, commonly known as Abalone.

Compounds in fresh \( P. \) cystidiosus mushroom were extracted into acetone (A), dichloromethane (D) and hexane (H). Freeze dried extract A was fractionated using solvent extraction method to obtain A1, A2, A3 and A4 fractions. Fraction A4 was further separated into A4-1, A4-2 and A4-3 fractions using a reverse phase column. DPPH radical scavenging activity and nitric oxide radical scavenging activity were assayed for extract A and A4, A4-1, A4-2 & A4-3 fractions. All experiments were performed in triplicates. The respective EC\(_{50}\) values obtained for DPPH radical scavenging assay were 1.12 mg cm\(^{-3}\), 1.13 mg cm\(^{-3}\), 0.87 mg cm\(^{-3}\), 0.81 mg cm\(^{-3}\) & 0.82 mg cm\(^{-3}\) and EC\(_{50}\) values of nitric oxide radical scavenging assay were 4.81 mg cm\(^{-3}\), 3.82 mg cm\(^{-3}\), 5.38 mg cm\(^{-3}\), 0.87 mg cm\(^{-3}\) & 0.61 mg cm\(^{-3}\). EC\(_{50}\) value obtained for ascorbic acid in DPPH radical scavenging assay was 44.57 \( \mu \)g cm\(^{-3}\).

The antioxidant activity shown by the DPPH radical scavenging assay and nitric oxide radical scavenging assay indicates that fractions A4-2 and A4-3 to have the highest activity. We conclude that the polar aqueous fractions of \( P. \) cystidiosus contain the compounds having antioxidant activities and there exists a possibility to use such extracts as a food additive.

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Purification of $\alpha$-amylase from *Aspergillus* species

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There is a high demand for amylases in textile industry as a hydrolytic enzyme. In this study we have attempted to purify $\alpha$-amylase from *Aspergillus* species grown in starch medium. We have purified $\alpha$-amylase successfully using DEAE cellulose ion exchange chromatography. The enzyme elutes at 600 mM NaCl concentration and the yield is ~96%. The molecular weight of purified $\alpha$-amylase is 54 kDa. The activity of the purified enzyme was determined by the Dinitrosalicylic acid colour reagent (DNSA) assay. The enzyme was most active at pH 5.0–6.0 toward soluble starch and stable is relatively thermostable with an optimum temperature of 60 °C. Further we have investigated other carbohydrate sources such as manioc (*Manihot esculenta*) to study the viability of scaling up this method for industrial scale production.
Xylanase from *Bacillus pumilus* by solid state fermentation using local carbon and nitrogen sources

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The aim of this work was to optimize the cultivation conditions and the media to produce xylanase by solid state fermentation of *Bacillus pumilus*, using paddy husk as the support. Solid medium was prepared by mixing 200g of paddy husk with 800mL of liquid fermentation medium, containing (gL⁻¹) xylan, 20.0; peptone, 2.0; yeast extract, 2.5; K₂HPO₄, 2.5; KH₂PO₄, 1.0; NaCl, 0.1; (NH₄)₂SO₄, 2.0 and CaCl₂·2H₂O, 0.005; MgCl₂·6H₂O, 0.005; and FeCl₃, 0.005.

Production of xylanase activity started on the 2nd day and the highest activity (141.96 Ug⁻¹DM) was obtained on the 6th day at room temperature at pH 9.0. When paddy husk to liquid fermentation medium ratio was optimized as 2:9, xylanase activity was increased by 1.04 times than the control which contained the husk to liquid medium ratio 2:8 at pH 9.0. When the culturing temperature was optimized at 40°C, xylanase activity was increased by 1.10 times than the temperature non optimized condition. When commercial Birch wood xylan was replaced with different concentrations of corn cob, xylanase production was increased. Highest xylanase production (224.18 Ug⁻¹DM) was obtained in the medium containing 150 gL⁻¹ corn cob at pH 9.0 and 40°C. Xylanase production was supported by sucrose (248.23 Ug⁻¹DM), fructose (235.54 Ug⁻¹DM) and arabinose (286.42 Ug⁻¹DM), while the enzyme production was reduced by glucose (212.42 Ug⁻¹DM), galactose (195.95 Ug⁻¹DM), lactose (207.29 Ug⁻¹DM) and amylose (213.95 Ug⁻¹DM) than in the control which contained no sugar (222.56 Ug⁻¹DM). When organic nitrogen sources were replaced with locally available nitrogen sources such as ground nut powder or sesame seed cake powder or coconut seed cake powder or soy meal powder, highest xylanase production (290.66 Ug⁻¹DM) was obtained in the medium containing soy meal powder. When different concentrations of soya meal powder were added to the optimized medium, highest xylanase production (326.45 Ug⁻¹DM) was obtained in the medium containing 16 gL⁻¹ of soy meal powder. Based on the optimization of the culture conditions, the xylanase production by *Bacillus pumilus* was increased by 2.29 times than that of the initial non-optimized condition.

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SECTION F

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Adoption of HACCP in dairy processing sector in Sri Lanka: Do firms act voluntarily when regulation is ill-defined?

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The food economic literature suggests that there are three elements that motivate firms to adopt a system of HACCP, i.e. market forces, food safety laws and regulation and product liability laws. The purpose of this study was to explore extent to which 10 different individual incentives generating from these 03 elements have an impact on the decisions of dairy processing firms in Sri Lanka to adopt a system of HACCP. Face-to-face interviews with HACCP coordinators / quality assurance managers / owners of 34 dairy processing firms operate in the Western, North Western, Central, North Central and Southern Provinces in Sri Lanka from July to August 2007 were used to collect data. These firms were categorized into two major groups: (1) “adopters” (i.e. those who possess a fully operational system of HACCP (21%) or in the process of implementing it (9%), and (2) “non-adopters” (70%). The data were subjected to the Confirmatory Factor Analysis techniques, including: (a) Scale Reliability using Cronbach Alpha; (b) Unidimensionality through Principal Axis Factoring, and (c) Construct Validity by constructing an MTMM matrix. It helps to derive Mean Scale Values for the 10 individual incentives for both adopters and non-adopters. The results highlight that both groups consider that “product liability laws” and “existing government regulations” motivate these firms’ decisions towards HACCP where the Mean Scale Values obtained by the adopters were greater than that of non-adopters. The least important incentives for adopters were “financial implications/costs” and “sales”, and for non-adopters was “commercial pressure”. On the contrary, “financial implications/costs” acts negatively on non-adopters’ decisions. The outcome of analysis, as a whole, suggests that dairy processing sector in Sri Lanka, in contrary to that in the developed countries such as Australia, Canada, the UK and the US, does not possess strong market-based incentives to adopt a system of HACCP, thus the voluntary/private action of firms towards adoption of HACCP is not significant to date.

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Tracer study of school leavers of the G.C.E. Advanced Level science stream

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From time to time, since in the past, there have been many Educational Reforms introduced in to the National Education system of the country. The Educational Reforms of 1997 that was introduced to the G.C.E. Advanced Level school curriculum is one such example. Major features of these reforms are reducing four main subjects into three, introducing Common General Paper and General English Paper, Compulsory Practical Work, School Based Assessments, Research Projects, and z-score based university admission. The present study was aimed at finding out the prospects of the Advanced Level science stream school leavers with special reference to the employability. For this purpose, a sample of 1500 science students who had followed the Advanced Level and left school after 2000, were selected in the Central, North-Western, Northern and Eastern provinces including different nationalities, family backgrounds, geographical backgrounds, schools in different locations (urban, semi-urban, rural, and disadvantaged areas) by considering the time limitation, financial constraints, data collecting difficulties.

A postal questionnaire survey was conducted to collect data followed by direct interviews for further clarifications and conformity of same. Analysis of data revealed that, about 80% of the school leavers of G.C.E. Advanced Level science stream were involved in higher education including other professional and vocational training courses. About 40% of them were already employed, while 58% were not employed and 2% were not keen to do a job. Among the employed, 43% were in the government sector, 41% were in the private sector, and 16% were in other sectors (NGOs). According to this study, there was no considerable correlation between performance of the grade five scholarship and G.C.E. O/L. However, there was a considerable correlation between G.C.E. O/L and G.C.E. A/L performance. In the Biological science stream, females performed better, while in the Physical science stream, males performed better. Major reasons influenced the unemployment were low standard of English, lack of knowledge in Information Technology, poor performances at Advanced Level, and absence of opportunities in the field of specialty due to the mismatch between the supply and demand of the job market. Majority agreed with the Compulsory Practical Work, General English Paper, and General Information Technology at G.C.E. A/L introduced in the Reforms, while many disagreed with the introduction of research projects and Z score based university admission.

Most of the employers were willing to recruit A/L/ school leavers with science background stating that their work is methodical and they have better analytical skills compared to the students in other streams. There was a considerable demand for science qualified personnel in other fields, such as Information Communication Technology, Management and Business Administration.

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Behaviour patterns of chronic kidney patients in North Central province of Sri Lanka

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North Central Province (NCP) is a major part of the dry zone of Sri Lanka. An increasing trend in admission of patients with renal diseases to hospitals is shown in Anuradhapura, Polonnaruwa, Monaragala and Badulla administrative districts. In NCP itself, over 5,000 patients are on treatment for Chronic Kidney Diseases (CKD) with unknown etiology. Hence a survey was conducted to collect information related to socio-economic factors and behaviour patterns of the patients who attending the renal clinics in Anuradhapura and Madawachchiya hospitals. The total number of patients questioned was 240 and they were found to be suffering from early stage of the disease.

According to the results 89% of the patients who participated in the survey are farmers and their helpers. The age group of patients is the other most significant finding. That is 61% of the total patients are in the age between 30 and 60 years. This shows that unidentified factors related to CKD are not suddenly affected the individuals. They are functioning or accumulating in the human body for a long period of time. The survey showed that exposure to agrochemicals including chemical fertilizers, insecticides, herbicides and fungicides is common for 55% of the CKD patients. Of the patients 69% do not consume alcohol but most of them have stopped consuming alcohol after the CKD symptoms appeared.

It also showed that the prevalence of the disease is more common in males (69%) than in females and 93% of the patients use groundwater for the drinking and household purposes.

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Application of Environmental Management Accounting (EMA) for crepe rubber manufacturing industry in Sri Lanka

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Environmental management accounting is a cost effective tool used for identifying the environmental costs incurred at factories which are not normally recorded under conventional accounting systems. In the absence of EMA, most of the environmental costs incurred by factories are usually allocated to overhead accounts. In the absence of actual environmental costs incurred at the industry, industrialists are always failing to apply pollution prevention strategies for their industrial premises. Therefore the objective of this study is to calculate the environmental costs of three different crepe rubber factories.

The selected crepe rubber factories were Millewa, Dartonfield and Kiriporuwa. In order to identify the environmental costs, secondary data sources such as company annual accounting records as well as other type of data collected by material balance were used as primary data. Conventional environmental costs were calculated without using EMA and then actual environmental costs were calculated using EMA.

When comparing the annual environmental costs per unit product, the environmental costs obtained with EMA were appeared to be relatively higher than those costs obtained using conventional accounting system. For example, the annual per unit costs at Dartonfield which is of Rs. 6.46 kg⁻¹ was increased up to Rs. 8.85 kg⁻¹ under EMA.

After applying EMA for factories, the environmental costs of all three crepe rubber factories were higher than those costs obtained before applying EMA. It implies that the tool of EMA provide means of identifying and investigate those costs which are hidden in general accounts where normally not investigated with the use of conventional accounting. Therefore, EMA is a more appropriate tool for calculating environmental costs of industries.

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Contribution of intercropping and cover crops for large scale rubber plantations: Economic analysis

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Intercropping maximizes land use efficiency and this could be considered as an important option for large scale rubber plantation in Sri Lanka. However, at present, except for a few plantation companies, intercropping on rubber lands is generally confined to the smallholder sector and mainly to the immature phase of growth. Cover crops can significantly control soil erosion, during the early stage of growth and could enhance soil fertility in rubber plantations. However, application of such practices is still not widespread and demonstration of such benefits in economic terms is a strongly felt need. The present study therefore intends to identify best intercrop and the cover crop among the available options and test the economic viability for a large scale rubber plantation with extent of 219.6ha.

Three intercrops (cocoa, coffee and pepper) and two ground cover options (Mucuna bracteata with paddy straw mulching and Crotalaria anagyroides with its lopping leaves as mulch) were selected for the study. Data related to these practices were collected from smallholders in Kalutara and Colombo districts during December 2007 to April 2008 regarding costs and revenues related to the selected practices. Other relevant data were obtained by expert opinion surveys, market surveys and secondary sources. Finally, cost benefit analysis was carried out for each practice and net present values (NPV) were calculated considering 30 year time horizon and 10% discount rate.

According to the results, cocoa was identified as the best inter crop with NPV of Rs 235 million and Crotalaria anagyroides tree legume cover as the best ground cover with NPV of Rs 25 million. The results will provide important guidelines for the intercropping of both small holdings and large scale plantations.

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A study on harvesting behavior of clove

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Clove is a perennial spice crop mainly grown in central highlands of Sri Lanka. It is a traditional export commodity and Sri Lanka exported 2435.1 mt of clove in 2006 valued at Rs. mn. 1265.4. Clove is largely grown as a home garden crop and harvesting is the only costly operation which needs skilled labor. To minimize harvesting cost clove farmers have adopted different strategies and the objective of this paper is to aware the harvesting and processing practices adopted by farmers. A survey was done in 2008 March in six villages of Kandy district and data was collected from a purposely selected sample of 85 farmers.

Clove harvest comes during February-April and the yield is an unopened flower bud which arises from the tips of side branches. Bunches of unopened buds with flower stems and two leaves are picked, remove leaves and stems and sun dried. For those operations farmers have adopted different practices. In the sample (1) 02 farmers harvested only by them selves (2) 02 had paid daily wage (3) 05 farmers had paid per kg of clove with leaves and stems (4) 09 farmers had paid per kg of clove with stems (5) 22 farmers had paid per kg of cleaned clove and (6) 12 farmers had leased their crop. Also (7) 11 farmers had practiced combination of 1st and 5th methods (8) 04 farmers had practiced 1st and 4th methods and (9) 03 farmers used 1st and 2nd methods. It was found that a laborer could harvest 20-30 kg of cloves per day with leaves and stems, 15-25 kg of clove only with stems and 15-25 kg of cleaned cloves. Payments for harvesting of kg of clove with leaves and stems was 40-50 rupees while the same for kg of clove with stems and kg of cleaned clove ranged from 50-60 and 70-80 rupees respectively. Therefore average labor earnings from clove harvesting varied from Rs. 1000-2000 per day and it was higher than a normal market wage rate. When clove is harvested with leaves and stems additional labor is required for cleaning and mostly the family labor was used by small holders. In large holdings, women were paid Rs. 30-40/kg to remove leaves and stems and an average worker had cleaned 2-4 kg/day. When leased, buyers of raw crop had employed outside laborers or done the job by them selves. In the second method pickers had earned much higher profits than they earn from laboring. Drying was largely done by the family labor and when employed they were paid on daily basis or per kilo basis. Harvesting cost had accounted half of the raw price of clove which ranged from Rs. 155-175/kg. To fulfill high liquid cash needs for harvesting some farmers had sold total harvest or part of their harvest. Study concluded that harvesting is a costly operation and more efficient and cost effective method must be invented for clove harvesting.

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Evaluation of methods of processing of kitul (Caryota urens) jaggery in Sri Lanka

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Sap of Kitul is obtained by tapping a young inflorescence. The end product of boiled sap is jaggery. The objective of the study was to make a comparative study on the existing processing techniques of jaggery in Sri Lanka to identify their weaknesses and strengths to recommend a suitable method. The study was conducted in Kotmale in mid country of Sri Lanka during the first quarter of 2006. Four ways of jaggery making and selling were identified in the area. The most frequent way was the processing of jaggery at cottage level and selling them in the village itself to the needy customers. In the second method, processing was done individually as described above whereas selling was done under one brand. In the third method treacle was collected from the cottage level processors and reprocessed into jaggery by adding excessive quantities of cane sugar to sell in urban areas. The fourth way of processing was done at a processing center in a mass scale, after collecting sap from identified tappers. Twenty individual processors at the cottage level, 20 processors who sold their products under a common brand name, three mass scale processing centers and one reprocessing center were selected for the study.

Product variation was a common feature of the individual processing at cottage level owing to adoption of inconsistent processing techniques. The different types of fuel wood were used for direct boiling the sap. Therefore, contamination with smoke and ash was possible. Boiling temperature, time and length all found to be varied and the jaggery product derived at cottage level was inconsistence with respect to taste, color and texture. The adulteration could be ranged from 50-90% of sugar in the reprocessing method and the consumers were deceived. The most credible method of jaggery making was community processing due to the following advantages. The sap collection was organized. The basic quality parameters, such as smell, color, cleanliness, and specific gravity were assessed by a skilled person on purchasing and inferior quality sap was rejected. Prompt boiling was done using steam or LP gas and thereby contamination of product with smoke and ash was averted. This method can even be recommended to international market as the final product was adulterant-free ensuring consistent and hygienic quality product.

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Analysis of empowering workforce performance of sewing machine operators at an export oriented apparel factory

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The Sri Lanka garment industry has experienced phenomenal growth during the past twenty-five years and has emerged as a major contributor of the economy. The study focused on the performance of sewing machine operators. The training provided and the extent to which sewing machine operators are empowered were tested with their performances. The overall objective of the study was to analyze the improvement of the quality and efficiency level of the performance of sewing machine operators. Specific Objectives were to identify the standard skill profiles of sewing machine operators, to identify the increase of awareness level of sewing machine operators on quality and efficiency at work, to analyse the improvement of the multi skill levels of machine operators and to find out the improvement of quality and efficiency of production lines.

Two modules/production lines of a leading apparel manufacturing factory were selected for the study. Operators were exposed to training and practice of new techniques independently. Data collection was conducted by administering a Questionnaire. Key individuals were interviewed and observations were made to verify the findings. EXCEL computer packages was used for data analysis. Key variables were tested for relationships. Majority of the sewing-machine operators had awareness on achieving the planned efficiency. Almost half of them were aware of the methods which could be implemented to increase the efficiency of the module. Operators expressed their ability to perform multi-operations and half of the operators could perform three operations within the target standards. Majority of the respondents were confident of operating without supervision and they perceived to be highly satisfied in their jobs. The skills profiles of the sewing machine operators had increased considerably and majority were aware of the quality aspects at work. Operators had shown improvement in efficiency and standards of performances. Understanding of the quality and efficiency concepts at work had facilitated their progress. Machine operators could be empowered by giving responsibilities and comprehending on related activities, targets and goals. It could be concluded that acquiring of multi-skills levels had contributed to the empowerment of operators had increased the overall performances.

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Assessments used in GCE Advanced Level Chemistry classrooms

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As learning of abstract concepts in chemistry is problematic for many students they tend to make efforts in earning good grades by rote learning. Seeking alternative ways to promote meaningful chemistry learning and critical thinking of students to solve many problems that exist around us with an understanding of chemistry is a necessity. Using multiple ways of assessments help students build up chemistry concepts that will help them in future use. The purpose of this study was to explore how chemistry teachers use assessments as a tool in their classrooms to facilitate students’ chemistry learning.

This study was conducted in Kandy and Matale districts with fifty chemistry teachers selected by stratified random sampling. The sample consisted of teachers from three media of instruction, English, Sinhala and, Tamil. An open-ended questionnaire with questions on different types of assessments was administered to all fifty teachers followed by in-depth individual interviews. At these interviews, in addition to the questions in the interview guide, teachers were also provided with their responses to the questionnaire to receive more elaboration and explanation to what they have written. Interviews were tape recorded and transcripts were made. Six classrooms (including two from each medium) were also observed paying attention to practice of assessments. Data gathered from the open-ended questionnaire, interviews and observations were triangulated in the analysis.

It was found out that although the teachers expressed that classroom assessment is important as a part of instruction to support and enhance learning they showed minimal in-depth knowledge and understanding of various ways of doing assessments to help students’ learning. This was partly due to the limited content and pedagogical knowledge. They have not used a variety of assessment techniques, strategies and tasks paralleling their conception of classroom assessments. As a result classroom assessments took a summative evaluative function rather than a formative assessment with feedback to students. It was revealed that teachers wanted to make their students as best fits to the G.C.E advanced level public examination and prioritized learning chemistry by asking questions in their classroom teaching focusing on past papers. It is recommended to provide professional development opportunities for chemistry teachers. The study provides an impetus for further and much needed study of teacher conception of assessments and teachers assessment practice in chemistry education.

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Use of team incentive as a tool of motivation in a production environment

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The organisation selected for the study is a major apparel manufacturer which produces and exports lingerie, hosiery and beachwear for women, men and children mainly to the European market. It practices the modern operating system called the modular production system that has compact work teams, flexible work groups and self directed work teams. Operators are expected to function as a team in this operating system. The overall objective of the study was to analyse the use of team incentive as a tool of motivation in a production environment. Specific objectives of the study were to identify the tools of motivation, to assess the role of incentive as a motivational tool, to analyse the effectiveness of team incentive in comparison to individual incentive and to make recommendations for the use of team incentive for improved performances.

Three teams were selected for the study based on stratified random sampling as per their performance levels. Performance levels were measured through secondary data. Performances of the thirty employees exposed to modular production system were measured as teams. Data collection was by administering a questionnaire and interviewing key individuals. Observations were made to verify the findings. EXCEL and SPSS computer packages were used for data analysis. Key variables were tested for relationships. Employees have identified nine motivational tools offered by the organisation and incentive played a major role in motivating workforce. Motivation through incentive has led to noticeable improvements in different facets of work. Employee satisfaction was perceived to be high as a result of higher admiration from team members, entitlement to team benefits and reduced job stress due to the helping hand of team members. Team incentive has played a major role for the overall improvement in efficiency and standards of performances. Team spirit was perceived to be high as a result of the monetary rewards associated with team performances. Among the many advantages the few drawbacks of team incentive included less admiration of star performers, difficulty of assessing individual performances and difficulty in identifying the responsible persons for defects in teams. Acquiring of multi-skills levels had contributed to the empowerment of operators and had increased the overall performances. Developing a star point scheme to encourage multi skill development and to link it with training and career development would improve quality and sustainability.

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A study of the effectiveness of household composting through an evaluation of ongoing composting programs

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This study was carried out to evaluate the effectiveness of three ongoing household composting programs in Sri Lanka. Major objectives of this study are to identify the drawbacks of household composting programs and to give necessary guidelines to improve the effectiveness of such programs. In order to collect the data for the given aims, first a questionnaire survey was carried out in three areas namely Katugoda and Magalle in Galle district and Bandiyamulla-East in Gampaha district where composting programs are implemented. A sample purposively selected households were used to take necessary data and observations (i.e. Educational level, monthly income, involvement of the program, Grade of separation, Grade of compost, type of waste inside the bin etc.). The evaluation of the programs was done by field observations, graphical analysis and MINITAB statistical software. The best program implementing area was selected by overall analysis of the data.

Being an owner of a house motivates people in making compost from the household waste as they own plant and flower beds in their land rather than a tenant. Household income level affects level of involvement in a household compost making program. Households with a high income levels are less likely to get involved in such a program. The separation of waste and collecting non biodegradable materials apart from the bin leads to make a good grade final compost product from the bin. One person involvement on dumping the waste into the bin makes the bin much free from non-degradable materials been added to the bin. Educational level does not influence the level of involvement in the program but on the grade of the compost. Bins being installed close to the house affect on making usable compost as the people are more likely to pay attention to the bin. Use of the labeled three bags for each category of recyclables makes the waste separation a successful exercise rather than using one separate bin for all type of recyclable materials.

With a high amount of good grade waste separation and good grade final compost products, Bandiyamulla-East area has the best program and their waste separation strategy has influenced on their success.

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The effectiveness of “Zakat” as a charity based supportive system for poverty reduction among Muslims in Sri Lanka

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The prevalence of poverty among Muslims is high though the Muslims constitute only 8% of total Sri Lankan population. Zakat is a charity based poverty reduction strategy that can be applied to reduce poverty among Muslims. Hence this study was carried out with objectives of assessing the effectiveness of Zakat contribution and to investigate the possible ways of developing Zakat as a supporting strategy in poverty reduction. This study was carried out in Kegalle district. Being a recipient of Zakat was the inclusion criteria. Data was collected using case studies, informal interviews and documentary analysis. The concept of Social Capital was applied to discuss the findings, as Zakat can be recognized as a form of Social Capital. The study revealed that provision of zakat to the needy has bridged the gap between the poor and others. The productive utilization of Zakat on initiating business and education has been helpful to overcome poverty. Unbiased selection of recipients, well organized nature of zakat distribution has made it more effective. The attitudes of the recipients of zakat varied depending on the level of education, the amount of zakat that they received their religious knowledge and the strength in religious belief. Some respondents had misused the amount that they received on unwanted activities such as consuming alcohol which is believed to be a sin according to Islamic interpretation. It is a significant observation that the majority of the Zakat recipients strongly believed that they should be able to contribute to Zakat in the next annual distribution than remaining as a recipient. Believing that poverty was a punishment given by Allah and he tests the faith (thakwa) of the religion, some respondents had become more religious than ever before. Encouraging the contribution, proper selection of eligible recipients, fair distribution and monitoring of effective usage of the Zakat through a properly established Zakat committee is recommended. Zakat should be recognized and incorporated as a supportive system for poverty reduction in national policy and programming. The government can mediate to get funds from Islamic countries by expanding the international linkages.

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Coping with the election violence: The case of a Sri Lankan Village

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Electoral Sociology is a sociological study of elections and voting (Unwinhyman Dictionary of Sociology 1995). This approach is employed to interpret Sri Lankan election violence. Asian politics in general and Sri Lankan elections in particular display a lot of violence when compared with western politics. With the introduction of party based political system in Sri Lanka, the antagonism among the parties has increased. Sri Lankan villagers have been divided on the lines of the political parties that they support. For whatever reason, Sri Lankan voters have been divided by the party system initially, and later people of the same party divided according to the candidate to whom they support under the preferential voting system. Gradually the politician too began to use various methods to win elections. Among them money, power, threats, intimidation, assault, etc. are very common.

The well-known Italian sociologist Vilfredo Pareto discussed the process of elite circulation which allows ambitious people to replace those who occupy elite positions currently. This would assure the socio-political stability of a country. However, we hardly see this theory validated in Sri Lanka as there is a lot of reported violence: post, pre and on the day of elections. When the ruling party estimates that it has no chance of winning it tends to use its terror machine in order to assure that its candidate wins.

On the one hand, the business community considers the election as a way of showing its gratitude to a party or politicians. On the other, it is an investment to get much benefit if the favoured candidate or party comes into power. Business community patronage has enhanced the capacity of the politician to mobilise thugs and put pressure on the voters.

Against this backdrop, a research was conducted by a team, including the author, in the District of Kandy between November and December 2007. The study has shown the various strategies of coping up with the election violence. The involvement of powerful politicians from outside areas plays a significant role in initiating electoral violence in villages. Moreover, it explains how the insiders justify it. The study shows that the villagers of both UNP and PA coped up with them. Factors such as caste, class, gender, relationship, matter very much in coping with election violence. People who belong to high caste, class were able to minimise the physical damage, while the others of the lower strata encountered both psychological and physical damage.

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 Awareness on biodiversity conservation among school children in Sri Lanka

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Conservation of biodiversity is of special significance to Sri Lanka (SL) which has now become a hot spot of the world. As recognized by the Convention of Biological Diversity, education, training and awareness play an important role in Biodiversity Conservation (BC). Incorporation of environmental education into National School Curricula has been an ideal way of encouraging positive thoughts of younger generation towards BC. The present study was aimed to identify whether school children were aware of the importance of BC, their first source of information on BC and the extent of participation in biodiversity related programmes. Further, the relationship between biodiversity education with the involvement of environmental activities, membership in environmental societies and students’ participation in workshops were also studied. The most effective mass media on biodiversity communication for school children in different districts of SL was also identified. Thirty Eight Sinhalese National Schools (SNS) from 19 districts out of 23 districts in which SNS have been established in SL were randomly selected. The survey was conducted using a questionnaire circulated among 456 school children between age groups 10-11, 12-16 and 17-18. According to a total of 253 responses (91, 86, 76 from age groups respectively) 100% of students were well aware of importance of BC. Students of 10-11 age group selected ‘school’ as the place from where they first received the message on BC even though only 69% of them learn environmental studies as a subject. Students of other two age groups identified ‘home’ and ‘parents’ as the first source of information. Although 80% of the schools had environmental societies, only 23%, 64% and 54% of students of age groups respectively, had participated in biodiversity related programmes. The students were mostly involved in BC programmes in school than home or in other environmental organizations. According to the Pearson’s Chi square test for relatedness (P ≤ 5%), the relationship between involvement of students on environmental activities did not depend on study of environment as a subject. Contribution for the BC had a significant relationship with students’ participation in workshops for the 12-16 age group. Being a member of an environmental society was not a significant reason. The most effective ways of gathering biodiversity information were the print and audio-visual media except in the 10-11 age group who preferred school to be the source. The study revealed that Sri Lankan school children have a good understanding on BC. We need to address and encourage adults especially the parents on conservation of biodiversity as they also provide the basic input of positive attitudes towards protecting our nature.

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A special bibliographical tool for the educational stakeholders with a special classification scheme

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Lacunae in the production flow circuit of educational information highlighted the necessity of exhaustive retrieval tools for the educational decision maker- specially the researcher and the administrator. In order to cater to the need of a chronologically continuous bibliographical tool for educational reports to bridge the primary gap of inaccessibility to existing information, an “Annotated Bibliography of Educational Reports on education in Sri Lanka from 1796 to 1987 with an analysis of post graduate theses on education up to 1987” was planned and compiled. Reports were collected from Department of National Archives, Museum libraries, and historical libraries like The Galle Library and Education Offices mainly in the Western, Southern and Central provinces. Exhaustive studies were carried out at the University libraries of University of Peradeniya and Colombo where educational theses were available. Data were analyzed according to the special classification Scheme and special cataloguing formats. It was intended to be an initial step to achieve bibliographical control of “educational reports on Sri Lanka “and to serve as a foundation for any retrieval service for educational reports both current and retrospective, to be up dated every five years. This work consists of three parts. Part 1 consists of three chapters highlighting the educational wastage caused by lacunae in the flows of educational information and the urgent need to bridge the gaps, is a especially a guide to educational information personnel. The section on “Educational Reports literature” in chapter 1, including original diagrams, on the producers, users, and decision makers in education, and the taxonomy of educational literature and also of methods of channeling educational information, in chapter three are intended to create awareness of the urgent need for educational documentation. It also includes short descriptions of important educational data bases the world over. Part II includes the special classification scheme devised by the researcher including the micro subjects of the whole spectrum of education, current at the time of compilation, enabling to locate particular specific information, for the decision makers and the main bibliography. Analysis of the distribution of educational theses according to the micro-subjects, in part II, caters to the specific needs of the researcher. The annotations for theses are almost short abstracts giving the research methodology and the important findings, which further saves the researcher’s time and yielding high relevance. This is an exhaustive tool in case of theses, as this bibliography includes all the master’s and PhD theses available at the universities of Colombo and Peradeniya since the inception up to 1987. Five formats of bibliographical descriptions are used for the entries, in order to prevent missing vital information. Part III include the following Indexes assisting the user in locating even the minutest piece of information:1. subject index 2. Personal and biographical author 3. Corporate author and 4.Index to sessional papers. The content of the entries were analyzed using content analysis techniques to identify patterns of reports and theses. Accordingly educational research studies appear from 1956 and history of education, is the main theme of theses during this early period. Tendency for Action Research is seen in theses submitted after 1969. Educational psychology gains prominence after 1975. Gap areas in educational research are also identified (525 words)

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Key features of government funded university based R&D output: Evidence from recently completed government funded projects of Sri Lanka

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The issue of Research and Development (R&D) has gained immense importance since its impact on economic growth and development has been widely recognized. Although Sri Lanka spends a fair amount of money for R&D activities, the scientific community has not been able to meet the R&D needs of the industry and society. Further most R&D output of our country is often not put to use, or commercialized. However this can not be taken as an indication either on the quality of R&D output or effectiveness of managing R&D. Because in practice, different countries may define R&D and its output differently with respect to Science and Technology (S&T) trends over time. Further such R&D output can be in different forms which may or may not be quantified. The main objective of this study is therefore to analyze the available data on government funded R&D projects, who in what form, and what does that mean for the future. A detailed study is being carried out and this paper highlights the findings of a qualitatively analysed sample data. The sample contains all the data pertaining to research projects funded by the National Science Foundation, Sri Lanka (NSF) completed during 2004-06 (69 nos.) Views of a sample of 21 researchers were used to canvass information.

The study reveals that 82% of the projects were university based, 15% were done under R&D institutes. The output of most R&D projects restricted to publish papers contributing more towards knowledge enhancement rather than technology applications. Out of those publications, number of publications in the internationally accepted journals was also limited. Among limited number of technology applications (17), there were only 5 patents and 4 were applied. As per the views of the sample, it is found that the system of rewarding available did not encouraged researchers for applications, but paper publications only. Lack of entrepreneurial culture among researchers, lack of necessary facilities for advanced research and scaling up of research output, non-conducive Institutional set up; limited Industry Institute partnerships among actors of National Innovation System and lack of government support for start-ups were found as other major causes for above key features of R&D output. Based on the empirical evidence, some recommendations are proposed to make the output R&D as a key to sustainable economic development.

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A study of productivity factors in the Sri Lankan raw rubber industry (Estate sector)

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Rubber is an industry of strategic importance to Sri Lanka as it is one of the top ten producers and exporters of rubber in the world. Rubber has become an essential part of our lives and its uses are ranging from the simple rubber eraser to the tire of airplanes. Further Sri Lanka is having a long rubber growing history being the cradle of Asian rubber industry with ideal climatic and physical conditions which allow for the growth of very high quality rubber. On the manufacturing front, Sri Lanka is the world’s leading supplier of solid rubber tires for off-road vehicles. However National yield levels, which have been on a declining trend since 1996, continued to drop further and declined by 4% and reached the lowest level ever on record in 2001, though Sri Lanka is bestowed with rich resources of natural rubber and other process materials.

So it is obvious that there is a burning problem in the raw rubber industry i.e. rubber plantation and processing sector. Therefore a detailed study was carried out to identify the factors that affected lower production, especially the productivity of raw rubber industry measured by annual yield per hectare. Study has shown that technology contribution coefficient of Sri Lankan raw rubber industry is very low compared to the global industry leaders like Malaysia, Thailand and India and that has resulted in a lower productivity of rubber growing industry. Further it was found that lower status of Infoware, Orgaware, Humanware and Technoware factors (e.g. lower stand) have affected productivity of the Sri Lankan raw rubber industry. Factors that affected the lower status of each technology component were evaluated with the qualitative techniques like, SWOT analysis, value chain analysis and cause and effect diagrams. It was found that lower consideration given to workforce; especially training and retraining facilities for the workforce, poor management practices due to poor managerial competencies and rigid organizational structure have become major drawbacks of this industry.

The views expressed herein do not necessarily represent views of the National Science Foundation, Sri Lanka or the Ministry of Science & Technology, Sri Lanka.

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Technology status assessment in Sri Lankan plastics processing industry

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Plastics processing is one of the dynamic industries in the world. Due to rapid changes in technologies and materials, developed countries have been relocating their plastics processing industries to countries with the ability to manage technology. Sri Lanka has the scope to attract such industry relocations and Sri Lanka thereby has an ideal opportunity to expand its market and attract investors to set up plastics processing industries as a result of new developments in the international scene. However, the entire plastics processing industry needs to focus on developing a competitive edge and the local industry itself is fragmented and comprises of a few large, mainly privately owned companies and many small and medium scale companies. Most of the present exporting sectors are for low value added product where cost advantages will liable to erode soon.

In order to gain sustainable advantages in international trade Sri Lanka needs to identify main strengths, weaknesses, threats and opportunities of the industry. Thereby an in-depth study of technology status of this industry was done for the sake of the potential investors. Study was done through industry visits and the sample was selected by taking the top twenty companies in the plastics processing industry according to the extent of raw materials imported. In this study, technology is considered to comprise of four basic components, which have been described as technoware, humanware, inforware, and orgaware, all of which interact jointly to fulfill the task of transforming the input into output and the technology status of the industry was assessed formulating criteria according to those components.

Lagging areas and specific technology need of each of the industries have been identified and they are as given in the report both at national level as well as at firm level. As per the study, Sri Lanka has been made uncompetitive at many stages in the industry. In competitive cost of production, frequent power failures or high fluctuation in the energy supply, labour problems e.g. not enough trained/Skilled workers, fairly high labour turnover, absenteeism in the night ships and retaining of the workers especially female workers in the industry have become severe problems for the industry. Further it was revealed that high raw material cost, mould/machinery breakdowns, automation of several manual processes, space problem and the quality problems have also become crucial in Sri Lanka. Survey assessed the general ICT usage and the R&D facilities of the industry as well. As found from the survey low usage of IT applications, lack of proper training and development for workforce are critical areas which need immediate actions to be inline with global developments and also to compete with global leaders in this industry.

The views expressed herein do not necessarily represent views of the National Science Foundation, Sri Lanka or the Ministry of Science & Technology, Sri Lanka.

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Cleaner production options for rubber tapping: An economic analysis

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Cleaner production (CP) is a strategy that is applied to the entire production cycle to increase productivity by ensuring a more efficient use of raw materials, energy and water and promote better environmental performance. The study intends to apply CP principles to the rubber plantation especially for the latex tapping and to determine their economic viability.

Rain guard application and early tapping were selected as CP options among the available options. Data collection was done through primary and secondary sources for the Millewa rubber estate in Kalutara District which has extent of 219.60ha. As primary data, latex and scrap from 300 trees in virgin bark and renewed bark trees and 200 trees of intensified trees were collected from 3 tappers within 3 days in 2 months (December and February which provide highest and lowest latex yield in a year). This was based on the number of trees tapped by a tapper per day from each aged tree. For each month, first week, last week and middle of the month was selected to get the average latex amount per month. Primary data related to rain guard establishment was gathered from field officers of Rubber Research Institute during December 2007 to April 2008. Benefits of rain guards which were number of days of tapping that are annually lost on the average (84 days) due to rain were collected from estate records. The cost of rain guards were derived using the adjusted market prices of materials required for rain guard establishment and benefits were derived using market price of latex (1kg) for increased latex amount from increased tapping days.

Finally, a cost benefit analysis was carried out for each option for a 30 year period (the rotation age of a rubber) at 10% discount rate considering the country's interest rates. Variation in prices of latex was not however considered in the computations. Results show that even though both options were capable of increasing latex production, early tapping has provided more benefits than rain guards. A sensitivity analysis also shows the higher positive value for early tapping than rain guard. The results imply that the need for proper emphasis of such cleaner production options at the policy level and promotion of adoption of such practices at the farmer/plantation level. Technical and financial constraints associated with the introduced CP options are also discussed.

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Construction of material flow balance for crepe rubber manufacturing: Implications for cleaner production

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Material and energy flow information such as data on resource use and waste generation is particularly important to make sound environmental management decisions. The accounting for all water, materials and wastes flowing into and out of an organization is called a “material balance”.

The present study intends therefore to construct a material flow balance for crepe rubber manufacturing industry in Sri Lanka. Therefore Millewa, Dartonfield and Kiriporuwa crepe rubber industries were selected for the study. For the construction of material balance, inputs and outputs of all necessary sub processes were considered and their weights and volumes were measured to the possible accuracy. The input-output analysis for each crepe rubber factory was conducted for two succeeding months where the initial latex crops were approximately similar to each other. Based on the values for a single production line, material flow balances were constructed for all three crepe rubber factories for one unit of output (one kilogram of crepe rubber).

The results obtained in the material balance for all three factories were compared using different components of environmental performance indicators (EPIs) such as input material usage, volume of waste water discharge and energy usage. Based on their consumption pattern, different values were obtained by them. As an example, the annual waste water discharge per unit product was recorded as 31,744.74 l kg⁻¹, 18,888.85 l kg⁻¹ and 6865.67 l kg⁻¹ for Millewa, Dartonfield and Kiriporuwa respectively.

Material usage data collected in the material balance provide an additional source of data, for tracking the physical material flow through the production line, which are usually unable to tract using the monetary information in conventional accounting system.

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Factors underpinning the intensity of banana intercropping in rubber smallholdings in Sri Lanka

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Rubber, being a perennial crop, is having a long gestation period of ca. 6 years causing significant problems to resource poor smallholder farmers. To overcome this problem and to increase the overall productivity, intercropping in rubber lands is practised. Considering the need, the Rubber Research Institute of Sri Lanka has issued a set of recommendations on suitable crops for intercropping in rubber lands. Among the rubber based intercrops, banana appeared to be a popular crop in most parts of the country. However, smallholder practices do not always go along with the recommendations, probably because the priorities of smallholders are different from what was met by those recommendations.

Therefore, the present study was carried out to characterize such social factors underpinning the level of intensity that banana being intercropped in smallholdings. For this purpose, 30 smallholders practicing rubber/banana intercrops in Kalutara, Ratnapura, Colombo and Kegalle districts were interviewed with a structured questionnaire and on-site observation on intercropping intensity was made.

The level of intensity of banana intercropping was directly related to three parameters, i.e. the extent of intercropping and the revenue & net profit from the intercrop. Therefore, three multiple regression models were run in order to identify different factors that contribute to above factors. These results imply that perhaps revising present incentives would be necessary in order to popularize banana intercropping among the rubber small holders in Sri Lanka.

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An environmental economic valuation approach for valuation of harvested roof rainwater

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Rain water is considered as a free good and the benefits are often ignored thus creating an external impact. The study is therefore sought to estimate the willingness to pay values for rain water harvesting, its wise use as well as conservation of water for future generation. A contingent valuation survey model with dichotomous choice question format was carried out in three locations (Colombo, Kekirawa and Yatigammana) which belong to three different provinces, Western, North central and central of Sri Lanka. These locations represented both wet and dry zones, rural and urban communities and rain water harvesting and non harvesting groups.

In all survey locations majority of respondents have clearly highlighted and accepted the value of rainwater. According to the results of the survey Mean Willingness To Pay (MWTP) values in the dry, wet and urban areas were Rs 59.06, 85.96 and 89.03 respectively. The proposed contribution is equivalent to their net monthly income as a percentage of 0.98% in rural, 1.01% in rural wet and 0.39% in urban areas.

Some differences existed in the degree of support of the two sub-samples of rural dwellers. The sub-samples of rural respondents chosen from the villages within the dry and wet or water shortage areas with certain difficulties to fetch day to day water requirement showed relatively similar support for the proposed trust fund than the respondents chosen from the urban zone. However, it seems that urban contribution as a percentage it is smaller but in comparison to their income it is larger in rupee values.

The results revealed that estimated public support (both of rural and urban dwellers) could generate funds in excess of the financial requirements of the funding assistance scheme proposed in this study. The implication of the results in developing appropriation mechanisms for correcting market failures in the rain water harvesting is also discussed.

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Attitudes towards rain water harvesting: A valuable factor to consider in resolving issues of water supply in Sri Lanka

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Along with the introduction of modern facilities together with technologies, many people tend to abandon the valuable resource of roof rainwater collection for day to day uses. The attitudinal issues are important in developing motivation and popularizing the utilization of rainwater (RW) as an alternative sources of water supply among rural as well as some urban communities in Sri Lanka.

This study was therefore carried out to find out attitudes and perceptions of the people in relation to harvested rainwater (RWH) in different parts of the country. The selected sites are Kekirawa in Anuradhapura District, Yatigammana and Thismada in Kandy District and Colombo Municipal area and suburban towns of the Colombo city in Sri Lanka. There were 150 families involved in this face to face interview process respectively from each of the above sites.

According to the results of this study there were 80 - 95% (both urban and rural) respondents who have indicated about their agreement and preference towards RWH. This analysis was based on logistic regression model to find out whether their response values on attitude has negative or positive coefficient. Their answers for general issues such as importance of RW showed that, rainwater is equally valuable with the other sources of waters. It is revealed that island wide extension programme for RWH, RW harvesters be rewarded, express concerned about authorities interventions needed to motivate people for rainwater harvesting are justifiable and has significant coefficient in accordance with the results of the “Chi-square” in the logistic regression model.

The majority of the respondents in both urban and rural sample expressed their support for the integrated economic approach proposed in this study for managing rainwater as freely available natural resource. Another important factors surfaced through this study are labour time saving, improvement of sanitation and health condition, time saving for the children for studies especially for rural groups, money saving in many ways due to improvement of water quality as non contaminated rainwater free of chemicals and fluorides are available for both urban and rural communities.

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Agricultural extension programme development: Use of participatory rural appraisal techniques

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Participatory Rural appraisal (PRA) is a series of techniques used in extension programmes. PRA techniques are used to ascertain the real problems and the solutions of farming community. In fact, PRA is a more farmer friendly, community based method with high degree of success. Therefore, a PRA practice was carried out in Pitigoda village area in Ududumbara Divisional Secretariat of Nuware Eliya district with the collaboration of two institutions, University of Ruhuna and Hadabima authority in September, 2007, to determine the current situation of the Pitigoda village, to determine the existing problems and issues of the village and to develop the development plan for the village with the help of villagers.

In PRA, number of different tools was applied for situation analysis, identify the problems, and also suggest solutions. The executed tools were participatory mapping, Venn diagramme, pair wise ranking, and matrix ranking. All those tools were carried out by the assigned group consisting 10-15 farmers; The Hadabima cum University students made the facilitator role.

The participatory map demonstrates all the resources, roads, lands, cultivations, institutions, etc very clearly and in meaningful manner which would be very helpful to get an idea about the village. Venn diagram revealed the available service providing institutes, individuals, and organizations in the area, their importance, and the extent of relationship built with community.

Grama Niladhari, Wildlife officer, Midwife, Death Donation Society and Farmer organization were identified as the best service providers, respectively. Pair wise ranking was assigned to identify the most severe problems in the area and they were determined by comparing a number of problems one against each other. The results show Wildlife damage, lack of new technology, and poor road facilities were ranked as the first, and problems regarding land ownerships and poor transport facilities were identified as the second and the third, respectively. Moreover, Housing problems and Common infrastructure facilities were also identified by the community as limiting factor.

Matrix ranking was carried out to investigate the most suitable crop for the area. The alternatives were evaluated using predetermined criteria and the total score ranking was done to select the best alternative crop to the area. As a result, mango, coconut and orange were selected as the most suitable crops for the area. Using the results of the study, any organization, individual, or institute can formulate extension programmes and development programmes which would be the most effective and efficient for the Pitigoda village.

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Study on temperature measurements in paediatric age group

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In general clinical practice and in ward situations for the measurement of core temperature oral or axillary sites are used in children. Infrared ear drum thermometers are used in developed countries while it is not commonly used in underdeveloped countries. The objective of our study was to compare the accuracy of the infrared ear drum thermometer with the axillary and oral thermometers.

Oral, axillary and ear drum temperature measurements were made on 34 children of age between five and twelve (5 -12) years at the same instance using a clinical mercury thermometer for oral and axillary while infrared thermometer was used to measure the ear drum temperature. Fever was not considered as an exclusion criterion. Minitab 14.1 statistical programme was used to test correlation, descriptive statistics and to perform paired t – test.

Mean temperature of right and left ear was 96.85 °F (SD=0.68), 96.79 °F (SD=0.75) respectively and there was no significant difference between these two values (p >0.5). Mean temperature of axilla was 97.84 °F and mean oral temperature was 98.64 °F. Mean value of the temperature of both ears was 96.82°F. Mean difference between ear mean and oral was 1.82 °F (SE=0.09), this difference was statistically significant (P <0.0001). Mean difference between ear mean and axilla was 1.02 °F (SD 0.63) and this difference was statistically significant ( P < 0.001).There was a statistically significant correlation between mean temperatures of ear and axilla (r= 0.629, p<0.001), and also between ear and oral temperature means (r= 0.71, p<0.001).

Results indicate that both oral and axillary temperatures are well correlated with ear drum temperature. However, both readings are significantly different from ear drum temperature. So that one has to take this fact into account when infrared thermometers are used. Our data suggests that when ear drum temperature measurements are made, one has to add on average 1.82 ° F to obtain an equivalent value for the oral temperature.

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Introduction of a clinical score for the evaluation of bacterial infection of dogs

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An infection is the colonization of a host organism by a foreign species. The infective organism, or pathogen, interferes with the normal functioning of the host. Generally, when an infected dog is admitted to the clinic it may be at different stages of infection. For research purposes, it is essential to have clear guidelines to evaluate the severity of the clinical condition by giving some numerical values which can be repeatable. In this study, we graded the severity of general bacterial infection by evaluating the clinical condition of dogs giving a score based on the severity of clinical signs, symptoms, and appearance of the dogs.

A normal apparently healthy dog was given 0, mild abnormal subject as 0-2, moderate abnormal subject as 2-4 and above 4-5 indicated a severe abnormal subject. Body temperature, appetite and the appearance of dogs were used in grading the subjects into above groups. Dogs with the clinical severity score 1 and above 1 can be considered as clinically abnormal.

Using this method 26 dogs admitted to a clinic with bacterial infection were compared. Dogs admitted to the veterinary clinics due to bacterial infections other than diarrhoea were recruited for the study. They all belonged to the local breed (Canis familiaris) with an average body weight of (13.92± 1.998). All the subjects (n=26) were between 1 to 5 years (19.14±7.40) of both sexes (15 males and 11 females). These dogs were treated with different antibiotics and with other symptomatic treatments. Five days after the treatment, they were again evaluated by 2 veterinary surgeons and values were compared. Results show that this method can be used to evaluate a dog based on its clinical signs and also to assess the efficacy of a treatment in clinical trials. This clinical score values give an overall picture of the dog considering behavior and clinical signs. This each clinical sign can also be used separately according to the requirement of the clinician.

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Comparison of rabies control methods in Colombo Municipality Area (CMA) with methods followed in Sri Lanka during the period from 1990 to 2006

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General Objective: - To critically evaluate the rabies control methods in CMA and Sri Lanka.

Methodology: - An audit was carried out during a period of one month using the past records available at relevant authorities after obtaining permission for data collection.

Results and Conclusion: - Vaccination of dogs against rabies, elimination of stray dogs, post-exposure treatment for humans and dog population control by sterilization and hormonal treatment are the main rabies control methods adopted by Colombo Municipality Council (CMC). Public health education and community awareness programmes, enforcement of rabies control legislation and registration of stray dogs are also carried out by CMC. The control methods that are adopted at national level are similar to those done at CMC. From year 2002 to 2005 there has not been a significant change in the incidence of human rabies in Sri Lanka. The males predominated, with the age group of 20-59 being the most vulnerable (47% of total cases), and >60 years of age, was emerging as a new risk group. In Sri Lanka rabid stray dogs were responsible for 48% of the bites in 2006.

Both at CMC and national level, there was a sudden rise in the number of dog vaccinations during 2006, making it the highest number of dog vaccinations achieved for the past 16 years, but proper dog vaccination practices were not followed. The post-exposure prevention with anti-rabies vaccines and serum was not cost-effective. Sterilization and hormonal treatment were done on house-hold pets, with a highly unpractical target, and not being cost-effective as well. In CMA, the number of dog registrations showed a sudden increase in 2006. Island wide, dog elimination was reduced by 46% from 2002 to 2005, but the number of confirmed dog rabies cases, which was identified as a better indicator of assessing the effectiveness of rabies control programmes, was constantly at a higher level.

Public awareness programmes on prevention of rabies conducted by CMC at school level is a good tool to reach the community, although it is expensive and time consuming. This practice should be expanded to include the risk group in the age of 20 – 59 years.

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Determination of some selected heavy metals in *Aravinda sava* used in Ayurvedic medicine

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*Aravinda sava* is an Ayurvedic preparation used as a medicine to treat many children’s disorders. It is also used as a vigor tonic, appetizer and a rejuvenation tonic. Fermentation is the main manufacturing process of this preparation. Concentrations of alcohols, acetaldehyde, ethylacetate, essential metals, acid values and pH values in this product have investigated and recorded previously. Use of plant materials, addition of sweetens and use of metallic utensils during the manufacturing process could contribute to a presence of heavy metals in the final product. Determination of the concentrations of these heavy metals in this product is significant to upgrade the quality and standards of these preparations to ensure the consumer safety in order to introduce it as an herbal healthcare tonic to the global market.

As an initiation step forward in this regard, the concentrations of toxic metals such as Cr, Al, Pb, Ni and Cd in 12 brands of commercially available *Aravinda sava* were determined. The product was subjected to wet digestion prior to analysis using Graphite Furnace Atomic Absorption Spectrophotometry (GFAAS). Quantitative determination of toxic metals in 12 brands of the preparation showed the metal levels in g/ml as Ni (Max 2.84, Min 0.12, Mean 1.13 ± 0.97), Al (Max 24.01, Min 2.46, Mean 9.09 ± 6.84), Cr (Max 0.38, Min 0.2, Mean 0.29 ± 0.05) and Pb (Max 0.75, Min 0.29, Mean 0.53 ± 0.10). Cd was not present in detectable levels from GFAAS.

Although these products do not consume as water, due to the non-availability of maximum contaminated levels defined by any recognized organization for these metals in herbal preparations the detected levels were compared with the WHO drinking water standards in g/ml as Ni (0.1), Al (0.2), Cr (0.05), Pb (0.05) and Cd (0.001). If a person consumes 30 mL of this product per day, except Al the detected levels of other metals do not exceed the maximum contaminated levels defined by the WHO for 1L of drinking water.

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Characterization of known and unknown mutations of human beta globin genes of Sri Lankan beta thalassemic patients using allele specific priming and Single Stranded Conformational Polymorphism techniques

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Beta thalassemia is a highly heterogeneous disorder resulting from more than 200 beta globin gene mutations, which are population based. It is characterized by reduced synthesis of the hemoglobin beta chains that leads to microcystic/hypochromic anemia, an abnormal peripheral blood smear with nucleated red blood cells and reduced amount of hemoglobin A (Hb A). Beta thalassemia is a severe health problem in Sri Lanka as treatment and management of such patients is a major drain on the annual health budget. Mutation analysis of the gene encoding beta globin is useful for prediction of the clinical phenotype. There is currently an urgent need for the development of a rapid, reliable and effective population based screening method. In this study, a selected population of beta-thalassemic patients attending the Anuradhapura and Ratnapura General Hospitals for blood transfusions were selected to characterize the mutations. A panel of allele specific primers based on known mutations (IVS1-1, IVS 1-5, CODONS 8/9, 41/42, 16 and 15) in beta-thalassemic patients from Sri Lanka were designed and tailored to investigate the presence of the above mutations. Single Stranded Conformational Polymorphism (SSCP) technique that detects both known and unknown mutations was developed subsequently. Hotspot regions of the beta globing genes (481bp), that contains 98% of known mutation in beta thalassemic patients (n=30) were amplified. To make them amenable to SSCP, amplified products of hotspot regions were split into two overlapping segments of 238bp and 268bp. SSCP analyses of these overlapping segments showed additional banding patterns compared to normal individuals. Off these, 6 DNA samples were sequenced and revealed the presence of mutations. The SSCP protocol developed in this study is a good method to detect the presence of mutations in the hot spot region of the beta globin gene and in combination with allele specific PCR, is an ideal method for presymptomatic diagnosis.

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Development of a modified Polymerase Chain Reaction - Oligonucleotide ligation assay (PCR-OLA) to detect the commonest mutations IVS1-1 (G to A) and IVS1-5 (G to C) in Sri Lankan beta-thalassemic patients

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Beta-Thalassemia is an autosomal recessive disorder characterized by reduced production or absence of functional beta globin chains. It is mostly caused by point mutations or by small deletions within the β-globin gene. This disease is common in Sri Lanka and its economic and social cost is high due to the patients' lifelong need for monthly blood transfusions and iron chelation therapy. There is currently an urgent need for the development of a rapid, reliable and effective population-based presymptomatic screening method for β-thalassemia. Although there are several mutations that cause β-thalassemia, studies have shown that in Sri Lanka, two mutations [IVS1-1 (G to A) and IVS1-5 (G to C)] are predominant and constitute 83% of all beta-thalassemic mutations. A modified form of the Polymerase Chain Reaction-Oligonucleotide ligation assay (PCR-OLA) assay was developed to screen the two predominant beta-thalassemic mutations in Sri Lanka.

Selected population of β-thalassemic patients attending the Anuradhapura General Hospital and Kurunegala Teaching Hospital for blood transfusions was chosen for the study. The hotspot regions of the β-globin gene containing ~98% of known mutations in Sri Lankan β-thalassemic patients were amplified using DNA extracted from the blood samples. Two primers were designed to anneal adjacent to each other on the PCR amplified target DNA. The nucleotide at the 5' end of the downstream primer (mutation specific primer) is positioned at the mutated site. Ligation of the upstream primer with the downstream primer will occur only if the target DNA carries the mutation. After ligation, products were detected by PCR using specific pan handle primer sets that anneal to panhandles in the downstream and the upstream primer. Amplification products of 112bp and 109bp indicated the presence of IVS1-5 (G to C) and IVS1-1 (G to A) mutations, respectively. Samples that were positive (n=19) were also analyzed by single stranded conformation polymorphism (SSCP) which showed different banding profiles when compared to normals. Due to the ability of this method to accurately detect single base mutations; the modified PCR-OLA technique (PCR-OLA-PCR) can be used as a better screening method for presymptomatic diagnosis of β-Thalassemia in Sri Lanka.

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Community factors affecting long-lasting impregnated mosquito net use for malaria control in Sri Lanka

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The Anti Malaria Campaign distributed approximately 300,000 long-lasting impregnated nets (LLINs) to residents in malaria-endemic areas in Sri Lanka during the years 2005 to 2007. We conducted a community-based cross-sectional survey in the Anuradhapura and Vavuniya districts among 2467 households distributed among the three major ethnic groups of Sri Lanka, to study the perceptions and practices with regard to the use of LLINs in order to improve their use. In a majority of households the number of LLINs available was not sufficient for the number of people, although there were a small percentage of households that had excess nets. The information and advice given at the time of distribution regarding use of the nets differed amongst the three groups and was not consistent. Only around 50% of the population received instructions on washing and drying the net or were told that the net given was a LLIN. Seven percent of the Sinhalese, 16% of Tamils and 6% of Moors indicated that they were advised to wash LLINs once in 6 months, while 40% of the Moors, 2% Sinhalese and 16% Tamils indicated that they were advised to wash it once in 5 years. Advice regarding drying was not received by 85% of the Tamil respondents, with only 9% indicating that they were asked to dry the net in the shade. This percentage was lower than that observed among Sinhalese and Moor respondents (81% and 34% respectively). The manufacturer's instruction for washing Olyset™ LLINs is once in 6 months so as to activate the chemical. Only 51% of Sinhalese, 34% of Tamils and 41% of Moors washed their nets once in 6 months as instructed by the manufacturers. However, the reason for washing the net was because it was dirty and not to activate the chemical. Of those who reported washing the nets, the correct procedure for drying (which is in the shade) was practiced by 92% of Sinhalese and 85% of Moors as compared to 70% of Tamils. It was noted that net shape may influence net use, with cone shaped nets being more popular. Interventions are required to improve practices with regard to LLIN use and will contribute to further reduction of malaria in Sri Lanka.

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Sleeping arrangements under long lasting impregnated mosquito nets: differences during malaria transmission seasons

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The Anti Malaria Campaign has distributed approximately 300,000 long lasting impregnated mosquito nets to residents in malaria endemic areas of Sri Lanka. The sleeping arrangements under LLINs was recorded in 2467 households during the low malaria transmission season (May/June 2007) and the same families were followed up during the high malaria transmission season (December/January 2008) in Anuradhapura and Vanuniya districts. Approximately 800 households from each main ethnic group were studied. The number of families lost to follow up was 68. The percentage of individuals who slept under a net increased significantly (p<0.001) in all three ethnic groups during the high transmission season. During the low transmission season it was children under five years of age in the Sinhalese and Moor households that were given the priority to sleep under the LLIN. In the Tamil households, children between ages 5-12 were given preference. During the high transmission all three ethnic groups gave preference to children under the age of five years. When the entire population of children under the age of five years was considered the percentage who slept under the LLIN was high (75% and 90% during the low and high transmission seasons respectively). The percentage of children who did not sleep under a LLIN due to the fact that their households did not have an LLIN was 28% during low transmission season and 18% during high transmission season. Further the percentage of women (16% and 40% during low and high transmission season respectively) who did not sleep under the LLIN during the high transmission season due to an absence of LLIN in their household was high. Usage of LLINs by children under the age of five years, who are classified as a vulnerable population was high and comparable to the standards set by the Roll Back Malaria Initiative which indicates utilization of LLIN should be 80% by young children and pregnant women. However, usage of LLINs by pregnant women was less satisfactory. At the time of LLIN distribution, the households should be educated on key messages regarding the importance of the nets.

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Proteases secreted by the infective larvae of *Toxocara canis* and partial purification of a 50 kDa protease

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*Toxocara canis* is a nematode parasite of dogs, a causative agent for human toxocariasis. It has become one of the major zooxo-parasitic infections in Sri Lanka. Infective second-stage larvae of *T. canis* secrete proteolytic enzymes which are suggested to be instrumental in their tissue-migration process. Therefore, this study aims at identification of proteolytic enzymes which are involved in the invasion and processing of proteins of these parasites and thereby targeting a specific enzyme for the control of the infection.

Proteolytic activity of these larvae during culture in vitro was determined by gelatin -zymography, pH optimum and substrate and inhibitor specificity. A partial purification of a 50 kDa protease was done using DEAE-anion exchange chromatography which was characterized for its optimum pH, temperature and inhibitor susceptibility.

Excretory-secretory products of infective larvae showed proteolytic activity as seven bands in gelatin zymography with their molecular weights lie between 175 kDa to 20 kDa. Serine, cystein and metalloproteasse activity were identified optimally at pH 5.5 to 6.5. Metalloprotease found to be predominated. Proteolytic activity was optimum against albumin over gelatin and casein. 50 kDa protease was partially purified by using DEAE-anion exchange chromatography and its activity was optimum at pH 8.5 and 70 °C .This protease activity was inhibited by metaloprotease inhibitor EDTA.

Proteases secreted by *T. canis* infective larvae exhibit diversity in classes of proteases, based on the differential migration in polyacrylamide gels containing gelatin. This result clearly demonstrates the heterogeneity of larval proteases that might be involved in important functions during the larval migration. Partially purified 50 kDa protease might be involved in a specific function and inhibition of this enzyme activity may arrest the activity of the infective larvae. Therefore, this enzyme could be a target candidate in the control of toxocariasis by inhibition with chemical or immunological methods.

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Partial purification and characterization of deoxyribonucleases from *Nepenthes distillatoria*

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Occurrence and some enzymatic properties of deoxyribonuclease/s in the pitcher juice of *Nepenthes distillatoria* were reported previously. High stability even at 50\(^0\)C and over a broad pH range suggested the presence of novel deoxyribonucleases with distinct properties in the crude *Nepenthes* juice. In this study the DNases were partially purified and their stability was investigated at different temperature and pHs.

Partial purification of DNases present in the crude juice was carried out using DEAE cellulose anion exchange chromatography at 4\(^\circ\)C. Optimum temperature and pH for different enzymes were determined separately. Thermal and pH stability of the DNases were determined by incubating them separately at different temperatures and pHs for a period of one month. Aliquots were removed at different time intervals and the percentage remaining DNase activity of each aliquot was determined.

Partial purification on DEAE cellulose chromatography suggests the presence of four different DNases (DNase1, DNase 2, DNase 3 and DNase 4) in the crude pitcher juice. DNases 2 and 3 were found to be the abundant enzymes according to the total volumes for each enzyme. Optimum temperature and pH for DNases 1, 2, 3 and 4 were 50\(^0\)C & pH 3.0, 40\(^0\)C & pH 3.0, 45\(^0\)C & pH 6.0 and 45\(^0\)C & pH 3.0, respectively. All four enzymes had a significant stability over a broad pH range for two weeks. Moreover, all four enzymes showed a remarkable thermal stability. On average, all the enzymes had more than 75% remaining activity after two weeks at 50\(^0\)C and at 37\(^0\)C it was more than 85%. These results clearly demonstrate that all four enzymes are stable at high temperatures over a broad pH range. Therefore, DNases present in the pitcher fluid of *N. distillatoria* may have remarkable properties to withstand against high temperatures, a wide pH range as well as attack by proteinases present in the crude juice. These features clearly indicate the wide applicability the enzymes. Further studies are in progress on purification and characterization of the different DNases.

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Production and characterization of antibodies against proteins of venom of Sri Lanka Cobra (Naja naja)

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The commonest snakes in Sri Lanka are cobra (Naja naja) and its venom is not characterized at the molecular level. The available antivenom is produced against Indian snakes, common cobra, thel karawala, saw scaled viper and Russel's viper and is a mixture of polyvalent antibodies. Although it has been used to treat snake bitten patients in Sri Lanka for 20 years, it is not effective against complete control of symptoms and fatality of snake bitten patients. There are many reports of severe antivenom reactions, including severe anaphylactic reaction with hypotension following treatment. Therefore, it is very important to produce antibodies specific for toxins proteins of snakes in Sri Lanka.

Cobra Venom samples were collected and centrifuged at 12,000 rpm at 4°C for 15 min. Proteins in the resulting supernatant were fractionated using Sephacryl S 200 gel filtration into five fractions. Rabbits were immunized with heat inactivated five separated fractions of venom of Cobra with Freund Adjuvant following a primary injection and two booster injection. Blood was collected after satisfactory booster injection. Antibodies were purified by ammonium sulphate precipitation followed by protein A-Sepharose chromatography. Antivenom vials manufactured by VNS Bioproducts Ltd.(AV1) and Bharat Serums and Vaccines Ltd (AV 2) in India were selected for the analysis.

Specific binding of antibodies with sephacryl S200 fractionated proteins of cobra venom were analysed by western blotting and dot blotting. Results suggest that all produced antibodies specifically bind with respective venom proteins used to raise antibodies. Further Indian antivenom preparations AV1 and AV2 bind with only phospholipase A₂ fraction and not bind with other toxic venom proteins. This might explain the less effectiveness of Indian antivenom for treatment of snake bitten patients in Sri Lanka.

Further studies are in progress to clarify the above.

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Studying the efficacy of selected fungicides against root rot disease of betel vine (*Piper betel* L.) in the Batticaloa district

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Root rot caused by the soil borne fungi *Sclerotium rolfsii*, is a serious disease of betel vine in the Batticaloa district. Identification in early stage and effective control measures of this disease is essential to minimize economic losses. In order to find out suitable fungicide/s to control root rot disease in betel vine, an experiment was conducted at the microbiology laboratory of Department of Agricultural Biology, Eastern University, Sri Lanka from September to November 2007. This experiment was arranged in a Completely Randomized Design (CRD) consist of five treatments and four replicates. Fungicides Captan 50% WP, Homai (Thiophanate- methyl 50% WP + Thiram 30% WP) and copper fungicide (copper 50% WP), which are commonly used for soil treatment were tested using poison food technique on Potato Dextrose Agar (PDA) media at the rates recommended by the Department of Agriculture, Sri Lanka. PDA plates unamended with fungicides were served as control. Fungicides amended plates were centrally inoculated with 5 mm diameter mycelial disc of *S. rolfsii* from 3 days old culture and incubated at room temperature (30 °C ± 2 °C) under aseptic condition. Radial mycelial growth of *Sclerotium rolfsii* was measured daily and percent inhibition was calculated. Result of this experiment revealed that, Homai had the highest level of inhibition (96.47%) of the mycelial growth of *Sclerotium rolfsii* at the recommended rate and found significantly better than the other treatments. Captan effectively controlled the growth of this fungus (83.27%) next to Homai. Homai produces Benzimidazole carbamate and it could interfere with the nuclear division of *Sclerotium rolfsii* thus, the fungus could be sensitive to the Benzimidazole carbamate. From this experiment it could be stated that the fungicide Homai could be possibly used to control root rot disease in betel vine at the recommended dosage level.

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Profitability of rice based cropping system in Jaffna district of Sri Lanka

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The study was conducted in Jaffna district of Sri Lanka during October to December 2004 to evaluate the present rice based cropping system in terms of its profitability. Sample farmers were selected randomly from 5 Agrarian Service Centres (ASC) such as Uduvil, Tholpuram, Chavakachcheri, Ampan and Puloly ASC divisions where rice based cropping system in practice. Selected sample farmers were interviewed by using questionnaire. In Jaffna district, rice is being cultivated in 9000 ha as rain-fed crop in 2004 and out of that nearly 2000 ha of land is cultivated with other field crops after harvest of paddy with the help of lift irrigation from dug wells. In this rice based cropping system, selection of crops, crop sequence, cropping index and profitability varies among different Agrarian Service Centres. It was found that selection of crops, cropping sequence and its index, use of inputs and level of management are the major factors that determines the profitability of the cropping system. Farmers practice different cropping sequences based on the market demand. High price, limited availability of manures and increased labour wages due to scarcity of farm labourers were identified as major problems which intern increased cost of cultivation. Farmers from Uduvil, Tholpuram and Chavakachcheri divisions adopt high cropping intensity (>2) by cultivating more than one crop after paddy harvest in the same field. In Ampan and Puloly divisions, farmers cultivate only one crop after harvesting paddy and cropping index is always two or less than two. This may be due to limitation of quality and quantity of water available for irrigation. It was observed that the profitability of rice based cropping system increased with increasing cropping index in all ASC divisions. Profit obtained from Uduvil ASC division is higher compared to other ASC divisions. Growing vegetables and cash crops give higher profit compared to the legumes and oil seed crops. Profit obtained from rain-fed rice is very much lower than that of vegetables and cash crops followed by rice in this system.

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Collection of wild rice germplasm in Sri Lanka

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Oryza is a very important genus belongs to the family Poaceae. According to the literature this genus contains twenty wild rice species and two cultivated rice species. Previous scientists have confirmed that five wild rice species (O. invar, O. rufipogon, O. eichingeri, O. rhizomatis and O. granulata) can be found in Sri Lanka. These genetic resources are very valuable assets for the Island. Due to many different reasons these valuable wild rice populations are continuously being destroyed. Therefore collection and conservation of these valuable resources are very important for future needs. Objective of this study is collection of wild rice species within Sri Lanka to fulfill this gap.

This study was carried out at Rice Research and Development Institute (RRDI), Batalagoda, Ibbagamuwa, Sri Lanka.

Twenty six collection missions were organized throughout the Island except north and east to collect wild rice accessions which are belonged to five species. During the collection missions 28 O.nivara accessions, 13 O. rufipogon accessions, 09 O. eichingeri accessions, 08 O. rhizomatis accessions, 03 O. granulata accessions and 01 weedy rice accession were collected.

These results indicate that O.nivara, can be easily found in the dry and intermediate zones of the Island. O. rufipogon can be observed in the coastal belt in the wet zone. O. eichingeri and O. rhizomatis spread in the special areas of dry and intermediate zones and O. granulata found in the intermediate zone. Seeds of collected accessions were conserved at cooling cabinet at RRDI, Batalagoda, Ibbagamuwa.

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A preliminary survey of predatory Coccinellids of cardamom (Elattaria cardamomum Maton) and cocoa (Theobroma cacao L.) fields in Matale

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Aphids are considered as important pests of cocoa and cardamom in several countries but in Sri Lanka aphids are the minor pests to cocoa and cardamom. One of the reasons for this may be the natural control of aphids by their natural enemies. Coccinellids or ladybird beetles belonging to family Coccinellidae are commonly known predatory insects of many sucking insect pests such as aphids.

A field survey was carried out in the 25 years old cocoa and five years old cardamom fields of Matale in 2007 to collect and report lady bird fauna of the plantations. Each field was sampled repeatedly at by-weekly intervals throughout January to December 2007. Adults and immature stages of predatory coccinellids were collected by hand picking, using insect nets and by using an aspirator. Beetles were dry preserved or wet preserved in 70% ethanol. Beetles were morphologically characterized and were identified using taxonomic keys and literatures.

Six different species of lady bird beetles namely, Pseudaspismerus flaviceps (Walker), Jauravia sp., Pseudoscymnus sp., Cryptogonus orbiculus var. fulvocinctus (Mulstant), Scymnus (Pullus) sp. and Stethorus sp. were recorded in the study.

Pseudaspismerus flaviceps (Walker) was found as the predator of cocoa aphid Toxoptera aurantii (Boyer de Fonscolombe) and other five species were collected from cardamom fields. Among them Jauravia sp. was the more frequently seen coccinellid beetle found in this study. Further studies are under way to exploit the host and the relative efficiency of these predators in the pest control.

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Impact of foliar and soil applications of urea as top dressing on productivity of radish (*Raphanus sativus* L.) in sandy regosol

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An attempt was done to study the effect of foliar and soil applications of urea on productivity of radish (*Raphanus sativus* L.) in sandy regosol. This experiment was laid out in a Randomized Complete Block Design (RCBD) with four replicates and five treatments. Recommended rate of urea (90 kg/ha) was applied to soil as top dressing in control treatment (*T*₁) and this recommendation was practiced with additional foliar application of 0.1% urea (*T*₂) and also the recommended rate of soil application was reduced to 3/4, 1/2 and 1/4 with additional foliar spray in *T*₃, *T*₄ and *T*₅ respectively. The agronomic parameters such as leaf parameters (leaf area index, number of leaves, leaf width, leaf fresh weight and leaf length) and tuber parameters (length, diameter and fresh weight of tuberous root and also total root length) were measured at regular intervals. The results showed that there were no significant differences in leaf parameters except leaf width and leaf fresh weight and also in the tuber parameters except fresh weight of tuberous root among the treatments. Significant difference was observed in fresh weight of leaves between *T*₁ and *T*₃. There was remarkable difference in tuberous root weight between *T*₁ and *T*₅. In the present study, there was no significant difference observed in tuberous root yield among the treatments except *T*₅. The 1/2 recommended rate of urea applied to soil in combination with 0.1% foliar urea spray is more suitable practice of urea application as top dressing among the treatments. It is an economical and also the fertilizer can be saved as compared to control.

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Study the suitability of the locally available waste materials for the production of large size blooms of oyster mushroom (*Pleurotus ostreatus*)

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The local agricultural wastes were tested to use as appropriate media (substrate) for the production of large size of oyster mushroom (*Pleurotus ostreatus*) blooms. The four wastes included sawdust, paddy straw, dry leaves and shredded paper. The sawdust is the control treatment and was mixed with other wastes in the ratio of 1:1. The experiment was a Complete Randomized Design (CRD) with seven treatments replicated thrice. The large bloom percentage, large bloom diameter and weight were the parameters used to evaluate the appropriate substrate to produce large blooms in this study.

The results revealed that, substrate consisting of sawdust and shredded paper produced the highest percentage of large blooms amounts to about 50 percent in contrast to the control treatment sawdust that showed only 30 percent. The diameter and weight of the large blooms were found to be high in the substrate consisting of sawdust and shredded paper mixture. This treatment showed significantly higher diameter and weight of the blooms compared to sawdust included as control. In this study, the sawdust and shredded paper mixture depicts as appropriate since it showed more number of largest size and highest weight of blooms. The sawdust and dry leaves mixture was found to be the less efficient substrate for the production of large oyster mushrooms due to production of the small size and low weight of blooms.

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Identification of parasitoids associated with *Bemisia tabaci* (Hemiptera: Aleyrodidae) on selected vegetable crops in the Batticaloa district

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This study involved the identification of parasitoids associated with whitefly, *Bemisia tabaci* on selected vegetable crops in the Batticaloa district. Twenty leaves of whitefly infested chilli, *Capsicum annum* and manioc, *Manihot esculenta* were collected from each of the highly cultivated area in the Batticaloa district at weekly interval for the period of one month. Collected samples were precisely observed and the total nymphal instars and parasitized pupae of *Bemisia tabaci* were recorded for the estimation of parasitization. The parasitized pupae were kept with leaves in the parasitoid rearing vials until the emergence of adult parasitoid.

Four hundred and thirty three mounted slides of adult parasitoids were examined to identify the species based on their taxonomic characteristics. A number of different keys, reference collections, taxonomic catalogues and many descriptions were used in the identification. The parasitoid species that parasitized the *Bemisia tabaci* was *Encarsia guadeloupae* Viggiani. The parasitization rates of *Encarsia guadeloupae* on *Bemisia tabaci* associated with chilli and manioc were 53.13% and 42.42% respectively and there was no significant difference (P>0.05) in the rate of parasitism between these two crops. Results of this study revealed that, the *Encarsia guadeloupae* has a great potential to suppress *Bemisia tabaci* on vegetable cultivation in the Batticaloa district.

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Determination of Iron and Zinc contents of some selected common pelagic fish species in Sri Lanka

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Minerals are important nutrients and their nutritional and physiological functions are very essential in sustaining a healthy life. Their deficiencies lead to severe disorders. Among the essential minerals, iron (Fe) and zinc (Zn) are two most vitally important ones. Most of the fish species are rich sources of Fe, Zn and many other essential nutrients. A study was carried out to investigate the iron and zinc contents in six locally popular fish species namely Sardinella melanura (Salaya), Carnax spp. (Para), Leiognathus spp. (Karalla), Anchovy commersonii (Handella), Amblygester spp. (Hurulla) and Hemiramphus spp. (Moralla).

Fish samples were purchased from fish markets around Colombo. The metals were quantified by using X-ray Fluorescence Technique. The dried fish samples were ignited to obtain ash and analysed in triplicate. In the fish species, the amounts of Fe and Zn were calculated on a dry weight (DW) basis. The data were statistically analysed using ANOVA to identify whether there was a significant difference between the mean Iron and Zinc content of different fish types.

The Fe and Zn contents were significantly higher (p<0.05) in S. melanura than the other fish species studied. The Fe contents of S. melanura, Amblygester spp, Hemiramphus spp, Carnax spp., Leiognathus spp and A. commersonii, were 103.8 ± 6.1, 65.4 ± 4.7, 41.0 ± 12.6, 34.2 ±1.3 , 26.9 ± 7.9 , and 21.0 ± 1.4 µg/g (DW), respectively.

The Zn contents of S. melanura, Hemiramphus spp, Leiognathus spp Amblugester spp, A. commersonii, Carnax spp., were 351.4 ± 3.5, 275.0 ± 0.8, 74.8 ± 0.6 , 51.8 ± 0.7, 43.6 ± 0.8, respectively.

The results showed that there was a significant difference (p<0.05) between the mean Fe and Zn contents of these fish species.

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Identification of carotenoids from yellow passion fruits found in Sri Lanka

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Vitamin A deficiency is of public health importance to Sri Lanka. Passion fruit which is widely recognized as a good source of pro vitamin A carotenoids, has not been adequately studied especially in Sri Lankan varieties. Researchers at the University of Florida have found that yellow passion fruit extracts can destroy cancer cells \textit{in vitro}. The phytochemicals which are responsible for this anti-cancer effect are carotenoids and polyphenols. The present study reports the carotenoid composition of Sri Lankan yellow passion fruit varieties carried out as a part of our overall research program to prepare database for carotenoid composition of commonly consumed Sri Lankan fruits and vegetables. Varieties analysed derived from species \textit{Passiflora edulis} and were collected from the open Market. The analysis of yellow passion fruit focused on identification of main carotenoids and isolation of carotenoids -carotene and prolycopene standards and quantification using RP-HPLC with Diode array detection. The pigments conclusively identified were: phytofluene, β-carotene, -cryptoxanthin, prolycopene, cis- -carotene, trans- -carotene, neoxanthin and violaxanthin. -carotene and prolycopene rear standards were isolated from the yellow passion fruit using open column chromatography. Figure 1 shows the HPLC chromatogram of saponified carotenoid extract of yellow verity of passion fruit. The variety yellow passion fruit contains -carotene 304.6 ±24.5 \(\mu\)g/100g, Fresh Weight (FW) and β- cryptoxanthin (74.4 ± 28.5) as the principal pro-vitamin A carotenoids.


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Comparative study of chemical analysis and near infra red spectrophotometric data of proximate composition of rice polish

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Rice polish is widely used as a feed ingredient in livestock feed formulations. 101 Rice polish samples were collected from rice mills at Anuradhapura, Polonnaruwa, Kurunegala, Mahiyangana, Hambantota and Matara. Samples were analyzed by Near Infra Red reflectance analyzer (perten 8620) for proximate composition. After the NIR measurements of rice polish samples were subjected to chemical analysis for proximate composition. NIR analysis results and chemical analysis results were compared graphically and the linear regression was carried out to study the nature and the strength of relationship between chemical analysis data and NIR data.

77% of samples for Moisture, 47% of samples for Ash, 42% of samples for Crude protein, 47% of samples for Crude fat content and 34% of samples for Crude fiber showed a < 1% deviation from chemical analysis. The correlation coefficient (r) for NIR and Lab method was 0.870 for moisture content, 0.676 for Ash, 0.268 for Crude Protein, 0.790 for Crude fat and 0.644 for crude fiber. Coefficient of determinations (r²) between two methods was 0.757, 0.457, 0.072, 0.625 and 0.415 respectively.

The Standard Error of difference for the mean values of Moisture for chemical method is 0.176 and 0.154 for NIR method. As these two values are low, it indicates that either method can be used for moisture determination. The values obtained were 0.389, 0.246 for Ash, 0.160, 0.190 for Crude Protein, 0.420, and 0.325 for Crude fat and 0.547, 0.483 for Crude Protein respectively.

These results indicate that the present calibration of NIR can be used only to predict moisture of Rice polish where as a new calibration is needed to predict Ash, Crude protein, Crude fat and Crude fiber.

There is a considerable variation in r² values of different areas for all the proximate components. That is suggests the variation in NIR results affect the factors other than chemical analysis variation specially in different areas.

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Rehabilitation of old cocoa plantation at Matale

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Cocoa is one of the important beverage crops having good export potential in Sri Lanka. The export volume was in decreasing order from 3000 mt in 1950 s to 1100 mt in 2003. The presence of unproductive moribund plants in the cocoa plantations is one of the reasons for low national productivity. As there is an increasing demand for cocoa in the world market, the potential for expansion of cultivation is very high. Therefore, rehabilitation of existing old cocoa plantation using improved high yielding materials would be one of the appropriate methods to increase the production of cocoa in medium terms. Therefore, development of a protocol for rehabilitation of senile cocoa estates is the overall objective of this study. This experiment was commenced in Matale (IM3a). Treatments were imposed on a senile cocoa plantation of about 25 years old. Four rehabilitation techniques, namely bud grafting on a naturally sprouting water shoot of an old tree with a chupon bud (T1), replanting of a bud grafted plant originated from fan branch (T2), replanting of a bud grafted plant originated from chupon branch (T3) and bud grafted with chupon originated scion on a chupon branch which emerge after ring bark of an old tree (T4) were practiced. According to the data collected during first 18 months, initial growth of scions is promising. The smallest scion height was observed at T3, but scion girth was almost similar for each treatment. The highest number of branches were found in T2 ($p < 0.05$) and the smallest number of leaves were found in T4 ($p < 0.05$). Overall observations suggested that infilling with bud grafted plants either with fan scion (T2) or a chupon scion (T3) appear to be promising. Continuation of this experiment appears to be worthwhile to develop a protocol in due course.

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Comparison of growth and plant production of 10 black pepper local selections with
Panniyur-1 under “Bamboo Rapid Multiplication System”

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Introduction of high yielding pepper cultivars with superior quality is prime important to
improve the pepper cultivation in the country. Although ten high yielding pepper local
selections have been identified by the Department of Export Agriculture, sufficient quantities of
planting materials are not produced. Therefore the objective of this study is to compare the
growth and plant production of the 10 local selections with Panniyur-1 i.e., the recommend
fast growing hybrid.

Ten local selections i.e. KW30, MW18, MN1, KW33, MB12, KW31, IW5, GM28, GK49, MW21
and Panniyur-1 were established in “Bamboo Rapid Multiplication System”. Ten vines in each
selection were established in plots and replicated three times. RCBD was used as
experimental design. Data were collected on vine length, number of leaves and number of
nodes at one month interval. Survival of mother vines after harvest was also recorded. After 4
½ months vines were harvested and single nodal cuttings were prepared and established in
5”x 8” “polythene bags filled with potting mixture of equal parts of top soil, sand, coir dust and
cow dung and placed in a humid chamber. Data were collected on percentage of success by
counting healthy plants (plants with 6-7 leaves suitable for field planting) after 5 months. Data
on length was analyzed by using ANOVA and LSD was used for mean separation whereas
the data on counts and percentages were transformed (log) and used for the analysis.

Significant differences were observed in vine growth, percentage of success and percentage
of mother vine death. Significantly higher vine growth was observed in Panniyur-1 (100.7 cm)
than 7 local selections i.e., MW18, MN1, MB12, KW31, IW5, GM28 and GK49 (60-87 cm).
Other three local selections i.e., KW30, KW33 and MW21 showed a higher vine growth similar
to Panniyur-1.

A higher percentage of plant success was observed in Panniyur-1 (68%) than local selections
(24-49%). The lowest plant success percentage was observed in MW21 (24%).

After first harvest, survival of mother vine was also low (23%) in local selections compared to
Panniyur-1 (80%). Results of this study revealed that growth, plant production and survival of
mother vine are highly dependant on clonal characteristics.

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Suitability of different cutting types and tissue cultured plantlets, as planting material for vanilla (Vanilla fragrans) cultivation

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Vanilla (Vanilla fragrans L.) is a tropical climbing orchid which belongs to family orchidaceae. Vanilla is by far the most economically important species as source of natural vanillin. It is valued for its sweet flavor and scent and is widely used in food industry. In Vanilla cultivation 1 meter cuttings are used as planting materials. Use of such large vines with about 12 nodes will lead to limiting the planting materials for large-scale cultivation. Alternatively a large number of 2, 3, and 4 nodal cuttings could be obtained from 1 meter long cutting but their success and performance are not reported. Therefore, this study was undertaken to investigate the suitability of different cuttings types and tissue cultured plantlets as planting material for Vanilla cultivation.

The experiment was conducted at Export Agriculture research station, Matale under the green house condition. Three types of nodal cuttings, i.e., 2, 3 and 4 and tissue cultured plantlets were taken for the comparison. For each treatment, 25 cuttings or 25 tissue cultured plantlets were taken and replicated three times. The cuttings were established in polythene bags (8’x 5’) filled with potting mixture containing equal parts of top soil: coir dust sand and cow dung. potting mixture. Each vine was tied up to 3 1/2 feet long dead wooden stick and trained along the stick to prevent entangle of vine. Data on initial length, number of leaves and girth (second node from the terminal) were recorded just after planting. The length of the newly developing shoot, number of new leaves and girth of second inter node were taken at monthly intervals. The data on vine length and girth were analyzed using ANOVA in SAS and LSD was used to compare the treatments. Data on counts were analyzed using non-parametric methods (Kruskal-Wallis or Wilcoxon).

After 5 months, higher survival percentages were found in cuttings (95%) and tissue cultured plants (92%). Out of the data collected on four parameters i.e., new shoot growth, new leaves, girth and plant survival, significant difference was found only in new shoot growth.

Three (38.8 cm) and four (46.5 cm) nodal cuttings showed a higher new shoot growth when compared to two nodal cuttings(20.5 cm) or tissue cultured plants (7.0 cm). The growth of tissue cultured plantlets was significantly lower (3-6 times) than the other type of cuttings. The results on highest shoot growth in longer cuttings indicated that initial food reserves and number of retention leaves in longer cuttings are associated with subsequent growth and development of vanilla shoots.
Development of technology to produce spice flavoured toffees as a commercial product

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Spices are major export agricultural commodity in Sri Lanka. The major uses are in food industries as a condiment and also as a seasoning agent to flavor a variety of food items. Value added spice products are more popular in food sector over the primary processed products since they are easy to handle, safe to use due to little contaminations and low cost of storage. The aim of the study is to develop technologies to make value added products (Confection–toffees) with spice flavours for the commercial market and promote them among the consumers. Cinnamon, clove and cardamom spice oil was obtained by water distillation method. These oil was used in different amounts to make flavoured toffees using trial and error methods with other ingredients used in the industry. A fixed recipe was developed and found that, to produce 1 kg bulk it was required 0.5 L of water, 750 g of sugar, 650 g of liquid glucose, 0.006 L of spice oil.

A sensory evaluation test was conducted to observe the consumer preferences for the three spice flavours with the developed recipe. A specific questionnaire was given to 200 members of the taste panel. The results were statistically analyzed. Overall preferences, as per the panel test were 98.29% for the cinnamon toffee, 97.14 % for clove toffee and 96.00 % for cardamom toffee. The preference values for color were 95.43 %, 94.86 % and 91.43 %, for sweetness 97.71%, 95.43% and 98.29 %, for aroma 98.86 %, 97.14 % and 98.29 %, for mouth feel softness 93.71 %, 89.71 % and 94.86 %, for adhesiveness 92.00 %, 90.29 % and 97.71 %, for cinnamon, clove and cardamom toffees respectively. Developed recipe can be introduced as a new value added product with spice flavour.

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Effect of immature harvesting on the physical and chemical properties of local and panniyur-1 pepper (*Piper nigrum* L.)

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The black pepper of commerce is the dried mature berries of *Piper nigrum* L. The aim of the study was to identify the changes of chemical and physical properties with maturity of berries. Pepper spikes of different maturity stages, starting from two months up to eight months were harvested. Number of berries per kilogram, bulk density and weight of a seed were determined for fresh berries and they were blanched for two minutes at 80 °C and oven dried at 50 °C to obtain black pepper. Weight recovery and light berries were determined after drying. Dean and stark method, Water distillation method, Soxhlet extraction method and refluxing method were used to determine moisture, oil, oleoresin and piperine contents respectively. Chemical constituents in oil were analyzed using Gas Liquid Chromatographic technique. Results indicated that physical parameters like mean berry weight, weight recovery and bulk density of fresh and dry pepper were increased while number of fresh and dry berries per kilogram and percentage light berries decreased with maturity. Chemical parameters like volatile oil, oleoresin and piperine contents were increased with maturity up to 5 months and then decreased. When consider the oil constituents in local selection α pinene concentration was increased up to 5 months and declined while camphene, β pinene, α phellandrene, limonene and sabinene concentrations increased with maturity. β caryophyllene concentration was fluctuated with maturity. It was highest at 4 months and lowest at 6 months maturity stage. In Panniyur -1 cultivar α pinene, β pinene and β caryophelline fluctuated during the development and α pinene and β pinene were highest at 6 months. Highest content of β caryophelline was found at 4 months. Highest levels of sabinene and limonene were found at 6 and 7 months maturity, respectively. Proportions of the most of the other components fluctuated with further berry maturity. When consider the changes of chemical and physical parameters most profitable harvesting time for black pepper production should be after 6 months maturity.

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Effect of Nitrogen and Potassium on the yield of Black Pepper \((Piper nigrum \text{ L.})\) in the wet zone mid country 3b (WM-3b), Sri Lanka

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Black pepper \((Piper nigrum \text{ L.})\) is the second important spice crop handled by Dept. of Export Agriculture which utilizes a considerable amount of inorganic fertilizer. A lot of foreign exchange is spent on these fertilizers but the national average yield \((300 \text{ kg/ha/yr})\) is still far bellow the potential yield \((1000-1500 \text{ kg/ha/yr})\). Nitrogen (N) and potassium (K) are the main elements in inorganic fertilizer combinations and therefore the determination of best combination of inorganic nitrogen and potassium is important for pepper production. The main objective of this research is to find out the best Nitrogen and Potassium combination that gives the highest yield of pepper. The experiment was conducted in the Central Research Station, Department of Export Agriculture, Matale. Main fertilizer treatments consisted of four levels of Nitrogen (as urea) at 0, 100, 150 and 200 g/plant/yr and four levels of \(K_2O\) (as Muriate of potash ) at 0, 100, 150, and 200g/plant/year and a control without fertilizer. Dry pepper yield was analyzed using SAS package. The highest yield was obtained from the treatment of nitrogen 150g/plant/yr with \(K_2O\) 150g/plant/yr. The second and the third highest yields were reported from treatments of nitrogen 100g/plant/yr with \(K_2O\) 100g/plant/yr and nitrogen 200g/plant/yr with \(K_2O\) 150g/plant/yr respectively. The lowest yields were recorded from the combination that has either zero levels of Nitrogen or Potassium. Result shows that the application of balanced fertilizer can enhance the yield of black pepper. According to the results the best combination of N and K for obtaining highest mean dry pepper yield of 4622.5Kg/ha/yr in the mid country wet zone was nitrogen 150g/plant/yr with potassium 150g/plant/yr.

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Effect of garlic (*Allium sativum* L.) water extract on the adults of black pepper lace bug, *Diconocoris distanti* Drake

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Black pepper (*Piper nigrum* L.) is an important spice cultivated in the mid country of Sri Lanka. The black pepper lace bug, *Diconocoris distanti* Drake (Hemiptera: Tingidae) is a major pest of pepper which damage by sucking the sap from leaves and young spikes and cause economically important damage. The use of eco-friendly materials such as botanical insecticides emerged as a superior alternative to the synthetic insecticides. Hence, a laboratory studies were carried out in order to assess the insecticidal and antifeedant effects of several concentrations of garlic (*Allium sativum* L.) water extract against the adults of black pepper lace bug.

Water extract of garlic cloves was used at 0.5%, 1%, 2.5%, 5%, 7.5% and 10% with distilled water as the control. Ten adults of black pepper lace bug were subjected to starvation 4h and release into petri plates containing immature pepper leaf disk (diameter 6 cm) treated with each of the above concentrations of garlic water extract under laboratory condition (temperature 27±1°C, RH 65±5%). After 48 h, data collection on number of feeding spots was counted in all three replicates using low power microscope for feeding deterrence experiment. Higher concentration (10.0%) of extract manifested higher antifeedant activity (58.67%) and all the concentrations of extract used gave significantly different effects than the control. There was a progressive increase in the feeding deterrence value for black pepper leaves with the increase in concentration of the garlic water extract.

For bioassay experiment ten starved (4h) adults were introduced in individual petri plates containing treated immature black pepper leaves. After 48 h of feeding period dead and moribund insects were counted in all three replicates. Higher LC<sub>50</sub> value (13.43%) proved low toxicity of garlic water extract against adults of pepper lace bug.

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Crown gall disease of black pepper (*Piper nigrum* Linn.) caused by an *Agrobacterium* sp.

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A new disease similar to crown gall disease is found in some pepper fields at Aranayaka area in the Sabaragamuva province of Sri Lanka. When consider the disease symptoms, brown colour deformation of the stem can be seen mostly on crown area of the vine. Because of splitting of the stem and decaying the splitting area, the vine can be broken, reducing the yield and ultimately death of the vine. This condition increases at wet weather conditions. The soil around the infected vine, roots and infected vine parts were checked for parasitic nematodes and all samples were free from parasitic nematodes. A bacterium culture showing similar colony characteristics was isolated from all infected parts placed on NA and PDA media. The suspected bacterium as the causal agent was produced slimy substance due to presence of polysaccharides in the medium when grown on PDA. Colony was pale yellow, entire margins; surface is smooth and glistening and has a convex elevation. Bacterium colony was developed purple color within 10 seconds as it is an oxidase – positive strain for the oxidative test. It is a Gram negative bacterium according to the Gram test and 3 % KOH test. Although high concentrations of suspected bacterium suspensions were poured into the soil, it could not infect vines. Healthy vines showed symptoms when infected the bacterium through wounds. Symptoms showing inoculated vine parts were cultured on PDA and NA medium and the bacterium which mostly isolated was sub cultured to obtain pure culture. The colony characters were same as the inoculated bacterium colonies and it is Gram negative, oxidase – positive bacterium. Results proved that the pepper crown gall disease is caused by *Agrobacterium* sp., according to the Koch’s rules.

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Development of a pumpkin variety HORDI-Pu -1 having good fruit quality attributes

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Pumpkin (Cucurbita moschata Poir) is considered as a minor crop in Sri Lanka. However, it is a valuable source of nutrition, particularly micronutrients and the highly beneficial phytonutrients. The most rational and sustainable strategy to prevent micronutrient deficiency is to ensure production and availability of nutrient rich vegetables at low prices to the consumers. This study was initiated in 1999 at Horticultural Crops Research and Development Institute with the objective of developing a promising pumpkin genotype having good fruit quality characteristics. The new pumpkin variety HORDI-Pu-1 is developed through inbred selection procedure from a local segregating population. It has vigorous vegetative growth and trailing habit. The fruits are uniform non ridged oblong shaped and medium size (1.5 kg/fruit). Rind colour is light brown when mature. The fruit cavity diameter is 8.2 cm whereas in recommended “Ruhunu” cultivar it is 11.5 cm. Flesh colour of HORDI-Pu-1 is golden yellow indicating its richness in carotene. Yield is about 30 t/ha. The performance of this variety in research and farmer fields indicated that it is better than the recommended cultivar Ruhunu, based on yield potential, disease resistance and good fruit quality characteristics. It has field resistance to downy mildew, tolerance to cucumber mosaic virus and powdery mildew. The palatability tests confirmed that it is highly accepted and preferred by the consumers. This is a promising variety for a national release in near future.

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Development of a whey based ready to serve nelli drink (*Phyllanthus emblica* L.)

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The objective of this study was to explore the possibility of utilizing whey for the development of nutritious whey based ready to serve (RTS) drink.

Liquid whey a by product of cheese manufacturing process was analyzed and it was pasteurized (85 °C, 15 sec) in order to destroy pathogenic microorganisms, inactivate the residual milk coagulating enzyme rennet and starter microflora added in manufacture of cheese. Nelli fruit was Steam blanched (95 °C, 4 bars, and 2 minutes) and juice was extracted. In developing RTS pasteurized whey was mixed with sweetened Nelli juice and Sulpher dioxide was added at three levels as 0 ppm, 35 ppm, and 70 ppm. Nelli, banana and vanilla essence were added separately. In sensory evaluation a five point Hedonic test was carried out by using a taste panel of 20 panelist to evaluate the flavour and colour and overall acceptability. It was found out that whey contain 93.80% moisture, 5.00% total sugar, 0.84% protein, 0.55% ash, 0.30% fat, 0.23% salt and 0.14% titratable acidity. The microbiological results (total plate count) revealed that 35 ppm and 70 ppm of preservative levels (sulphur dioxide) were acceptable after one week storage at 4 °C. Since the level of 70 ppm formed off flavour, 35 ppm was selected for further studies. The composition of developed RTS was 15.3% total solids, 14% sugar, 0.65% titratable acidity, 0.44% protein and 0.08% vitamin C. Development of acidity at room temperature stored product was significantly (p<0.05) higher than refrigerated stored product. Off colour formation was not observed during storage. Nelli and Banana flavourings were acceptable for the whey based RTS.

It can be concluded that the acceptable levels of whey and Nelli juice for RTS were 74% and 15%, respectively. Nelli and Banana flavourings, natural colour and 35 ppm of sulphur dioxide concentration were acceptable for the whey based RTS.

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Development of nutrient formulations for different crop growth stages in simplified hydroponics

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Increase in quality and yield and reduction of the cost for fertilizers can often be obtained with nutrient formulations developed, based on the crop, growth stage of the plant and climatic conditions. Simplified hydroponics is a potential growing system applicable to any part of Sri Lanka. A low cost nutrient pack, preferably optimized according to the growth stage is much needed in order to popularize it. Therefore, in this study, a new nutrient formulation (NF) which was proved to be more productive and of low cost (compared to Albert’s Solution) when applied to simplified hydroponics system was optimized according to the growth stages and named after three main growth stages, “Grow”, “Bloom” and “Fruiting”. For the optimization of NF, the important factors considered were, the change in the nutrient levels after application in the field trial with NF, optimized formulations used in countries having similar climatic conditions and K : N ratios accepted as required according to the growth stages. The composition of macro elements in the new formulations were (in ppm): Grow - N = 356, P = 80, K = 392, Ca = 301, Mg = 78; Bloom - N = 270, P = 90, K = 569, Ca = 270, Mg = 78; Fruiting - N = 169, P = 95, K = 650, Ca = 169, Mg = 95. The composition of micro elements in all three formulations were (in ppm), Cu = 0.29, Fe = 1.2, Zn = 0.26, Mn = 1.8, Mo = 0.05 and B = 0.4. The Optimized formulations were prepared using commercial grade chemicals. The cost of the chemicals for the optimized formulation was about 38\% less than that of Albert’s Solution. A field trial (May – Oct.,2007) was carried out in the wet zone for bean and tomato plants with the optimized formulations (O – for all the optimized formulations) and Albert’s Solution (Al) (control). Foliar analysis showed that the levels of the essential elements of bean plants, of the treatment O, of both “Grow” and “Bloom” stages were in the sufficient range for beans. The nitrogen level of bean plants of both “Bloom” and “Grow” stages and the levels of P and Cu in the “Bloom” stage of treatment Al were lower than that of the sufficient range. Levels of Ca and Fe in both “grow” and “bloom” stages of both the treatments, the level of Mn in the “Grow” stage of both treatments and the level of N in the “Grow” stage of treatment Al were lower than the sufficient levels of these elements in tomato leaves. Since plant growth could not be continued to the “fruiting” stage, further field evaluations should be carried out with the new optimized formulations (O) involving fruit and foliage analysis, crop growth and yield performances.

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Evaluation of the main limitations of Albert's Solution as a hydroponics fertilizer and optimization of its use

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Most hydroponics systems in Sri Lanka use the commercially available nutrient pack, Albert’s Solution. The major drawbacks of this nutrient pack are lack of proper guidance for preparing working solutions, incomplete solubility and inadequate supply of nutrients. In order to investigate these problems and suggest solutions, the composition and maximum weight to volume ratio with the minimum undissolved matter (optimum pH & Electrical Conductivity (EC) range = 5.8 – 6.5 and 2 – 3 mS/cm respectively) and the composition of undissolved matter of Albert’s Solution were determined. Field experiments were carried out to determine whether an adequate supply of nutrients is provided for tomato plants by Albert’s solution (with root solution and foliar analysis). A high variation of the compositions of the elements was found due to poor mixing of the compounds in the packs. The maximum concentration of Albert’s Solution with least undissolved solids was of 4 g/1 dm\textsuperscript{3}. Therefore, preparation of stock solutions having more than 4 g/1 dm\textsuperscript{3} is not advisable. Solutions less concentrated than 4 g/1 dm\textsuperscript{3} (with less undissolved matter) were prepared and pH and EC was measured. For those solutions, suitable pH and EC for plants were obtained with 1.6 g (pH 6.12 and EC 1.63 mS/cm) and 2.6 g (pH 6.01 and EC 2.92 mS/cm) in 1.0 dm\textsuperscript{3} of tap water. The weight: volume ratio, 1.6 g / 1 dm\textsuperscript{3} and 2.6 g / 1 dm\textsuperscript{3} were selected for the seeding & growing stages and blooming & fruiting stages (since more nutrients are required) respectively. If the pH is adjusted manually to 5.8 the amount of undissolved matter in these solutions can be further reduced. The undissolved matter contained Ca, Fe, P, S and in some instances, Mg and Mn as well. With increasing pH (> 6.1), the amounts of Ca and Fe increased while that of P decreased. It is likely that Fe(OH)\textsubscript{3}, Ca\textsubscript{2}(PO\textsubscript{4})\textsubscript{3} and also CaSO\textsubscript{4} (> pH 6.5) would precipitate since their solubility product (K\textsubscript{sp}) values are low. In solutions where high concentrations of Mg and Mn were present, it is likely that Mg\textsubscript{3}(PO\textsubscript{4})\textsubscript{2} and Mn(OH)\textsubscript{2} precipitation also takes place. When the pH is increased from 6.1 to 6.5, the weight of Ca in the precipitate increased 3 – 4 fold while the amount of Fe in the precipitate doubled. The high absorption of macro elements by plants in the field experiment shows that the nutrient solution was suitable (pH, EC and nutrient availability) to meet the high nutrient demand at the bloom and the fruiting stages. Levels of all the essential elements other than the levels of Ca and Fe in both grow and bloom stages and the level of N in the grow stage were at sufficient levels in tomato leaves. Therefore, Ca, Fe and N need to be supplied additionally in the respective growth stages.

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Effect of land suitability classes (LSC) on growth and development of above ground and below ground components of coconut (Cocos nucifera L.) seedlings

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Effect of land suitability classes (LSC) on growth and development of above ground and below ground parts of coconut (Cocos nucifera L.) seedlings grown in LSC S2 (lands that have minor limitation to coconut cultivation), S3 (lands that have some limitations to sustained coconut cultivation) and S4 (lands that have limitations to sustained coconut cultivation) in Bandiruppuwa Estate, Lunuwila was evaluated. The effect of LSC on physiological performances of the shoots was also investigated. Six months after establishment of seedlings physiological data collections were started. One year after planting, the first set of seedlings was harvested from each LSC to investigate the root growth performances.

Nine months after establishment, rate of transpiration ($E$) and stomatal diffusive resistant (SDR) of seedlings grown in S2 were significantly different ($p<0.0001$) from S3 and S4. Photosynthesis ($A$) and leaf water potential ($\psi_{\text{leaf}}$) of seedlings grown in three suitability classes were not affected by LSC at this stage. However, seedlings grown under S2 showed 12% higher rate of $A$ than the other two suitability classes.

Seedlings grown under S2, S3 and S4 did not show significant difference ($p<0.05$) in number of 1st, 2nd and 3rd roots at one year after field planting. The highest total root fresh weight and the lowest dry weight of total roots were observed in seedlings grown in S2 soils implying that the water content of these roots were higher than those of other two suitability classes. The primary root fresh weight and the 1st root volume in S2 seedlings were significantly higher ($p<0.001$) than those of S3 and S4. Total root length and volume were significantly different ($p<0.01$) between S2 and S4 suitability classes. The highest total root length and volume were observed in S2 soils and the lowest was observed in S4. This indicated that there was a restriction for root growth and development created by the physical properties of LSC. Though no significant differences were found in leaf area development, the highest and the lowest figures were recorded in the seedlings under S2 and S4 respectively. It can be concluded that, though one year old seedlings did not show significant differences in all physiological performances, root system and the leaf area development were slightly affected by LSC. The significant effect of LSC did not observe at this stage may be due to the provision of a better environment for root growth in 3’ x 3’ whole buried with coconut husk. At uprooting it was found about two third of roots of one year old seedlings was in the planting whole and only the rest was observed beyond that.

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Comparison of the growth of *in vitro* propagated *W. somnifera* with seed raised plants

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*Withania somnifera* is an important medicinal plant used in Ayurveda. Vegetative propagation methods are not successful thus tissue culture protocol has been developed for mass propagation.

*In vitro* plants are often compared with seed-raised plants in order to minimize physiological or morphological disorders, which could be appeared in *in vitro* propagated plants. The objective of this study was to compare the growth and active chemical components (Withanolides / steroids) present in tissue cultured plants of *W. somnifera* with those of seed raised plants in order to confirm that the tissue cultured plants are true to type.

Tissue cultured and seed raised plants of *W. somnifera*, which were in the same size (4-5 cm) were grown in black polythene bags (12’’ height and 6’’ diameter). They were kept in a greenhouse. Plants were watered regularly and maintained carefully applying fungicide when necessary. There were twenty replicates in each type of plants. Growth, anatomy and physiology of those two plant types were compared over a period of six months and the comparative chemical analysis was done after ten months.

The results indicated that the growth of tissue cultured plants are comparable with those of seed raised plants. Rate of photosynthesis was higher in tissue cultured plants than those of seed raised plants (6.20±0.52, 5.85±0.24 respectively) but the stomatal resistance was low in tissue cultured plants compared to those of seed raised plants (2.01±0.30, 4.72±0.40 respectively). Due to high photosynthetic rate in tissue cultured plants they are more productive but less developed leaf structures has to adapt to control the rate of transpiration. However tissue cultured plants were harder than seed raised plants thus may have more resistance to drought etc. Chemical composition of the tissue cultured plants was comparable with those in seed raised plants and found that Withaferin A – the active secondary metabolite of medicinal importance is present in high quantities in tissue cultured plants.

From all of the above observations it could be suggested that tissue culture protocol could be used successfully for large scale production of *Withania somnifera* as plants produced through tissue culture are comparable with seed raised plants in growth and chemical identities.

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Adaptation of hydroponics technology in Matara district – Case study in Beralapanathara

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Department of Agric Engineering, Faculty of Agriculture, University of Ruhuna commenced an industrialization program of the Hydroponics technology developed by the Department for farmer groups in Beralapanathara along with SEEDS (Sarvodaya Economic Enterprise Development Services) and ITDG (Intermediate Technology Development Group of Sri Lanka) in 2001. Initially 10 farmers were grouped in to a company and technology was transformed to the members in the company by employing a Graduate for a period of one year, and providing necessary inputs, technology, and know how by the project. Present study was conducted from April to May in 2008 to assess the success of the program after seven years of its existence. The main objective of the study was to assess the economy of the Bell pepper and hydroponically grown Cucumber in Beralapanathara green houses. Survey results revealed that, at present total number of green houses in Beralapanathara were increased up to 16 by grouping 15 farmers. About 76.92 % of farmers have tunnel floor area over 1000 sq.ft; 23.08 % of farmers have floor area less than 1000 sq.ft. Majority of the green houses are dent shape and used the technology innovations for the construction. Bell pepper and Cucumber are the dominating vegetable crops that grown hydroponically in Beralapanathara green houses. 38.46 % of farmers grow only Bell pepper due to its high demand and high market price. Olympus, King Arther, Adino, Golden Bell and Twingo are the commonly grown Bell pepper varieties. Among them, King Arther is better adapted for the area and gives a higher yield compare to other varieties. Cucumber, variety Efdal and variety Sakura have better adoption to this area. Results revealed that, hydroponically grown Cucumber and Bell pepper in a 1000 sq.ft tunnel provides more profit compare to tea. Limiting factor for further expansion of Cucumber appears to be the transport problem, even though profit gain from Cucumber is twice that of the Bell pepper.

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Evaluation of growth and yield performances of vetiver (Vetiveria zizanioides) under hydroponic system

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Vetiver (Vetiveria zizanioides) commonly known as Savandara and directly use for the medicinal purposes and indirectly by extraction for the distillation of the essential oil. Vetiver oil is used both in fine perfumery and in a whole range of soaps, skin lotions, deodorants and other cosmetic applications (Sreenath et al., 1994). Economically most important part of Vetivaria is its fibrous root system. The root system of Vetiver is wide, consisting of long fibrous roots and rootlets going down more than 2m depth. About 85% of the roots can be found in the first 30-35 cm under the soil surface. Major problem in Vetiver cultivation is root damages during harvesting and 40% of the roots remain in the soil, unharvested. These conditions badly effect on the oil quality. It also requires more labour and time for harvesting.

Therefore, it is important to introduce easy and safe harvesting technique for Vetiveria cultivation. Use of hydroponic culture is the most effective and easy method for root harvesting of Vetiveria zizanioides. Using this technique harvesting of whole root system, in pure form would be possible. Hence, an experiment was set up at the medicinal plant garden, Faculty of Agriculture, University of Ruhana to select suitable organic liquid fertilizer to obtain higher growth and yield of Vetiver. Albert solution, Maxicrop, worm wash, Albert solution with phosphorous, Maxicrop with phosphorous and worm wash with phosphorous were used as treatments. As a phosphorous source, Triple Super Phosphate (TSP) was added 21.6 g per box. Each box contains 36 l of solution and four Vetiver plants. Treatments were arranged in Completely Randomized Design (CRD) with three replicates. Data on shoot fresh and dry weight, root fresh and dry weight were collected in destructive sampling method and numbers of tiller per bush and number of leaves were collected as non destructive measurements.

Results revealed that, all the growth and yield parameters were significantly higher in Vetiver grown in worm wash and water (1:5) with phosphorous than other treatments and phosphorous markedly effected on root production of vetiver. Therefore, it can be concluded that, worm wash with phosphorous at above rates can be used successfully as a hydroponic solution to obtain higher growth and yield of vetiver and facilitate the harvesting in without damages.

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Effect of grazing on botanical composition and stratification of natural herbage in a coconut land

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Herbage in a coconut land is subjected to changes in botanical composition, stratification and dry matter content. The objective of this study was to determine the changes occurred in the herbage in a coconut land under grazing and non-grazing conditions. The experiment was conducted in a coconut land in Kamburugamuwa in Matara district. Twelve cross bred heifers of mean age of 18±6 months and weighing 155±6.6 kg were randomized into six paddocks, each of 0.4 ha. The treatments were namely coconut without cattle (T1); coconut with fertilizer without cattle (T2); coconut with cattle fed with natural herbage (T3); coconut with cattle fed with natural herbage + tree fodder + low cost concentrates (T4). The experimental design was a randomized complete block design with three replicates. Pasture sampling was done at bimonthly intervals. Dry matter yield, botanical composition and crude protein content of pasture were determined. Percentage of grass species has been increased in grazing treatments (around 80 %) and has been decreased in non-grazing treatments (lower than 5 %). Common grass species available are Axonopus affinis and Axonopus compressus; both are edible to cattle. Percentage of species other than grasses and legumes has been increased in non-grazing treatments (60-70 %) and has been decreased in grazing treatments (around 15 %). Common examples are Eupatorium odoratum, Ocimum tenuiflorum, Urena lobota, Lantana camera; they are non edible weeds. Lower stratum of herbage (15 cm >) has become dominant in grazing treatments, while it has been suppressed in non-grazing treatments. The reason for this suppression is mutual shading by upper layer of herbage. Upper stratum of herbage (15 cm <) has become dominant in non-grazing treatments, while it has been suppressed in grazing treatments. Grazing reduces the cost of weeding considerably. In T1 and T2, weeding had to be done four times a year and the weeding cost was Rs 5000/ha/yr while in T3 and T4, once a year was enough and weeding was required only to remove non-edible weeds. Therefore, the cost was only Rs 1250/ha/yr. The results revealed that grazing positively improved the botanical composition of herbage as indicated by the higher grass percentage in grazing treatments. These results suggest that the yield and quality of natural herbage under coconut could be improved through grazing.

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Studies on wedge grafting of wall anoda (*Anona glabra* Lin) Using different scions

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Wall anoda (*Anona glabra* Lin,) belongs to family Anonaceae, is a small tree, some what swollen at the base, naturally grown in near swamps & river banks. Also this plant has Quick growing ability & tolerance to flooding as well as salt conditions. In Sri Lanka this plant is a problematic weed especially wet zone low lands as well as paddy fields.

The fruit is a heart shaped. When fully ripped it has yellow colored skin. The pulp is orange colored and has smooth aroma. The raw fruit is edible but there's no commercial value on it.

Seedlings of *Anona globra* are quick – growing and more vigorous, the taproot is branched & with less fibrous roots. Since the tree tolerates for flooding and marshy conditions, plant is very suitable for use as a root stock. This study was undertaken to observe the suitability of using *A. globra* as a stock plant to four edible commercially cultivated verities. Research was conducted at the faculty of Agriculture, University of Ruhuna.

Three months old ploy bagged *Anona glabra* saplings were used for the stock plants. Experimental design was RCBD with five replicates. Each replicate has 10 plants and blocking was done according to the diameter of stock plants. Different scions were used as *Anona reticulata* (weli anona) (T1), *Anona muricata* (katu anona) (T2), *Anona cherimola* (Cherimola) (T3), and *Anona squamosa* (seeni anona) (T4).

Wedge grafting technique was applied. After 21 days successful percentage, number of leaves, number of branches in the scion part was measured as non destructive method and it was continued up to another two months period. (80 days after grafting) Treatment 2, 3, and 4 showed significant success than treatment one, three weeks after grafting (p>0.05) T1 showed the lowest success percentage (2%). Eighty days after T2 grafting showed significantly higher success percentage (69%) and number of leaves than T3 and T4. It was concluded *Anona muricata* was the best scion for wedge grafting with *Anona gabra*.

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Evaluation of different types of commercially available domestic compost bins as an option for kitchen and garden waste management

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Composting is one way in which some of the problems associated with the utilization of various organic wastes can be resolved. Particularly in the urban area compost bins are being used for home composting, however, no any performance evaluation has been done with regard to different compost bins in Sri Lanka. The objectives of this research were to evaluate the different parameters in the composting process in different compost bins currently available in Sri Lanka, in order to find the comparatively most effective compost bin for kitchen waste. Four types of compost bins, namely, concrete box type (CB), plastic cylindrical shape (PC), plastic conical shape (PCO), and concrete cylindrical shape (CC) bins were used. Kitchen waste was used as main source of materials and garden waste was also used as a supplement. Parameters such as temperature, pH, electrical conductivity (EC), moisture content (MC), bulk density (BD), dry matter (DM), ash, Carbon: Nitrogen (C:N) ratio and volume reduction were measured for about 2 months. Highest temperature was reported from CB and PC (37 °C) during first week which was quite higher than ambient temperature (28.8 °C). Mature compost, dark brown in colour, moderately sticky, and no odor, were observed after 8 weeks of operation in CC. Moisture content of each type of bins were observed in the range of 50 % - 60 %. pH was reduced during the composting process, and it was close to pH 7 at maturity stage. Ash percentages at the maturity stage of compost were 8.15 %, 8.05 %, 9.10 % and 7.65 % in CB, PCO, PC and CC, respectively. At maturity the highest organic matter content (92.31 %) and Nitrogen content (1.06 %) were observed in CC and PCO, respectively with compared to other bins. Lowest C:N ratio (1:10.65) was observed in CC. Due to passive composting (no mixing of bulk) within the compost bin, the rate of decomposition was relatively low. According to the results, other parameters except C:N ratio, were shown relatively similar observations. However, since C:N ratio is vital factor in composting, CC can be recommended, compared with other types, for home composting of kitchen waste.

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Validation of critical control points in HACCP system for broiler processing

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Processing is the final step in the production of broiler chicken and the quality of the final product is dependent on proper processing conditions. Internationally accepted food safety management tool, Hazard Analysis and Critical Control Point (HACCP) certification and Good Manufacturing Practices (GMP) are essential to achieve well recognized market standard. Therefore the presence study was conducted to validate Critical Control Points (CCPs) of existing HACCP system in one of the largest broiler processing company. Ante mortem Inspection, Evisceration, Post Mortem Inspection, Chilling of Carcass, Chilling of Giblets, Blast Freezing and Storage are the main CCPs in broiler processing. Although, evisceration is the most critical place which causes more hazards in manufacturing process. Hence validation was done only for evisceration process using swab sampling technique and visual observations from randomly selected carcasses. Swab samples were taken from 3 places of the surface of carcasses to estimate the E. coli, Coliform and Total Plate Count (TPC). Gut and organ damages, faecal and bile contaminations were selected as the visual observation parameters. In addition, the effect of distance (30, 30-60 and >60 km) and time of live bird transportation on carcass quality was assessed counting the number of physically damaged carcasses (hemorrhages, bruises, dislocations) from randomly selected carcasses from each farm. Microbiological analysis reveal that the E. coli/ Coliform and TPC have reduced after evisceration with compared to before evisceration. E-coli, Coliform and TPC values were log 3.48, log 3.9 and log 5 before evisceration and log 3, log 3.48 and log 4 after evisceration. Visual observations shown that there were significantly high level of gut damages (30%) and faecal contamination (20%) during processing and highest level of gut damages and faecal contamination were observed in 1st hour of production due to the instrument used for vent cutting. There were higher level of organ damages (40%) and bile contaminations (10%). It depended on skillness of labour for organ harvesting. Time of transportation had no effect on carcass quality parameters due to different practices. The high percentage of physical damages when transporting less than 30 km, would be due to the overcrowding of the crates to reduce the number of journeys. Effectiveness of existing carcass washing system is low in removing contaminations and evisceration methods adopted in present situation may cause higher contamination and gut damages. Therefore a Chlorinated water spray with a concentration of 5ppm after defeathering prior to the evisceration is recommended.

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Effect of casing types and diameter on quality of skin on chicken sausages

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Natural and artificial casings are used as forms and containers for sausages. The casings bind and protect the delicacy of the sausage mixture; they regulate contraction and expansion of the sausage. Therefore this experiment was conducted to find out the effect of casing type and casing diameter on quality of commercially available skin on chicken sausages. Three types of chicken sausage samples were prepared using hog, sheep, and devro casings; artificial (cellulose) casing was used as a control. Samples were vacuum packed and stored for 3 months period in freezing (−18°C) (quick) conditions. Cooking loss (CL) was measured just after the sample preparation. Total plate count (TPC) log CFU/g and sensory evaluation was done at 3 weeks intervals. pH, Water Holding Capacity (WHC), Purge Loss (PL), color and tenderness were also measured.

Sample stuffed in sheep casing was showed highest (11.8±0.22%) CL when compared to the other 3 types of casing. WHC decreased in all 4 types of casings during the 3 months period. Sample stuff in devro casing and sheep casing shown the highest redness (12.9±0.38) and highest yellowness (15.6±0.6) respectively. Sample stuff in sheep casing and cellulose casing showed the lowest redness (9.29±0.74) and lowest yellowness (12.16±0.32) respectively. Casing type and diameter had a significant (P<0.05) effect on texture of the sausage sample. The highest texture (0.046kN) was observed in sample stuff in hog casing while the cellulose casing showed the lowest texture (0.015±0.001kN). PL was high (3.48±0.01%) in artificial casing which has large diameter.

Sausage stuff in artificial and devro casing shown good appearance than other samples. However natural casing samples had better flavor, but all other quality parameters were not acceptable. Overall acceptability was high in devro casing. Highest microbial count (7.5×10^5) was observed in sheep casing when compared to other casings, but all the values were in acceptable level.

Sample stuffed in devro and cellulose casing can be stored for 3 months period and had better microbial and other quality standards when compared to hog and sheep casings.

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Hot water double dip method as an effective postharvest treatment for the control of anthracnose disease of papaya

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Papaya fruits (variety solo) from plants previously sprayed with 0.1% prochloraz and 0.1% tricyclazole and from non sprayed plants, harvested at color break stage were used to study the effect of different postharvest treatments in controlling anthracnose disease. Fruits were subjected to different hot water treatments such as control (without any treatment), dipping in 48 °C for 15, 20 and 30 minutes, 50 °C for 15, 20 and 30 minutes and the double dip method (42 °C for 30 minutes followed by 20 minutes at 49 °C). Fruits were stored in plastic crates at room temperature (28 ± 1 °C) after the treatments until symptom development and observations were recorded to examine the disease development. The disease incidence was significantly less (\(P=0.001\)) when fruits treated with hot water double dip method compared to other treatments. Both hot water double dip and 50 °C for 30 minutes treatments reduced the number of anthracnose spots significantly. When the harvested fruits kept at 50 °C for 30 minutes and treated with hot water double dip method, the size of anthracnose spots was reduced significantly compared to untreated fruits. Hot water double dip treatment in combination with either pre-harvest spray of prochloraz or tricyclazole found to be effective in controlling the anthracnose disease of papaya. The temperature used in hot water double dip treatment did not show any heat injury to the fruit.

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Wet feeding reduces the feed conversion ratio of young broiler chicks

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Wet feeding has been found to increase growth and, in particular cases, feed efficiency and utilization of phytate phosphorus in poultry. The objective of this study was to determine the effects of wet feeding on growth performance, feed and water intake, some faecal qualities and gastric transit time (GTT) of young broiler chicks from 11 to 21 days. From day 11 to day 21, broiler chicks in 16 pens were fed a commercial broiler starter diet either in dry (DF) or wet (WF) form. WF was prepared every morning by mixing water and feed at 11:9 ratio, giving a porridge-like consistency. Daily intakes of water and feed were recorded. Intake of feed from wet feed container was corrected for water in the feed and for evaporation losses. On day 21, one bird was selected from each cage and GTT was determined. Faecal samples were collected and analyzed for nitrogen (N) and ash. Growth performance parameters such as live weight on day 21 (998 g), weight gain (751 g) and feed intake (888 g) of the chicks given dry feed were not significantly different from those of the birds given WF (998 g, 751 g and 855 g, respectively). Importantly, the feed conversion ratio of the DF given chicks (1.18) was significantly reduced to 1.14 when WF was given. Birds given WF drank significantly less water from drinkers compared to those given DF. However, the total water intake (water from drinker + water from feed) of the birds given WF was significantly higher than that of birds given DF. GTT, faecal N and ash contents were also not affected by the form of feed. It was concluded that wet feeding increased the feed efficiency and water intake of young broiler chicks.

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Effects of curry leaf extract (*Murrya koenigi*) and Lovastatin® on egg yolk cholesterol contents of chicken egg

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The poultry industry is under tremendous pressure to produce cholesterol-low eggs to meet the consumer demands arising from cholesterol scare. The objectives of this study were to determine the effects of curry leaf extract (CLE) and Lovastatin® given with water on the physical properties and yolk cholesterol contents of chicken egg. Giving completely randomize design, forty weeks old layers (n=72) in 24 pens were given normal water, water with 5% CLE or water with Lovastatin® for two weeks. Randomly selected eggs were analyzed for egg physical qualities such as weight of the egg, albumin, yolk, shell and yolk pH and shell ash. Yolks and serum samples were analyzed for cholesterol. In general, egg production, feed intake and water intakes were not affected by the treatments. Egg weight of the birds given CLE tends to be lower than that of other two treatments. Albumin pH was tended to be low in Lovastatin® given birds. Other egg quality parameters were not significantly affected by the treatments. Yolk cholesterol contents (mg/g of fresh yolk) of the birds given Lovastatin® and CLE were 1.56 and 3.1% lower than that of normal water given birds. The total yolk cholesterol content of the control birds, CLE and Lovastatin® given birds were 222, 215 and 205 mg/yolk, respectively. Though not significant, CLE and Lovastatin® reduced the total yolk cholesterol content by 3 and 7.6%, respectively. It was concluded that under the present experimental conditions, Lovastatin® was more efficacious than CLE in reducing the cholesterol contents of chicken egg.

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Effect of complete replacement of fish meal from a sesame meal free diet on growth performance of broilers

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Both fish meal (FM) and sesame meal are among the most important feed ingredients used in broiler feeds. The price of fish meal and sesame meal are increasing and sesame meal has been not available in the local market during recent years, making the feed formulators to look for alternatives. In this study, using a linear model based computer software, two sesame-meal-free least cost broiler rations with 0% or 5% FM were formulated. Subsequently, broiler chicks (n=300) in 12 pens were fed one of the above two diets (FM- or FM+) from day 21 to 35 and growth performances, feed and water intakes were compared. The cost of FM+ and FM- formulations were 64 and 58 Rs/kg, respectively. The removal of FM increased the dietary soy bean meal levels from 19% to 30%, while reducing the coconut poonac content from 9.2% to 21.9%. The feed and water intake values and the feed to water ratio were not significantly different between the two groups of birds. Though not significant, growth performance parameters such as live weight on day 35 (1553±35g), weight gain (772g) and feed conversion ratio (2.37) of the birds given FM- feed were inferior to those of the birds given FM+ feed (1612±35g, 838g and 2.06±0.2, respectively). The total feed cost from day 21 to 35 reduced from Rs. 111.15 to Rs. 107.09 when FM was completely replaced. However, the feed cost per 1 kg of live weight gain from day 21 to 35 of the birds fed FM+ (Rs. 133.33) was tended to be lower (P=0.06) than that of the birds fed FM- feed (Rs. 138.71). It was concluded that complete replacement of FM from a sesame meal free broiler finisher diet increased the feed cost per kg of live weight gain, though the general growth performance was not significantly reduced.

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A comparison of the ammonia emission rates and some physio-chemical properties of the litter of broilers fed diets with or without fish meal

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Dietary factors are among the important determinants of the poultry litter quality parameters. The objectives of this study were to compare some physio-chemical properties of the litters of broilers fed diets with (FM+) or without fish meal (FM-). Broiler chicks (n=300) in 12 pens were raised from day 21 to 35. Birds in six pens were fed a broiler finisher diet with 5% FM, while other six groups were fed a diet without FM. Random litter samples collected from each cage on day 28 and 35 were analyzed for moisture, pH, total solids, electrical conductivity and mineralized carbon. Ammonia emission rates were also determined. The litter moisture and pH levels were not affected by the feed, but were high in both litters. The total litter solid content of the FM-litter (4080 mg/l) was tended to be higher than that of FM+ litter (3486 mg/l). In contrast, the electrical conductivity (8176 ms/cm) and the mineralized carbon content (2598 mg/kg liter) of the FM+litter were significantly higher than those of the FM- litter (6934 ms/cm and 2022 mg/kg liter, respectively). Litter or faecal N contents were not significantly different between two litters. It was concluded that broiler finisher diets with or without FM had no significant effects on important litter quality parameters such as litter moisture, total litter solid pH and ammonia emission rates, but had significant effects on litter parameters such as total litter solid pH, electrical conductivity and mineralized carbon contents.

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Effects of fish silage given with water on growth performance, organ weights and carcass parameters of broiler chickens

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Fish silage (FS) is a nutritious liquid feed produced by ensiling fish waste either with fermentable sugars or acids. Fish silage has to be co-dried with a suitable material if to be used in practical poultry diets. The objective of this study was to determine the effects of giving FS with water on growth and some carcass parameters of broiler chicken. Twenty days old broiler chicks (n=36) were allocated into 12 pens. From day 21 to 42, broilers in six pens received normal water, while those in other six pens received water containing 5% FS. 5% FS reduced the pH of normal water from 6 to 4.1. The feed intake was not affected by giving FS with water. However, the intake of water with FS (290ml/bird/day) was significantly lower than that of water without FS (353 ml/bird/day). Consequently, water to feed ratio reduced when FS was mixed with water. FS given with water had no significant effects on other growth parameters such as live weight on day 42, weight gain, feed conversion ratio and weights of visceral organs such as liver, heart, gizzard, pancreas and proventriculus. Interestingly, broilers given FS supplemented water had higher empty carcass weight (P=0.06), dressing percentage (P<0.05) and sellable carcass weight (P<0.05) than those given normal water. It was concluded that the provision of water with 5% FS reduced the water intake and increased the empty carcass weight and dressing percentage of broiler chickens.

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Social obstacles of community based urban waste management projects: lessons learnt from Matara municipality

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One of the emerging and burning issues in municipal areas of Sri Lanka is the inefficiency in collection and disposal of solid wastes and consequent widespread scattering and dumping grounds of garbage. Unplanned dumping sites of garbage in many areas cause pollution of ground and surface water and encroachment also. In Matara municipality the problem is more critical as the dumping sites are along the Nilwala river bank which generates serious environmental and hygienic threats due to contamination of ground water and river water.

Although, several authorities are spending a huge sum of money and other resources on disposal of solid wastes, still it is an unsolved and complex problem. In the year 2006, after conducting a baseline survey to estimate household solid waste generation, awareness programs were launched for households in Walpola GN division in Matara municipality with the help of different stakeholders. Model composting bins were established at household level to produce compost using kitchen and garden waste while collecting non-degradable waste separately. Urban agricultural techniques were introduced to utilize composts made of household waste and people were mobilized to cultivate vegetables using modern home-gardening techniques. Social obstacles in different forms were recorded during a period of two years.

The study identified that poor attitudes and understanding of people is the main hindrance while friction made by the fleet of the waste collectors of municipal conventional system also significant. Bureaucracy and local politics also play a role to discourage people who are involved in the project activities.

Proper identification of such groups, awareness programs and providing a significant role to the conventional fleet of waste collectors helps the progress of community based household waste management programs for a pleasant environment.

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Effective coastal vegetative landscaping for the tsunami protection in Sri Lanka

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Coastal vegetation acts as a natural barrier against natural and man made disasters protecting infrastructure and saving lives. A research on coastal vegetation and its responses to Tsunami for last two years was conducted by a team comprising researchers from Saitama University, Japan and University of Peradeniya. The findings from this research proposes several options for coastal vegetation that can response effectively and reduce the impacts of Tsunami and other natural disasters in future. Accordingly, the team suggested to establish a pilot scale coastal plantation on 26th December 2006 in Matara Thotamuna area which was drastically affected at Tsunami in the South Coast of Sri Lanka, and to continue the research on the growth and other issues for a period of 5 years. The growth and development of Casuarina equisetifolia and Pandanus odoratissimus plants were continuously monitored during the period. The average height and diameter of the Pandanus plants were around 92.22cm and 117.11cm, respectively and the average height and diameter of the Casuarina plants were 627.5cm and 3.97cm, respectively after 18 months of planting. Dense growths of the plants are evident at present which acts as a wind barrier in the area. It was noticed that the project was more successful and effective through better maintenance and operations and also the support from local authorities and local communities is essential to make this program a success.

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Efficiency of compost production in household level to reduce waste generation in Matara municipality

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Solid waste management is a serious problem in Sri Lanka. With increasing waste generation, the final disposal is predominantly open dumping leading to increasing environmental degradation and growing health problems. The national solid waste management strategy aims to establish proper solid waste management systems throughout the country and local action plans urgently needed to implement this strategy. Matara is a large town in the southern province of Sri Lanka which disposed waste amounting, 38 t/day. Among this waste majority consists of degradable waste. The objective of the study was to assess the quality of prepared compost with standards value and to find the efficiency of householders in producing quality compost.

The project was planned to undergo in Walpola GN division in Matara municipality. Sample of 50 house holders were selected and initially under gone with questionnaire survey. Then compost bins made by concrete were installed and mobilization programme was undergone to prepare backyard compost. After six months, prepared compost samples were analyzed for the parameters such as EC (electrical conductivity), pH, and moisture content. Compost bin temperatures within the compost bin were taken fortnightly. Results of the survey reveals that land extent of the selected group were, 46% medium land (10-20 perch), 37% small land (< 10 perch) and 17% larger land (>20 perch). Since most of them have medium land availability, most favorable option of waste management is concrete compost bin installation. Again it was found, 30% of the households separate waste and 70% are not. Again 57% disposed the waste by supplying to the municipal council tractor. After installation of compost bin prepared compost were subjected to measure quality and parameters as, pH, salinity, and moisture content complied with standard quality values in compost. Bin temperature was 40°C and it was best for the regulating of composting procedure. In concern of efficiency of producing quality compost within householders more than 50% (pH-60%, salinity-91%, moisture-89%) were been able to attend there compost with best quality. It can be concluded from the above study that the quality of compost made with kitchen waste management complied with standard quality parameters in compost. At the same time initial project target group were been able to have there own waste management practice with composting with best quality standard.

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Estimating the quantity and composition of household solid waste in Walpola GN division

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One of the immerging and burning issues in Sri Lanka is the inefficiency in collection and disposal of solid waste and consequent widespread scattering and dumping grounds of garbage. Waste that are improperly dumped impede water flows in drainage canals, and provide breeding places for disease vectors such as rat mosquitoes, and flies. Waste is a by-product of human activity. Solid waste has great potential for adversely affecting the quality of the environment. In other hand it is a misplaced resource. Due to absence of proper household waste management method, several problems have emerged. The objectives of the study were to estimate the different composition of household waste, and to identify the present waste disposing methods.

The project was undergone in 1st and 2nd cross lanes, Walpola GN division in Matara municipality. House holders in above cross lanes were selected and initially under gone with questionnaire survey and participatory appraisal to estimate different categories of waste. Separate baskets were given to householders to measure the amount of wastes. Basically kitchen wastes, plastic/polythene, paper/cardboards, and glasses & tins were measured in volume basis and afterward it converted into weights. Data were analyzed with suitable parametric and non parametric techniques. Out of total household waste generation 48% was kitchen waste, 39% of glass, 7% of paper and 6% plastic and polythene. Out of total sample 30% separate waste while 70% were not. In disposing of kitchen waste, 57% supply their waste to municipal council (MC) tractor while 30% compost, 4% burry and 4% with no special practice. In disposing of polythene waste 74% supply to MC tractor 9% burn 9% throw and 8% burry. With concern of glass waste 44% sell, 26% supply to MC tractor 9% throw and another 13% no special practices is used. In disposing of glass 48% supply to MC tractor, 39% sell and 9% throw and 4% with no special practices. The study also reveals that out of different waste generated almost half have been supplied to MC tractor ex. kitchen waste 57%, polythene 74%, plastics 57%, glass 53%, and 48% metal. Number of family members has positively related to per capita household waste generation. But Income and expenditure on foods showed non-significant positive relationship with per capita household waste generated. Study concludes that majority of the house holders disposed there waste to municipal council tractor. Research finding revealed that per capita kitchen waste production per day is 0.280kg in Wapola GN division.

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Identification of cost effective medium for oyster mushroom cultivation in Sri Lanka

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The growth, yield performance and cost effectiveness of using three different substrates were evaluated for the cultivation of two widely grown American oyster and Lanka oyster mushrooms (Pleurotus ostiatus). The experiment compared mycelial growth, time taken for the formation of fruiting bodies, marketable yield and cost benefit ratios in two harvests of two mushroom types under the three substrates with three replicates. Results indicated that saw dust and paddy straw at the rate of 1:1 as the most suitable substrate for American oyster mushroom while saw dust without mixing with paddy straw as the most suitable substrate for Lanka oyster mushroom.

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Effect of pod exudates of *Solanum melongina* L. (Brinjal) on conidia development of *Colletotrichum gloeosporioides* causing anthracnose disease

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Studies were undertaken to detect the effect of pod exudates, at the surface of the pods of *Solanum melongina* L. (Brinjal) on the development of the conidia of *Colletotrichum gloeosporioides* that causes anthracnose disease. Three varieties of brinjal i.e. ‘Padagoda’, ‘Amanda’ and ‘Anjali’ were selected. Pod exudates of these varieties before and after fractionation in ether, were tested for the conidial germination, length of germ tube and formation of appressoria using a Completely Randomized Design (CRD). Conidial development was significantly (P=0.05) influenced by the pod exudates of variety ‘Padagoda’, which was a susceptible variety to anthracnose disease than the other two varieties. Drops of the conidia suspension of *Colletotrichum gloeosporioides* and the control (sterilized distilled water), were pin pricked inoculated to healthy mature pods of the three varieties and the order of appearance of symptoms and the lesion diameters were measured over time. The Variety ‘Padagoda’ showed a faster lesion diameter increment than the varieties ‘Anjali’ and ‘Amanda’. Chemical factors found in the water soluble fraction significantly (P=0.05) stimulated the conidial germination than the water insoluble fraction after 22 hours of incubation. The effect of synthetic compounds on the differentiation of these conidia was also investigated. Conidia germination percentage was significantly higher (P=0.05) in 10⁻², 10⁻³ and 10⁻⁴ g ml⁻¹ concentrations of Glucose, 10⁻² g ml⁻¹ concentration of Sucrose, 10⁻³ and 10⁻⁴ g ml⁻¹ concentrations of KCl and 10⁻² g ml⁻¹ concentration of CaCl₂. Paper chromatography was conducted to separate the compounds in pod exudates which were suspected as stimulatory to the development of the conidia of *Colletotrichum gloeosporioides* and were able to separate but not identified. Results revealed that the stimulatory effect of the pod exudates on the development of conidia could be used to compare the susceptibility / resistance of *Solanum melongina* L. (Brinjal) to disease anthracnose among the tested varieties.

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Need for an intensive extension approach to promote the cinnamon Industry in Matara district

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Cinnamon (Cinnamomum zelanicum), an indigenous spice in Sri Lanka, has decreased its total production, average yield and the extent of cultivation during the last two decades. Cinnamon is one of the major spices important in the export economy with more than 90 percent of the total production being exported. Cinnamon growers are not satisfied with continuing this crop, because profit is low due to very high land rents which is not matching with the opportunity cost of cinnamon cultivation, high marketing cost, poor marketing extension activities related to cinnamon quills production and lack of skilled labour for harvesting and processing. These have created an uncertainty regarding the future of cinnamon cultivation in Sri Lanka.

This study investigated into the relationship between extension activities and cinnamon quills production in Matara district. A field survey was conducted, using a structured questionnaire, covering 50 cinnamon farmers in three Divisional Secretariats of Hakmana, Kumburupitiya, and Mulatiyana in the Matara district, during 2007. Data collected was subject to descriptive and correlation analysis.

The study revealed that there were several problems faced by cinnamon farmers, such as use of inappropriate technology, traditional management of processing and grading, lack of market information to the growers, lack of knowledge about quality requirements, inadequate government subsides and lack of entrepreneurial skills of the growers. Unskilled labour was a major constraint in producing quality cinnamon quills. Creating awareness of proper quality and sanitary standards, provision of necessary institution support and inputs, supply of subsidies credit facilities, strengthening the relationship between extension officers and farmers, motivate farmers to attend more farmer training classes and create farmer organizations are recommended to rejuvenate the cinnamon industry in Matara district.

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Efficacy of some selected fungicides in controlling smut disease in sugarcane

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Sugarcane smut caused by the fungus *Ustilago scitaminea*, is one of the most destructive diseases of sugarcane in Sri Lanka. As the disease is a sett-born, use of healthy seed cane is vital to reduce the losses due to disease. Present study was undertaken to find out the effect of sett treatment and spraying of fungicides on smut disease.

Promising systemic fungicide Tebuconazole (Folicur EW 250) was tested with fungicide carbendazim (Bavistin) in a randomized blocked field trial at Udawalawe, Sugarcane Research Institute. Each block consisted with plots (10 m * 6.85 m) replicated 3 times. Smut susceptible variety SL 88-116 was used and 3 budded setts were inoculated with smut (*Ustilago scitaminea*) spores using the immersion method. These pre inoculated seed setts were used for the trial. Three methods of fungicide application were used: 1. a cold dip of setts (a.i. 500 ppm) for 30 min, 2. a cold dip of setts (a.i. 500 ppm) for 30 min 3. spraying fungicides fortnightly until crop reaches 4 months and Spraying fungicides fortnightly until crop reaches 4 months (concentration 0.27 a.i. g / lit. of water). Observations on standing crop were recorded periodically and cumulative disease development was evaluated. In addition preliminary study was conducted *in vitro* using the above fungicides.

Results shows that seed setts dipping in fungicide tebuconazole i.e. T4 (dip in 500ppm solution) and T5 (dip + spry 0.27 a.i.g/l); has a good effect on controlling primary smut infection over the other fungicide treatment methods. When cumulative disease incidences of plant crop above 6.5 months (26 weeks after planting) considered, same treatments gave smut incidences less than 5% while all other treatment combinations including controls gave higher disease incidences. In plots where fungicide spraying was done, i.e.T3 (spray carbendazim) and T4 (spray tebuconazole) drastic increment in disease incidence was observed. Although sett dipping in Folicur was effective, spraying Folicur at a rate of 0.27 a.i. g / lit. of water was not effective in controlling primary smut infection. This may be due to maximum colonization of smut fungi as other competitive fungal colonies are suppressed by spraying these fungicides.

Seed setts dipping in 500ppm solution of tebuconazole (Folicur® EW 250) for 30 min effectively controls smut infection in sugarcane.

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Preparation of jujubes from locally available fruits

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Jujubes are traditional western candies; exist with sweet taste and unique rubbery nature. Water melon, pineapple and wood apple are readily available in dry zone of Sri Lanka and underutilized during their seasons. Present study was conducted to develop Jujubes incorporated with Watermelon (*Citrullus vulgaricus*), Pineapple (*Ananas comosus*) & Wood apple (*Feronia limonia*). Further, studies were undergone to determined the most acceptable formula for Jujubes and evaluate the shelf life. Jujubes were studied under three different combinations of sugar, pulp and gelatin contents. Selected ripen fruits were blended to get fruit pulp of 35%, 37%, and 39% (W/W %). It was mixed with Sugar of 35%, 40.5%, and 45%, liquid glucose (42°DE) to boil up to 82° Brix and eventually mixed with 3.1%, 5%, and 7% of Gelatin dissolved solution and left to cool. During cooling, colors and citric acid were added and allowed to settle down in oiled mould to form Jujubes. These Jujubes were subjected to sensory, chemical, and microbiology analyses. Sensory evaluations (seven points hedonic scales) were conducted to find out the best formulation in terms of Color, Texture, Taste, Flavor and overall acceptability. The combination of 5% of gelatin content, 37% of pulp and 40.5% of sugar content was sensed by most of the panelist as best formula. Results of the ranking test showed that 47% of panelist preferred the develop Jujubes; in contrast 53% selected commercial available Jujubes. After 5th week watery nature was observed due to hygroscopic properties of the product and titrable acidity also gradually increased. However, negligible aerobic plate count, yeast and mould were observed during that period. The results revealed that Jujubes can be prepared from Watermelon, Pine apple and Wood apple with satisfactory consumer acceptability and kept for five weeks.

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Use of domestic level rainwater harvesting techniques for agricultural purposes in the dry-zone of Sri Lanka

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Domestic level rainwater harvesting techniques have been promoted by several organizations in the areas where the water is limited. The two main techniques promoted were the rainwater harvesting tanks (RWHT) and rainwater ponds (RWHP). The objectives were to identify different techniques used, assess the socio-economic factors associated with their adoption, identify the problems and limitations and to make recommendations on improving the applicability of rainwater harvesting in the dry-zone of Sri Lanka. Based on the adoption in the dry zone, Hambantota and Puttlam districts were selected for the research. Primary data were collected from 62 farmers chosen by using stratified random sampling technique. Using the Statistical Package for Social Sciences correlations and Chi squares tests for associations between variables were performed.

Except for one person who had constructed RWHT with his own funds, all others (61) had received assistance from non-government organizations such as Practical Action, World Vision, OXFAM GB, etc. The assistance and the farmer’s participation depended on the organization, which had provided the construction materials and technology in constructing the RWHT or RWHP. In Puttlam, RWHP were the primary water source for all respondents, but in Hamabentota, since there were other water sources, only 60% of the respondents used RWHT as primary water source. The RWHP (108000-324000 liters) had comparatively larger capacities than the RWHT (10000-15000 liters), but there was no significant relationship between incomes from farming with the type of technique. Majority of the respondents from both areas (81.3% in Hambantota and 56.7% in Puttlam) take out water manually. A significantly higher proportion of those who had larger storage devices used water pumps to take out water (Chi square value= 9.04, df=3, Sig < 0.05). Majority (90.3%) of the respondents was able to increase the income from farming and half of them have been able to cultivate Yala season using harvested water. They used pond water for numerous purposes except for cooking and drinking, but the tank water is mainly used for agriculture and brick making from which they were able to earn an average annual income of Rs.75,417.00 from brick making industry. It can be concluded that providing assistance have contributed to the adoption since it cost around Rs. 50000 for a RWHT and Rs. 15000 for a RWHP. It is important to disseminate the knowledge and skills of rainwater harvesting at household level and methods of efficient irrigation. It is recommended to have ground liners to prevent the water loss mainly through seepage, especially in areas where the soil is sandy.

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Studies on allelopathic activity and weed suppression by leaf litter leachates of three invasive weed species

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Allelo chemicals leached from certain plants suppress the growth of other plants. The action of the leaf litter of three invasive weeds Lantana camara, Wedelia trilobata and Clidemia hirta on establishment of common weeds was tested to find out their allelopathic effect on other weeds. Surface soil collected from a weedy area put into aluminium trays were enriched with two rates of leaf litter (20g/tray and 40g/tray) of each invasive weed species and were incubated under net house conditions for the establishment of common weeds. Untreated control was maintained without addition of any leaf litter. Randomized complete design was used with four replicates. The number of weeds in each tray was counted at 2, 3, 4 and 8 weeks after initiation of the experiment. The allelopathic activity of leaf litter was expressed in terms of percentage reduction of the weed count when compared to the control. Both rates of leaf litters of three invasive weeds significantly reduced (p=0.01) the weed population compared to the control. Low rate and high rate of Wedelia trilobata reduced the weed population averagely by 47% and 81% respectively while Lantana camara reduced by 62% and 86% respectively during the period of 8 weeks. Low rates of Clidemia hirta reduced the weed population averagely by a slightly higher percentage (92%) than that of higher rates (83%). Leaf litters of three invasive weeds have negative impact on the natural weed flora. Further investigations on allelopathic effect using not only the leaf litters but also the other parts of more invasive and common weeds may help to develop a proper detection method of invasive weeds.

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Effect of planting geometry on yield of brinjal (*Solanum melongena* L.) intercropped with groundnut (*Arshis hypogaea* L.)

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Increased population with limited land resources is imperative to increase agricultural production per unit land area by suitable agronomic practices. Maintaining optimum plant population and intercropping systems are two important factors for consideration to achieve this goal. By appropriate planting geometry, the plant population of base crop can be kept without causing reduction in yield and also there is an additional land area to cultivate an intercrop. Therefore, this study was carried out at the Agronomy farm, Eastern University, Sri Lanka to evaluate the effect of planting geometry on yield of brinjal (*Solanum melongena* L.) intercropped with groundnut (*Arshis hypogaea* L.). This experiment was designed in a Randomized Complete Block Design with five treatments and three replicates. Base crop (T1) and intercrop (T2) were grown in pure stands and other treatments were brinjal single row with groundnut single row (alternate planting of brinjal and groundnut) (T3) and brinjal paired row with two rows (T4) or one row (T5) of groundnut. Yield components such as 50% flowering, number of pods, weight of pod, length of pod, girth of pod and pod yield were taken at regular intervals. In addition, land equivalent ratio (LER) as an index of intercropping advantage was determined to assess the efficiency of intercropping comparison to monocropping. The results showed that 50% flowering, number of pods, weight of pod, length of pod and girth of pod were not affected by planting pattern. There was no significant difference (P>0.05) in brinjal yield among the treatments, however, the brinjal yield in T4 was recorded 8.99 kg per plot (4.5 m²) and high as compared to other treatments. Land equivalent ratio was superior in all tested intercropping system than monocropping. In intercropping treatments, crop gave higher yield with compared to monocrop brinjal. Brinjal paired row with two rows of groundnut (T4) is most suitable planting geometry to obtain higher yield in brinjal-groundnut intercropping.

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Effect of particle size and soil texture on soil nitrogen mineralization

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Decline in soil productivity and environmental quality and progressive deterioration of natural resources in the tropics have led to a search for new methods to sustain crop production via more efficient nutrient cycling. In tropical agricultural systems with limited access to fertilizers, plant residues are often used to meet the N requirements of most of the crops. Plant residues, particularly leguminous residues, are an important source of N to crops in low input agricultural systems, and contribute significantly to the N requirements of crops. A study on Gliricidia leaves decomposition was conducted under laboratory conditions to elucidate the effect of the particle size ($S_1 \leq 0.5$ mm, $S_2 = 4$ mm) and texture of soil ($T_1 =$ Sandy clay loam, $T_2 =$ loamy sand) on nitrogen mineralization after incorporation in to the soil.

The early stages of the incubation were found to be significantly influenced by the particle size of the Gliricidia leaves. However, in the case of NO$_3^-$-N mineralization, no any treatment was found to be significant. Present results revealed that nitrogen mineralization of Gliricidia leaves were affected by the texture of the soil. Sandy clay loam soil (clay 28%) showed higher N mineralization when compared with loamy sand soil (clay 9%). It is important to standardize residue particle size and residue quality determination to relate their intrinsic chemical characteristics with their rate of N mineralization.

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Insect diversity and abundance in vegetation in conventional and pesticide free mixed vegetable ecosystems

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Assessing the insect diversity and abundance in vegetation in conventional and pesticide free mixed vegetable fields were the objectives of this study. Three fields with low country vegetables that were under conventional management and three fields under pesticide free management were repeatedly sampled using sweep nets to collect insects in the vegetation. Collected insects were processed and identified up to taxonomic families. The data were compared using contingency tables.

Insects collected in pesticide free and conventional agroecosystems belonged to nine Insect Orders: Coleoptera, Diptera, Heteroptera, Homoptera, Hymenoptera, Lepidoptera, Odonata, Orthoptera and Thysanoptera. Total number of adult insects collected in conventionally managed sampling sites was higher (566) than that of pesticide free fields (324). Numbers of insects belonging to these orders were significantly different between pesticide free and conventional agroecosystems ($\chi^2=56$ $df=8$ $P<0.01$). Numbers of insects belonging to different taxonomic orders were significantly different among the study sites Dodangolla, Doluwa and Mahaillupullama which were managed as conventional vegetable fields ($\chi^2=118$ $df=16$ $P<0.01$). A similar difference was found among the sites Peradeniya, Dodangolla and Mahaillupullama which were managed as pesticide free mixed vegetable fields ($\chi^2=67$ $df=16$ $P<0.01$). The insects collected in all study sites of pesticide free fields belonged to 45 taxonomic families while the insects collected in conventional fields belonged to 44 taxonomic families. The insects collected in all study sites under pesticide free cultivation belonged to 25 phytophagous families, 8 predatory families and 9 parasitoid families. In conventionally managed fields, there were 26 phytophagous families, 11 predatory families and 10 parasitoid families. In both cultivation systems, Family Cicadellidae and Aphididae dominated in terms of insect abundance. It appears that conventionally managed vegetable ecosystem supports the abundance of insects, but majority of them are phytophagous insects. In the sites under pesticide free cultivation had more individuals of parasitoids compare to the conventional sites, which indicate the promotion of parasitoid populations perhaps due to low selection pressure of agrochemicals. Differences of diversity among sampling locations could be associated with the differences of agro-ecological zones.

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Ex-situ conservation of bird's nest anthurium (*Anthurium hookeri*)

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*Anthurium hookeri* is one of the most popular landscape plants grown in Sri Lanka. Usually plant is propagated by using underground stems, offsets and from herbaceous stem cuttings. But number of plants produced by those methods is limited due to scarcity of planting materials. Excessive use of planting material for landscape purposes will be badly affected on natural occurring of species. Therefore *ex-situ* conservation of bird’s nest anthurium is timely important.

A series of pot experiments were conducted to study germination ability of bird's nest anthurium, seedling growth in different potting media and growth performances as a potted plant under greenhouse conditions. All experiments were set up according to Completely Randomized Design with ten replicates. Seeds were extracted from fully ripen berries and washed thoroughly in order to remove jelly-like substances. Seed germination studies were done by using five different media such as coir dust, charcoal, sand, wet filter paper and sand 1: coir dust 1: bricks pieces 1. Germinated seedlings were then transferred to similar media except for wet filter paper.

The highest germination rate was observed in charcoal media (88%). Vigorous roots were formed on the charcoal pieces. It may be due to epiphytic growth habit of the plant. The lowest rate of germination was observed in wet filter paper media (52%). Sand: coir dust : bricks pieces (1:1:1) medium showed good performances of seedling growth. Number of leaves were recorded in this medium was 4.4. According to the results, it can be concluded that *Anthurium hookeri* can be produced by using both seeds and plantlets, using different potting media for landscape purposes while keeping natural habitats. Therefore this method can be identified as one of the *ex-situ* conservation methods of bird’s nest anthurium.

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Intercropping performance of radish (*Raphanus sativus* L.) planted with vegetable amaranthus (*Amaranthus tricolor* L.) in response to paired row planting system

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Intercropping is widely practiced by the farmers in the tropics, because of increased productivity and reliability in production. This study was carried out at the Agronomy farm, Eastern University, Sri Lanka to evaluate the effect of intercropping performance of radish (*Raphanus sativus* L.) planted with vegetable amaranthus (*Amaranthus tricolor* L.) in response to paired row planting system. Radish, Japan ball variety was used for this attempt. Experiment was designed in a Randomized Complete Block Design with six treatments and four replicates. Treatments included radish as a sole crop with the spacing of 30 cm × 10 cm (T1), vegetable amaranthus as a sole crop with the spacing of 10 cm × 5 cm (T2), 20/50 cm paired row planting of radish with three rows of vegetable amaranthus in between paired rows of radish (T3), 20/50 cm paired row planting of radish with four rows of vegetable amaranthus in between paired rows of radish (T4), 25/40 cm paired row planting of radish with three rows of vegetable amaranthus in between paired rows of radish (T5) and 25/40 cm paired row planting of radish with two rows of vegetable amaranthus in between paired rows of radish (T6). In radish planted as base crop, leaf area index (LAI) was recorded at regular intervals, while tuberous root diameter, total root length and fresh and dry weights of leaf and tuberous root were measured at harvest. In addition, land equivalent ratio (LER) was calculated.

The results revealed that LER was high in intercropping system compared with monocropping. It ranged from 1.16 (T6) to 1.31 (T3). There was no significant difference (P>0.05) in radish yield among the treatments. However, the yield of radish (39.26 tons/ha) in monocropping was higher as compared to that in intercropping. Among intercropping, T3 gave slightly higher yield (37.78 tons/ha). In all treatments reached optimum LAI at harvest. Fresh and dry weights of tuberous root and leaf and other parameters were high in T3. In the present study, 20/50 cm paired row planting of radish intercropped with three rows of vegetable amaranthus in between paired rows of radish would be the most suitable planting system.

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Investigation of domestic kitchen wastes as potential colouring agent for textile substrates

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This research study focuses on the dyeing of cellulosic (cotton) fabrics with aqueous extracts from two different domestic wastes. Two methods of dyeing (i.e. with mordanting and without mordanting) were carried out on cotton fabric. In this study extraction of brilliant brown and red colours from kitchen wastes are of particular interest. Colouring matter from used tea leaves (*Camelia sinensis*) and big onion (*Alium cepa*) skin were extracted and dyeing tests were performed. Colour strength, shade and fastness properties of the dyed textiles were investigated. The extracts were applied under optimum conditions with one synthetic mordant (*CuSO₄*) and two natural mordants Sepalika (*Nyctanthes arbor-tristis*) and Aralu (*Terminalia Chebula*). The results prove the potential of such wastes as a source for natural dye extraction. To obtain textile dyeing with acceptable fastness properties, however, rigorous selection of dyes and development of suitable processes are required.

When a commercial gamut of natural dyes is formed, the total capacity of available material can be expected to be sufficient to provide the textile market with natural dyes. While the shade of the dyeing obtained with the plant material is of considerable interest because brilliant brown and red shades can be obtained, careful selection of plant sources is necessary to achieve suitable fastness properties.

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Effect of decapitation on yield of greengram (*Vigna radiata* L.)

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An attempt was done to study the effect of decapitation on yield of greengram (*Vigna radiata* L.) at the Agronomy farm, Eastern University, Sri Lanka. The experiment was laid out in a Randomized Complete Block Design with five treatments and four replications. In control treatment (T1), removal of apical portion of main stem (decapitation) was not practiced whereas in other treatments, decapitation was done at 3rd, 4th, 5th and 6th weeks after planting (T2, T3, T4 and T5) respectively. The size of each plot was 70 cm x 90 cm. Greengram (cv. MI-5) seeds were planted at a spacing of 30 cm between rows and 10 cm within plants and other agronomic practices were done as recommended by Department of Agriculture. Number of days to 50% flowering, number of pods per plant, number of seeds per pod and yield per plot were recorded. Data collected were statistically analyzed using analysis of variance and the significance of difference between means was estimated using Duncan's Multiple Range Test at 5% level. The results showed that 1st flowering appeared at 30 days after sowing in T1, T4 and T5 whereas in T2 and T3, it took longer period (34-37 days) however, all treatments showed 50% and 100% flowering within 4-15 days after appearance of 1st flower. There were significant differences (P<0.05) observed in number of pods per plant, number of seeds per pod and dry weight of pod per plant in T2 compared to other treatments except T3. T2 gave high yield (152.85 ± 14.89g per plot) among the treatments. In the present study, decapitation done at 3rd week after sowing (T2) is most effective practice to achieve higher yield of greengram in sandy regosol.

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Growth performances of selected cinnamon cultivars at different locations in Matara, Galle, Kalutara and Rathnapura districts

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True cinnamon (Cinnamomum zeylanicum Blum, 2n=24) endemic plant popularly known as Ceylon cinnamon belongs to the genus Cinnamomum of the plant family Lauraceae. This paper describes growth performances of selected ten cinnamon cultivars in four different locations regarding field establishment, plant height (cm) and plant diameter (mm).

Based on the germplasm screening and competitive evaluation, ten cinnamon lines were selected. They are CRS 351, CRS 166, CRS 156, CRS 23, CRS 201, CRS 83, CRS 317, CRS 184, CRS 318 and CRS 40. These selected lines have been vegetatively propagated and initiated four different experiments at Cinnamon Research Station in Matara, Kosgoda in Galle, Lihiniyawa in Kalutara and Pallebedda in Rathnapura districts. The experiment plot having 25 planting points were laid out in a randomized complete block design (CRBD) with four replicates. Detailed study of growth characters including establishment percentage, plant height (cm), plant diameter (mm) were recorded 3, 6, 12, 18, 24, and 30 months after field planting.

Among the different locations, maximum variation of establishment percentage was observed in Rathnapura district at Pallebedda experiment (6% – 85.2%). But 7% - 100% field establishment percentage was recorded Matara district followed by in Galle 63%- 95.8% and in Kalutara Districts 66% - 98% . Due to higher percentage of casualties in Pallebedda experiment, Vegetative propagated plants are not suitable for dry areas of intermediate zone like Pallebedda.

Plant height measurement in Matara and Galle experiments did not show significant differences even at initial stages. Therefore all the cultivars gave better performances regarding plant height in Matara & Galle districts. The highest plant height & plant diameter in four locations were exhibited in CRS 317 in Galle district (214.2 cm 47.5 mm) respectively. Finally, plant height and plant diameter in each location showed same pattern.

Based on the overall growth performances CRS 317 exhibited higher results in each location and Matara district is more suitable CRS 317 for vegetatively propagated Cinnamon plants.

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Flowering behavior of *in vitro* propagated *Zeuxine flava*

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*Zeuxine flava* (Family Orchidaceae) is an important medicinal plant found in natural forests of Sri Lanka. Due to its variegated leaves this is named as jewel orchid. This species is categorized as threatened species in the 1999 list of threatened flora and fauna (red data book) published by IUCN. This becomes threatened mainly due to habitat destruction and over exploitation of the species. Other than the medicinal value this species has a potential as an ornamental plant if sufficient quantities can be supplied. Therefore it is important to develop a mass propagation protocol for clonal propagation of this rare species.

*In vitro* plants were produced using apical meristems as explants. After 8 subculturing in the shoot initiation medium (1/10 strength woody plant basal medium + 2.25 mg/L BAP + 1.0 mg/L 2,4-D) elongated shoots able to produce root nodules. After root nodules were induced they were kept further 2 weeks under same condition for root elongation.

After acclimatization, *in vitro* plants were established using coconut husks as the potting mixture for comparative studies with natural plants in green house condition. *In vitro* produced plants were healthy and observed a fast growth rate than natural plants collected from the field in green house condition. When grown under green house conditions texture and the colour of the leaves of the natural plants were not comparable with those grown under natural conditions but the leaves of the *in vitro* propagated plants were dark green in colour with prominent shining silver line along the mid rib.

Under natural conditions *Zeuxine flava* produce flowers from December to March. However natural plants grown under green house condition did not flower at all. *In vitro* produced plants showed an unusual pattern of flowering and produced flower spikes during March – May which is off season for flowering under natural conditions. Number of flowers in a spike in natural plants are around 6 – 8, but only 3 – 4 flowers per spike was observed in flowers produced by *in vitro* produced plants. However there was no difference in floral morphology. Natural plants maintained under green house condition did not produce flowers and they were dried off at the end of flowering season but *in vitro* produced plants were not dried off after flowering season instead they produced multiple shoots. Artificial pollination was not successful for flowers produced in *in vitro* produced plants.

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Effect of different inhibitory substances on fermentation of sweet sugary sap of kithul in Jaffna

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The main source of crude sugar in Sri Lanka is the sweet sugary sap obtained from the tapped inflorescence of the Coconut (Cocos nucifera), Palmyrah (Borassus flabellifer) and Kithul (Caryota urens) palms. This sap is sterile and highly charged with sugar, but unless special precautions are taken, fermentation by yeast and bacteria leads to accumulation of alcohol and acids. Lining the inside of the pot with fresh lime, placing Hal bark (*Vateria copallifera*), Kahata bark (*Careya arborea*) and the leaves of Ankenda (*Achronychia laurifolia*) in a clean pot before used for collecting sap, are the most common methods used to reduce fermentation. The objective of the study was to study the effect of various substances used in Jaffna, to prevent fermentation taking place in the Kithul sap and to recommend the cheapest and easily available, efficient fermentation preventing substance. Pieces of fresh bark of Hal, Kahata and leaves of Ankenda at the same rate (weight -10g / pot) were put into each collecting pot before use. Another pot was lined with lime. Control was also maintained without any materials. The samples of sap were collected at equal time intervals and analyzed for reducing sugars, total sugars, pH, alcohol content, number of yeast and bacterial cells. The pH of Kithul sap in Hal, Kahata, Ankenda and control showed significant difference separately with the pH values in Lime (p = 0.05). The pH was very high (12 -13) in lime and remained the same throughout the experiment. Bacterial cells (in order of $10^7$ – $10^8$ cells / ml) were found after 15 hours in all the treatments except in the one with lime. Number of bacterial cells was much lower initially and the growth rate gradually decreased with the time. Kahata and Ankenda also showed decrease in the bacterial population. Yeast cells were found in almost all treatments except lime. In Hal, yeast cells were much lower initially but increased towards the end. In other treatments yeast showed a slightly slower growth rate when compared with control. No alcohol was found in the limed pot. Hal and Ankenda showed significantly lower percentage reduction in the amount of sugar as compared to that of control. Lime is the most effective, cheapest and easily available substance that prevents fermentation taking place in the sweet sugary sap of Kithul. Hal could be used as effectively as lime to preserve sweet sap of Kithul, for 45 hours. Due to the difficulties in getting Hal bark and Kahata bark in Jaffna they are not recommended. Ankenda is also not recommended because of its poor ability to inhibit fermentation.

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Content and *in vitro* bioaccessibility of β-carotene from two mango fruit varieties

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Among the local mango (*Mangifera indica* L.) varieties, “Karuthacolomban” and “Beti Amba” are widely consumed in Sri Lanka. The objective of the present study was to quantitatively analyze pro-vitamin A carotenoids in the varieties, “Karuthacolomban” and ‘Beti Amba” which were identified by the horticultural crop research and development institute, Gannoruwa, Kandy, Sri Lanka and to assess their *in vitro* bioaccessibility. A reversed phase HPLC method has been developed for the separation and extraction of carotenoids in crude and saponified extracts from “Karuthacolomban” and ‘Beti Amba’ fruits. All fruits at the uniform ripening stage (i.e., fully ripe) were selected from local market and used for the analysis.

Carotenoids were extracted and identified by using Open Column Chromatography (OCC) and UV Visible absorption spectra (maximum absorption and spectral fine structure). Purity of the identified carotenoids were further confirmed using the HPLC with photo diode array detection (*C*18 column Spherisorb ODS2, 5µm, 4.6mm x 150mm; gradient elution of mobile phase of Methanol, Acetonitrile and 0.05% Triethylamine in Ethylacetate). *In vitro* bioaccessibility of provitamin A carotenoids were analyzed using Gastro Intestinal Tract simulation method .The quantification of those carotenoids were carried out using reverse phase HPLC with external standard.

The HPLC analyses of crude extract of carotenoids of the variety Karuthacolamban highlighted the existence of four main peaks which had UV- Visible spectra similar to those reported for violaxanthin, neoxanthin, β-carotene and α-cryptoxanthin and in variety Beti Amba highlighted the existence of three main peaks which had UV- Visible spectra similar to those reported for violaxanthin, neoxanthin, β-carotene. The variety Karuthacolombat contains 2.7 ±0.3 µg/g (Fresh weight) and the variety Beti Amba contains 2.6 ±0.3 µg/ g (Fresh weight) of β-carotene as the principal pro-vitamin A carotenoid. The amount of *in vitro* bioaccessible.

β-carotene was higher in the Beti Amba variety (29.6%) than Karuthacolomban (24%). Thus, this study has indicated that varietal differences may not exist in the content but in the bioaccessibility of beta-carotene in mango varieties examined in this study.

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Isolation of microorganisms from an effluent sample having tolerance to different metal ions

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Effluent samples were collected from a textile dyeing industry which uses many chemicals for dyeing process. Initially, the effluents were analyzed to check for the presence of microorganisms that can survive under these conditions and the extra chromosomal elements of these microorganisms were investigated using standard procedures. The microorganisms were classified using gram staining procedure and microscopic observations. The effluents were screened for possible metal contaminants using Atomic Absorption Spectrometry. The tolerance limits of the microorganisms for different metal ions were determined. Finally, the metal ion remediation efficiency of the microorganisms was determined.

Plasmids containing nine bacterial strains which can survive in the presence of metal ions were successfully isolated from the effluents. Among them, the metal ion tolerance ability of the G strain is 0.02- 4.0 ppm concentrations of Cu\(^{2+}\) ion and 0.40 ppm to more than 10.0 ppm concentrations of Zn\(^{2+}\) ion. The bioremediation ability of G and P strains for Cu\(^{2+}\) and Zn\(^{2+}\) ions showed 1.1 ppm to 0.5 ppm decrease in concentration of Zn\(^{2+}\) and 1.1 ppm to 0.6 ppm decrease in concentration of Cu\(^{2+}\) during three days time period.

<table>
<thead>
<tr>
<th>Strain No.</th>
<th>Collected site</th>
<th>Classification</th>
<th>Plasmid size (kb)</th>
<th>Morphology of colonies</th>
<th>Tolerable Metal ion</th>
</tr>
</thead>
<tbody>
<tr>
<td>D(_2)</td>
<td>Oxygenation process</td>
<td>Gram positive, Rods</td>
<td>4</td>
<td>Orange coloured, large</td>
<td>Cu(^{2+}), Zn(^{2+}), Pb(^{2+}), Cd(^{2+})</td>
</tr>
<tr>
<td>G</td>
<td>Gram positive, Coccus</td>
<td>6, 4</td>
<td>White coloured, small</td>
<td>Cu(^{2+}), Zn(^{2+})</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>Gram Negative, Filamentous</td>
<td>3</td>
<td>White coloured, large</td>
<td>Cu(^{2+}), Zn(^{2+})</td>
<td></td>
</tr>
<tr>
<td>K, L, M, O, P</td>
<td>Biological treatment process</td>
<td>Gram positive, Rods</td>
<td>3</td>
<td>Yellow coloured, large</td>
<td>Cu(^{2+}), Zn(^{2+})</td>
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<tr>
<td>N</td>
<td>Gram Negative, Filamentous</td>
<td>3</td>
<td>Yellow coloured, large</td>
<td>Cu(^{2+}), Zn(^{2+})</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Characters identified in isolated bacterial strains

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Species richness and diversity of amphibians of the Giritale nature reserve of North-Central province, Sri Lanka

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A study on amphibian diversity and evenness of the Giritale nature reserve of North Central Sri Lanka was conducted from May 2006 to April 2008. Four habitat types, namely, grasslands, paddy fields, forests and human habitats were identified using digital maps. Amphibians in each habitat type were recorded using three quadrates (10mx10m). When trees were present inside the quadrate trunk and branches were checked for arboreal species. Amphibian species richness (S) and Shannon-Weiner Diversity Index of species diversity \( H' \) were calculated. Four hundred and thirty one amphibians belonging to the three families Bufonidae, Microhylidae and Ranidae were recorded. A total of ten species were recorded, they were Atukorale’s Toad (\textit{Bufo atukoralei}), Common Toad (\textit{Bufo melanostictus}), Sri Lankan bullfrog (\textit{Kaloula taprobanica}), Ornate narrow mouthed frog (\textit{Microhyla ornata}), Indian skipper frog (\textit{Euphlyctis cyanophlyctis}), Common paddy field frog (\textit{Fejervarya limnocharis}), Jordon’s bullfrog (\textit{Hoplobatrachus crassus}), Sri Lanka Wood frog (\textit{Rana gracilis}), Polonnaruwa shrub frog (\textit{Philautus regius}) and Spotted tree frog (\textit{Polypedates maculates}). Of these three species, Atukorale’s frog (\textit{Bufo atukoralei}), Sri Lankan wood frog (\textit{Rana gracilis}) and Polonnaruwa shrub frog (\textit{Philautus regius}) are endemic. The total abundance was highest in the paddy fields with 5.0±0.0 (Mean±SD) individuals and the lowest was in the human habitations with 3.70±2.56 (Mean±SD) individuals. Highest diversity index (\( H' \)) of 2.87 was recorded in the paddy fields while forest had the lowest diversity index of 1.24. Highest species richness of 07 was recorded in the human habitats. Lowest species richness of 03 was observed in the forests and paddy fields. Shannon Weiner evenness (J) was highest in the paddy fields (J=1.6) and was lowest in the forest habitat (J=1.13). Common paddy field frog (\textit{Fejervarya limnocharis}) was the most abundant while ornate narrow mouthed frog (\textit{Microhyla ornata}) was the least abundant amphibian species. The base line data on diversity and richness obtained during this study could later be used in conservation status assessments.

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Diversity and abundance of medium and large mammals of the Giritale nature reserve of North-Central province, Sri Lanka.

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Thirty medium and large mammal species are known to occur in the dry zone forests of Sri Lanka. However, there is a paucity of data related to species diversity and abundance of those species. This study was conducted in three habitat types namely forest, shrub-land and grassland in the Giritale Nature Reserve in North-central province of Sri Lanka. Study was conducted from June to December 2007. Many short line transects (total length 4km per habitat) were used for each habitat and marked using a GPS. Havahart live animal cage traps were used to capture the medium sized mammals each month. Direct and indirect observations were also conducted. Two hundred and forty five medium and large sized mammals belonging to seven orders, sixteen families and species were recorded at the three different habitat types by the direct census method. Rainfall data were obtained from the Meteorological Department. Three endemic species Trachypithecus vetulus, Macaca sinica and Moschiola meminna and five threatened species Manis crassicaudata, Lutra lutra, Panthera pardus, Moschiola meminna and Trachypithecus vetulus were recorded. Bandicota indica and Herpestes brachyurus were trapped. Forest had the highest Shannon diversity (H') index of 0.967 while Shrub-land had the lowest diversity index (0.458). Shannon diversity index was not significantly different in three habitats. Diversity index was not significant related with the rainfall. Axis axis was the most abundant and lowest abundant was Bandicota indica. Highest evenness value was recorded in grassland (0.967) and lowest (0.701) recorded in shrub-land. Giritale Nature Reserve consist 60% of mammal species, 60% of endemic species and 62.5% of near threaten species with regarding the total mammalian fauna present at each category in the country. Present study which is the first to reveal the species diversity and abundance of medium and large sized mammals inhabits at the Giritale Nature Reserve.

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Chemical composition of selected varieties of chicken sausages

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“Ready to eat meat products” are very much popular among the Sri Lankan population than they were a few decades ago. The meat products available do not carry any information of nutritive values on the label. The present study determines the chemical composition and iron content of selected chicken products available in the local market. Where possible the nutritive values were compared with standard values given by the Sri Lanka Standard Institution (SLS).

A market survey indicated chicken sausages to be most popular. The most popular brands of chicken sausages were then selected for this study. Samples for each brand were obtained from two batches. These were fried for 2 – 5 minutes using medium flame and used for analyses of moisture, ash, crude protein, digestible carbohydrate, fat, and iron content using standard methods (AOAC). Moisture, ash, crude protein, digestible carbohydrate, fat, and iron content of the three different brands ranged from 52.6 – 63.6 %, 0.10 – 0.17 %, 12.4 – 15.0 %, 2.7 – 4.8 %, 14.6 – 23.6 % and 1.1 – 2.2 mg/g respectively. In all three brands moisture and fat contents totaled to more than 75 % of the wet weight. Moisture and fat contents were significantly different among the three brands (p < 0.05). The sample which had the lowest fat content had the highest moisture content. Among the three brands one brand had significantly low protein amount (p < 0.05) in the samples from both batches. Ash content was significantly low (p < 0.05) in one sample and correspondingly the iron content was also significantly low in the same sample (p < 0.05) compared to the other two brands. The difference in proximate composition among the three brands may be due to different raw materials used in their product, age of the animal, type of feed they used and different body parts of the animal that were used in the product. There was no significant difference between the two batches of the sample (p > 0.05) except for protein in one brand. The fat content compared well with the data given by the Sri Lanka Standard Institution (SLS) and all the three samples had higher carbohydrate content (on dry basis) than the standard values given by the SLS.

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Rhizobiology of some selected crop wild relatives of Vigna in Sri Lanka

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In this study, four legume species collected from different locations in Sri Lanka were subjected for analysis of which hardly any information is available on their rhizobiology. They are *Vigna dalzelliana*, *Vigna trinervia*, *Vigna trilobata* and *Macroptelium* sp. The object of the study was, characterizing rhizobia, maintain a rhizobium collection, examination of infectivity & effectivity of the rhizobial isolates and development of effective inocula for crop varieties. During the work, isolation, purification, characterization and authentication of rhizobium isolates from the root nodules of host plants were done.

Characterization was performed using morphological characters such as colony characters, gram staining and spore staining, biochemical characters such as BRYMA test and checking for gas and acid production and infectivity and effectivity was checked using a reference plant, siratro (*Macroptelium artropurpureum*).

Rhizobium isolates could tentatively assign into 14 isolates according to the results of characterization. These include seven isolates from *V. dalzelliana*, one isolate from *V. trinervia*, two isolates from *V. trilobata* and four isolates from *Macroptelium* sp. All of them are gram negative non spore formers. Among them 11 isolates are fast growers and the other 3 are slow growers. All the slow growers are non gas producers where as all the fast growers except 2 are gas producers. Upon inoculation of isolates to siratro the VTL2 isolate showed highest infectivity and this could be used to inoculate crop species of *Vigna* with the aim of increasing the yield. Other isolates showed less or no infectivity.

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Preliminary investigation into antibacterial and antifungal activity of a species of *Trichoderma* isolated from Soil

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Fungal metabolites are important source of wide variety of drugs including the antibiotic penicillin and popular cholesterol lowering agent lovastatin.

Soil samples collected were cultured in yeast malt agar using standard procedures to isolate fungi which were later purified. To determine the bioactivity of these fungi, pure cultures were grown in the same medium in large scale. Extracts of cultures were made using methanol followed by separation with ethyl-acetate to obtain low molecular weight compounds. Crude ethyl-acetate extracts in methanol were used to determine antibacterial and antifungal activity against several bacteria spp, (*Bacillus* sp, *E. coli*, *Staphylococcus* sp and *Klebsiella* sp.) and several yeast strains (*Saccharomyces* strains, and a *Shizosaccharomyces* strain) using Kirby-Bauer method. Each disc contained 500 μg of the crude extract. Discs containing Amoxicillin (25 μg), Polymyxine B (20 μg) and methanol separately were used as positive and negative controls respectively. All assays were done in duplicate and average diameters of clear zones were recorded. Out of the seventeen extracts tested, one showed antibacterial activity against *Bacillus* sp. Both sample and Amoxicillin gave 11 mm clear zone. Same extract showed antifungal activity against *Saccharomyces* strain giving clear zones of 15 mm. The positive control, Polymyxine B gave only 12 mm clear zone. By studying colony characters, fungal morphology and asexual reproductive characters, the bioactive fungal culture was identified as a species of *Trichoderma*.

The above fungus was grown in different media to select the best medium for growth and to determine any change in bioactivity in different media. Potato dextrose broth (PDB) was found to be the best medium. To study changes in bioactivity and chemical diversity in the presence of the different metal ions, an experiment was also set up where fungus was grown in PDB medium containing different metal ions (Mg\(^{2+}\), Cd\(^{2+}\), Al\(^{3+}\), Ni\(^{2+}\), Fe\(^{2+}\), Cr\(^{2+}\), Ca\(^{2+}\), Zn\(^{2+}\) and Co\(^{2+}\)) at concentration of 1 mg/100 mL. The ethyl acetate extracts of above cultures were tested for antibacterial activity using *Bacillus* sp. The yield and antibacterial activity of the fungal extract had increased when the fungus was grown in the presence of Mg\(^{2+}\), Cd\(^{2+}\), Al\(^{3+}\) and Ni\(^{2+}\) while in the presence of Ca\(^{2+}\) and Zn\(^{2+}\) only the yield of extract increased.

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Moss (*Barbula* sp.) used as biomonitor of atmospheric heavy metal deposition: Estimation of uptake efficiencies

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Concentrations of Pb, Ni, Cu, Cr and Cd in two *Barbula* species in permeable bags (moss bag method) were compared with bulk deposition measurements of these elements at three monitoring stations; Dalugama, Biyagama and Sedawatte which can be identified as highly polluted areas in Sri Lanka. Amount of heavy metals in moss and bulk collector were determined by Atomic Absorption Spectrophotometry (AAS) during six months of period from October 2007 to March 2008.

Heavy metal concentrations measured in three monitoring stations during six months period is given in $\mu$g/g dry weight of moss sample. Concentration of heavy metals in bulk collector is expressed in $\mu$g/cm\(^2\) area of the funnel. These elements showed generally significant correlations between moss and bulk deposition, and uptake efficiencies ($E_x$) relative to that of Pb were estimated using the formula

$$E_x(\%) = \frac{K_x}{K_{Pb}} \times 100$$

where $K_x$ is the slope of the regression line of element $x$, and $K_{Pb}$ is the slope of the regression line of Pb in mosses vs atmospheric deposition. The uptake efficiency of heavy metals were also established for each site using another formula

$$E_s^x(\%) = \frac{C \times A}{D}$$

where $E_s^x(\%)$ is the uptake efficiency of an element $x$ at monitoring station s, C is the moss concentration, D is the bulk deposition and A is a “ratio constant” estimated for each monitoring station. The uptake efficiencies of heavy metals to be: Ni 50-65%; Cu 55-70%; Cr 45-60%; Cd 60-70% for *Barbula* sp.1 and Ni 65-70%; Cu 80-90%; Cr 30-50%; Cd 45-60% for *Barbula* sp.2. Therefore Ni and Cu have higher uptake efficiency towards *Barbula* sp.1 whereas Cr and Cd have higher uptake efficiency towards *Barbula* sp.2.

Figure 1

Plot of amount of Pb in two *Barbula* species against the bulk deposition
Inhibitory effect of *Allium sativum* on pathogenic bacteria

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The goal of the present study was to authenticate the antibacterial activity of different solvent extracts of *Allium sativum* (garlic bulb) obtained by sequential hot extraction method using soxhlet apparatus. Garlic bulbs were dried in an oven at 40 °C and powdered. This powder was extracted using dichloromethane, ethyl acetate, ethanol, methanol and water. Solvent from each extracts was completely evaporated. Working stock was prepared in the mixture of acetone and DMSO. Antibacterial activity of these extracts was assessed by agar well diffusion method against *Staphylococcus aureus, Pseudomonas aeruginosa* and *Escherichia coli*. Nutrient agar plate containing $10^6$ cells / ml of bacterium was prepared and allowed to set. The well of 8.0 mm of diameter was made on it and 50 mg / 100 µl of each extract was inoculated into the well. Streptomycin was used as standard and the solvent mixture of DMSO and acetone was used as control. The antibacterial activity was recorded by measuring the zone of inhibition after 24 hours of incubation at 37 °C. Each experiment was carried out in triplicates and the mean value was taken. The result demonstrated that all the test samples except water extract had the ability to inhibit all the test organisms at 50 mg / 100 µl concentration and the degree of zone of inhibition was in the range of 11.0 ± 0.26 mm to 22.0 ± 0.18 mm. *Pseudomonas aeruginosa* and *Staphylococcus aureus* were found to be highly sensitive to methanol and ethyl acetate extract respectively. Dichloromethane and ethanol extracts on *Pseudomonas aeruginosa* and *Staphylococcus aureus*, ethyl acetate extract on *Pseudomonas aeruginosa* and methanol extract on *Staphylococcus aureus* showed moderate inhibition. *E. coli* was found to be less sensitive to all the test samples except methanol extract which expressed moderate inhibition. The standard experiment demonstrated that the zone of inhibition produced on *Pseudomonas aeruginosa* and *Staphylococcus aureus* by streptomycin, methanol and ethyl acetate extracts was almost similar.

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Preliminary study on antibacterial activity of extracts of *Eucalyptus melliodora*

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The objective of the study was to demonstrate the antibacterial effect of ethanol, methanol and aqueous extracts of leaves of *Eucalyptus melliodora* on five pathogenic bacteria by *in vitro* bioassay. Dried leaves powder was soaked with ethanol for 72 hours and filtered with No.1 whatman filter paper. This procedure was repeated for three times and all the extracts were pooled together. The resultant residue was dried and similar extraction was done with methanol and sterile water. The solvent from each extracts was removed and antibacterial activity was tested against *Pseudomonas aeruginosa, Klebsiella sp, Escherichia coli, Staphylococcus aureus and Bacillus sp* by agar well diffusion method. 15 ml of autoclaved and cooled nutrient agar was incorporated with 1 ml of bacterial inoculum (10^6 cells / ml). It was poured into sterile petri-dish and allowed to set. The well of 8.0 mm of diameter was made on it and 100 µl (50 mg/100 µl) of each extract was inoculated into the well. 100 µl (50 µg/ 100 µl) of streptomycin was used as standard and the mixture of DMSO and acetone was used as solvent control. Plates were incubated at suitable temperature (37°C) for 24 hours and the diameter of zone of inhibition was measured. The results were expressed as mean value of triplicate experiments. The results revealed that the growth of all the test pathogens were suppressed by all the test samples with the zone of inhibition ranging from 12.0 mm to 29.0 mm. Ethanol, methanol and aqueous extracts showed the highest activity on *Klebsiella sp, Bacillus sp* and *Staphylococcus aureus* respectively and the zone of inhibition was fallen in the range of 24.0 mm to 29.0 mm. The effect of ethanol extract on *Pseudomonas aeruginosa* and *Escherichia coli* was found to be less compared to the rest of the data and the zone of inhibition was 13.0 mm and 12.0 mm, respectively. The standard experiment demonstrated that among the test bacteria *Bacillus sp* was more sensitive to streptomycin and *Escherichia coli* was less sensitive to streptomycin. In order to make clear comparison of the crude extracts with standard further bioassay should be done with the equal concentration of both. Mixture of DMSO and acetone did not affect the growth of all test bacteria.

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Soil and groundwater salinity variation in Matara district coastal belt- Sri Lanka

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The present research study identifies changes in salinity of soil and groundwater in tsunami affected and unaffected areas in Matara district. Within study area a total of 21 auger holes were drilled representing both tsunami affected and non-affected areas. The auger holes were distributed within approx 0.5 to 0.7 km distance from the coastline. Auger holes are selected to maintain perpendicular transacts to the coastal line. From each auger point, soil samples were taken from the surface layer and followed by each 50 cm depth until groundwater table is reached. Groundwater samples were also taken from auger holes and from dug wells near to auger holes. Soil physical parameters such as specific gravity, soil moisture, were determined. Soil chemical parameters such as pH, electrical conductivity (EC), total dissolved solids (TDS) and salinity were measured using pH and EC meters. The electrical conductivity (EC) of the soil in the tsunami affected area varied from 100 μS/cm to 422 μS/cm and groundwater salinity changed in between 400 to 2000 μS/cm. A direct relationship between EC and soil depth was detected. The prepared maps confirm that soil salinity, pH and EC variations were directly related with groundwater salinity. Additional salinity levels are related with morphological factors and soil physical parameters.

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A Preliminary study of the water intake pattern in rats

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The objective of this preliminary study was to evaluate the water intake pattern in rats. The experiment was carried with Charles foster strain healthy albino rats in both sexes bred and kept in the animal house attached to the Pharmacology laboratory of the Institute of Post Graduate Teaching and Research in Ayurveda, Gujarat Ayurvedic University, India. They were maintained on Navchakan Oil Mill's "Amrut" brand rat pellet feed and exposed to natural day and night cycles. The trial was performed in three replicates, each containing six rats. Simple random sampling method was applied. Rats weighing between 178 – 226 g were used. The method described by Dixit. U. D., Ravishankar. B. and Dwivedi. R.B. was adopted. (Dixit et al., 1995) Duration of the experiment was eight days. Rats were placed in separate metallic cages. Each day, 100 ml of tap water and 50 g of food were supplied to each rat in the morning at 9.00 a.m. Water was given to the animals by glass bottles attached to the cages. Water remaining in each bottle was recorded each day. Body weight was recorded before and after the experiment.

No significant difference in water intake could be observed in group 2 and 3 in comparison to group 1 rats. The mean water intake of rats in the term of the absolute value of group 1 was 43.43 ± 1.95 ml, group 2 was recorded as 45.15 ± 2.25 ml and group 3 has shown 43.06 ± 3.84 ml intake. Differences obtained in between the groups were statistically insignificant.

Intake water per unit of body weight per day was calculated by the rule of three to find the relative values. When the relative values were calculated, the mean water intake of rats in the group 1 was 20.62 ± 1.03 ml where the group 2 was 20.93 ± 1.48 ml and group 3 was 19.62 ± 2.09 ml respectively. The result was not statistically significant in unpaired 't' test.

Variations gained in both the absolute values and the relative values in this preliminary study were not statistically significant. The result obtained from this study has ensured the homogenous water intake pattern of the albino rats and the suitability of using animal models for the experimental studies.
Effect of water quality on shrimp larval catch in seagrass ecosystem of the Negambo lagoon

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Negombo Lagoon is one of the most productive shallow brackish water estuaries in Sri Lanka. Sea grass beds cover 22% of the lagoon area and are highly productive, providing habitats and nursery grounds for a variety of brackish water organisms including many economically and ecologically important species. However, the lagoon environment is under threat due to increased human activities and the discharge of wastes into the lagoon.

The shrimp population depends on the environmental parameters (both physical and chemical) of the sea grass ecosystem. This study therefore mainly intends to build the relationship between the water quality parameters (physical, chemical) and the larval catch within the sea grass beds. The seagrass beds located in the Negombo lagoon namely, Kadolkele on the northern side Aluthkuruwa, Thalahena and Sethapaduwa on the western shore and Liyanagemulla Katunayake and Kurana on the eastern shore were selected for the study.

Water samples were collected twice a week for a period of one year. Environmental parameters such as temperature, salinity, pH, turbidity, dissolved oxygen Ammonical–Nitrogen, Nitrate–N, Nitrite–N and Phosphate –P were measured. Production function for the sea grass habitats (relationship between the larval catch and other chemical and physical parameters) indicate that salinity, ammonical nitrogen, nitrate, and phosphate contribute positively to the larval catch while nitrite and phosphate contribute negatively for the larval catch. The usefulness of this model in predicting productivity of the lagoon is also discussed.

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Development of a database for invasive alien plants of Sri Lanka

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Plants that spread in natural or semi natural habitats producing significant changes in terms of community composition and ecosystem processes are categorized as invasive plants. Majority of plant invaders are aliens that have been introduced from one country to another. Thus, Invasive Alien Plants (IAP) can be found in all countries of the world. Biodiversity of Sri Lanka has also been threatened by IAP. At present information on these plants can be found in literature and other storage devices which are scattered in different institutions through out the country.

With the advancement of global information technology and fast information retrieval systems, advance computer technologies are increasingly applied to handle biological, ecological and environmental information. Today, many countries maintain their own information management systems as a part of their strategies in biodiversity conservation. The present study aims to fulfill the urgent need of an easily accessible integrated computerized information retrieval system for Invasive Plants of Sri Lanka in order to strengthen our National Action Plan on IAP Management. The objectives were to make the system available as an automated checklist of IAP and geo-referenced inventory or tracking tool to identify their distribution.

The methodology included designing of the software according to the identified requirements, coding and testing. The software design was based on the client server / two-tier architecture using SQL 2000 and Interfaces were designed using Microsoft Visual Basic.NET 2005. Coding of the software program was done using Visual Basic.NET programming language and SQL query language in order to integrate information and make the system functional. Testing was conducted to certify the proper functionality of the system. Finally, information on IAP was fed to the system. This information management system on IAP allows access for data entry and search facilities depending on the user's requirements. It also allows the administrator and registered user to update information in order to assist monitoring and successful management of IAP of Sri Lanka.

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A study of natural radioactivity levels in beach sand collected from Uswatakeiyawa to Chilaw

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High radiation background levels have been reported in certain areas in Sri Lanka. Pulmudei in the East Coast, Beruwala in the South West Coast and Uswatakeiyawa in the West Coast are some examples. The measured background radiation levels in these areas are high due to the presence of thorium rich monazite in the beach sand. However a systematic study to measure the activity levels in beach sand in these areas has still not been carried out. Such a study is important with respect to estimating the radiation exposure to the public and also in locating previously unidentified mineral sand deposits.

The activity concentrations of $^{238}\text{U}$, $^{232}\text{Th}$ and $^{40}\text{K}$ in 49 sand samples collected from a 72 km coastal stretch from Uswatakeiyawa to Chilaw have been determined using gamma ray spectrometry. The measured activity concentration of $^{238}\text{U}$, $^{232}\text{Th}$ and $^{40}\text{K}$ range from 0.5 to 12.07, 0.4 to 5.997 and 3.8 to 20.48 Bq kg$^{-1}$ respectively. The detection limits for the activity concentrations of $^{238}\text{U}$, $^{232}\text{Th}$ and $^{40}\text{K}$ for the geometry used were 1.70, 2.37 and 10.41 Bq kg$^{-1}$ respectively. A good correlation between the measured activity concentration of $^{238}\text{U}$ and $^{232}\text{Th}$ could also be seen.

The highest activity level of both $^{238}\text{U}$ and $^{232}\text{Th}$ was found in a sand sample collected from a location in Kapumgoda which is situated about 16 km north of Uswatakeiyawa. The radiation level measured at Kapumgoda was 3.2 µSv h$^{-1}$ which is more than 10 times the normal background.

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Dynamic light scattering: Instrumentation and data processing

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Dynamic Light Scattering (DLS) also known as Photon Correlation Spectroscopy is one of the most popular methods used to determine the size of small particles. The advantage of using dynamic light scattering is the possibility to analyze samples containing broad distributions of species of widely differing molecular masses (e.g. a native protein and various sizes of aggregates). With this technique it is also possible to obtain absolute measurements of several parameters of interest like molecular weight, radius of gyration, translational diffusion constant and so on. The aim of this work was to develop an experimental set up for Dynamic Light Scattering, to develop a method for data processing and to check the reliability of the developed experimental set up and data processing method.

The experimental set up is illustrated above. It consists of He-Ne laser with wavelength \( \lambda = 632.5 \text{nm} \), a Photomultiplier tube (PMT), Fiber optics probes, a high voltage supply, cell (sample holder) and personal computer with vernier labpro software. Scattered light is collected at PMT and amplified before sending to the computer. Since we have only numerical data set to be dealt, using an appropriate software intensity auto correlation coefficient is calculated. The intensity correlation of the scattered beam is fitted to the autocorrelation function \( g_2(q, \tau) = 1 + \exp(-2Dq^2\tau) \). Here, \( D \) is the diffusion coefficient, \( q \) is the scattering vector, and \( \tau \) is the lag time. \( q \) is calculated using \( q = 4\pi \sin(\theta/2)/\lambda \). Knowing \( D \), the particle size is calculated using the Stokes–Einstein equation \( D = K_B T/6\pi \eta a \). Ferric Hydroxide colloid was used to measure the accuracy of this method. 750ml of boiling distilled water was poured into 12ml of a 32% Ferric Chloride solution. The hydrolysis of Ferric Chloride occurred instantly and a sol of Ferric Hydroxide was formed. The colloid was quite stable and the particles size usually lies in the range 0.1 \( \mu \text{m} \) to 1 \( \mu \text{m} \). The results of the particle size analysis of Ferric Hydroxide colloid using the method described above agree well with the particle size given in literature for the same system.

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Radiation effect on Poly (Ethylene Oxide) complexed with Copper Thiocyanate

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Effect of radiation on polymer materials is an area of rapidly increasing interest. Some high technology industries require polymers that exhibit a specific response upon exposure to high energy radiation.

AC impedance measurements, DC polarization test, Differential Scanning Calorimetry and Mechanical testing were performed on irradiated and unirradiated systems of (PEO)$_9$CuCNS in order to study the effects of radiation on the polymer electrolyte. The conductivity variation of (PEO)$_9$CuCNS polymer electrolyte has been studied over a temperature range of 25 – 100 °C and it follows the VTF (Vogel-Tamman-Filcher) type behavior. At 25 °C the conductivity of the unirradiated system is about $10^{-9}$ S cm$^{-1}$ and it increases as temperature increases. However, the conductivity of irradiated systems decreases as temperature increases.

Mechanical testing of the above system revealed that the strain energy release rate $G_{1c}$, which is a measure of fracture toughness of the material, was increased from 3 to 81 kJ m$^{-2}$ as the sample is irradiated over time duration of 0 to 1 month. The DSC results show an increase of glass transition temperature by ~2 °C after irradiating the polymer sample. DC polarization test revealed that the ionic transference number of irradiated polymer decreases by 3.5% while electronic transference number increases by 21%. This is attributed to the crosslinking effect and formation of free radical under irradiation. Therefore, it can be concluded that the absorption of high energy radiation by the polymer electrolyte lead to produce more crosslinking than chain damage.

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SECTION E2

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Studies on the carotenoids and the in-vitro bioaccessibility of β-carotene of jakfruit (Artocarpus heterophyllus) kernel from the major cultivations of Sri Lanka

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Ripe jakfruit (Sinhala: waraka) is widely available in Sri Lanka. In present study the specimens (n=6) collected from the major cultivations in the Kurunegala and Matale districts, the major jakfruit producing districts in Sri Lanka showed a marked variations from specimen to specimen not only in total carotenoid content but also in components. Carotenoids were extracted with acetone and separation was done by open column chromatography (OCC). Identification was carried out by position/order of elution in OCC, uv/visible spectrophotometry, thin layer chromatography (TLC), chemical tests; HCl vapour test, epoxide-furanoid rearrangement test, iodine catalyzed cis-trans isomerisation test and peak enrichment in reverse phase high performance liquid chromatography (RP-HPLC). Quantification was done by HPLC. The following carotenoids were detected from ripe jakfruit; β-carotene (traces to 50), α-carotene (traces to 20.5), lutein (2.7 to 22.1), unidentified I (traces to 33.7), unidentified II - trans isomer (8.3 to 45.5), unidentified II - cis isomer (11.1 to 59.9), unidentified III (non-detectable amount to 32.2) and unidentified IV (traces to 32.8), all in units of μg/100g of dry weight (DW). The major carotenoids common to all specimens were lutein and unidentified II. Theoretically calculated retinol equivalent (RE) and retinol activity equivalent (RAE) varied from traces to 10 and 5/100g DW, respectively. This made prediction of percentage contribution from this fruit to the recommended daily allowance (RDA) of provitamin A per portion impossible. In-vitro bioaccessibility was performed by simulating the gut physiology. Results showed a low bioaccessible β-carotene (~ 8%) probably due to the nature of the rubbery texture of the kernel. In-vivo mastication and re-gurgitation prior to in-vitro digestion showed a higher accessibility (12-18%) of β-carotene. Crocetin; a carboxylic acid carotenoid was extracted into the methanolic KOH water extract after saponification and it was tentatively identified by its chemical characteristics and spectrum. The kernel subjected to autoclaving (121 °C). This resulted in a new carotenoid released into the water layer with marked changes in carotenoid profile. In addition, there was isomerisation in the case of β-carotene with the reduction in total carotenoid concentration indicating that canned products will be even less significant contributor to the recommended daily allowance (RDA) of vitamin A.

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A predictive model for determination of the iodine value of coconut oil by GLC analysis of the component fatty acids

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Iodine value (IV) is one of the most important and frequently used quality control parameters of coconut oil. A study was conducted to develop a predictive model for determination of iodine value (IV) of coconut oil using gas liquid chromatographic (GLC) analysis of the component fatty acids (FA). Altogether twenty-six samples were selected to represent three sub-categories of coconut oil, namely ordinary coconut oil, virgin coconut oil, and coconut paring oil. Out of the twenty-six, fifteen samples were used as a calibration set while the remaining eleven samples were kept for validation purpose. Samples were analyzed for iodine value using the AOCS method Cd Id–92 and for FA composition using GLC detection of fatty acid methyl esters (FAME). Pearson correlation analysis between IV and individual FA indicated that lauric (C12:0), myristic (C14:0), palmitic (C16:0), oleic (C18:1) and linoleic (C18:2) were the five parameters having strong correlation with the iodine values. When these five parameters were used as independent variables in a stepwise regression procedure, a predictive model for iodine value was obtained with C16:0 and C18:1 as independent variables (coefficient of determination, $R^2 = 0.9611$ and standard error, SE=0.93). When the model was validated with an independent set of eleven samples, the coefficient of determination was 0.946 with an overall SE of 0.95. The study concludes that the iodine value measured by the GLC method was comparable to that obtained by AOCS method Cd Id–92.

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Feldspar-fluoride interactions: Examination of interfacial processes by potentiometry

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Fluoride is an essential constituent for the production and maintenance of healthy teeth and bones. However, high levels of fluoride are found to cause health hazards in many respects, requiring effective means of fluoride removal from water. Defluoridation of fluoride-rich water by naturally occurring minerals and porous materials has been addressed for many decades. Nevertheless, microscopic picture of fluoride-substrate interactions yet needs further clarification. This research is on mechanistic investigation of feldspar - fluoride surface interaction under experimental conditions that are important from the environmental view point.

Analysis of methylene blue adsorption data indicate that the specific surface area of the feldspar used for this investigation (31.2% Al, 11.6% K and 57.2% Si) is 9.79 m² g⁻¹. Further, variation of surface charge density, as determined through surface titrations of an aqueous feldspar suspension in two different ionic strengths, results in the point of zero charge of feldspar between pH = 3.5 and pH = 4.0.

Fluoride adsorption changes both surface and bulk properties of feldspar. The structure of crystalline feldspar was gradually changed into amorphous phase upon reaction with fluoride according to X-ray diffraction measurements. This is a rapid process reaching an apparent plateau within a 20 min stirring time and a 2.0 h equilibration time for a 10 % (w/v) fluoride/feldspar suspension. More importantly, aluminium is found to leach out during fluoride –feldspar interaction at low pH values suggesting enhanced dissolution of feldspar, although this effect is not significant at high pH values.

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Comparison of antioxidant activity of seeds of *Dolichos biflorus* with some edible seeds

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Plant seeds play a major role in human diet all over the world. Considerable scientific evidence suggests that whole grains, as commonly consumed by humans reduce risk for chronic diseases including cancer and heart disease. Recently we commenced a chemical investigation on the seeds of *Dolichos biflorus* L. (Sinhala. Kollu). *D. biflorus* is widely used in traditional systems of medicine for rheumatism, liver diseases etc. As a part of this study we compared the antioxidant activity of the seed extracts of *D. biflorus* with some popular edible seeds: *Cicer arietinum* L.(kadala), *Lathyrus aphaca* L.(yellow pea), *Pisum sativum* L.(green pea), *Vigna unguiculata* L.(red cowpea), *Lens culinaris* L. (mysore lentil), *Zea mays* L. (badairingu), *Vigna cylindrica* L. (wanduru mae), *Phaseolus mungo* L. (undu) and *Phaseolus aureus* Roxb. (green gram) against 2,2'-diphenyl-1-picrylhydrazyl (DPPH) radical by spectrophotometric method.

Each variety of seed (25g) was extracted with methanol using sonicator at room temperature (30min. x 3). Each extract was evaporated to dryness and subjected to testing for antioxidant activity. The antioxidant activity of *D. biflorus* was observed as IC$_{50}$ = 330 μg/ml. The highest antioxidant activity was observed for the methanol extract of seeds of *V. cylindrica* (IC$_{50}$ = 23 μg/ml). The antioxidant activity of methanol extract of *P. mungo* (IC$_{50}$ = 218 μg/ml) is higher than that of *D. biflorus*. Further the seed extracts of *L. aphaca* (IC$_{50}$= 940 μg/ml), *P. aureus* (IC$_{50}$= 340 μg/ml), *V. unguiculata* (IC$_{50}$= 475μg/ml), *Z. mays* (IC$_{50}$=510 μg/ml) showed lower antioxidant activities than that of *D. biflorus*. The IC$_{50}$ of *C. arietinum* (IC$_{50}$>1000 μg/ml), *P. sativum*(IC$_{50}$> 1000 μg/ml) and *L. culinaris*(IC$_{50}$>1000 μg/ml) showed lowest antioxidant activity out of the tested seed extracts.

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Fluoride removal studies of water using natural materials found in Sri Lanka

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Fluoride is considered as a double edged weapon as in correct dosage it strengthens the enamel to prevent dental caries and in excess causes ugly brown stains of the teeth called dental fluorosis. High fluoride levels in the ground water are a major problem that leads to diseases related to high fluoride intake amongst people. This problem now has risen to endemic levels in Sri Lanka, especially in the North Central Province and some other dry zone areas.

In this research removal of fluoride from water was attempted using natural materials such as red soil, brick, mica, serpentine and charcoal. Initially the defluoridation capacities of these materials were analyzed by setting up a vertical column (height 55 cm, diameter 3.5 cm) of each material and then by passing a known volume of 10 mg dm⁻³ fluoride standard solutions within predetermined time intervals. By this analysis brick, red soil and mica were identified as the best fluoride removal materials. Then ground water collected from Eppawala and Polpithigama areas were analyzed using the three materials after the defluoridation process. First, each sample of natural water was passed through individual columns packed with each material. This study reveals that red soil and brick have the best fluoride removal capacity, followed by mica, serpentine and charcoal. The same procedure was repeated for another separate set of water samples, but using mixed beds packed proportionately according to the defluoridation capacities of materials. In each experiment the effluent of the ground water was analyzed for fluoride as well as nitrite, nitrate, iron and hardness (non fluoride parameters). However, no significance difference was observed for non fluoride parameters.

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Developing a simple method for identification of plastics

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Today the plastic is a hugely consumed ready-made product. The amount of consumption of plastic product reaches thousands of tons of kilograms per year. Therefore, huge amounts of solid plastic waste are observed in Sri Lanka and it has been a great environmental problem for all the living beings. In all recycling factories sorting is done by laborers manually with their experience and ability. But there are some cases where they fail to determine the plastic despite their experience. In this case they have to abandon these plastics without recycling. So the aim of this study is to develop a simple method for sorting of plastic. In this research plastics are classified using their densities and the properties of flame for different plastics were also studied.

In order to measure the densities, samples of PP, LDPE, HDPE, PVC, PC, PS, ABS and PET were dipped in the water. Samples of PP, LDPE and HDPE floated on water. Therefore they were dipped in 20 cm of isopropanol. The density of isopropanol was changed by adding water. Required water volumes for each sample were 15 cm 25 cm 40 cm respectively. The samples PVC, PC, PS, ABS and PET sank in water. Therefore they were dipped in a saturated sugar solution. Only ABS and PS were seen floating in the sugar solution. PS can be identified from ABS by using Petrol. Only PS formed a sticky gum with petrol.

In the flame test, both LDPE and HDPE gave a yellow I white flame without smoke; PP gave yellow I white flame with slight smoke; ABS gave a yellow I white flame with a heavy smoke; PVC gave yellow I white flame inside the burner, but no flame without burner only a slight smoke; PET gave yellow I white red flame and black smoke with and without the burner; PC gave neither a flame nor smoke with or without burner. Only black color pieces were observed.

The results and the observations clearly show that simple density based method and a flame based method can be used, in combination, to identify different kinds of plastics.

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Seasonal effects on cooking and eating quality traits of some improved Sri Lankan rice varieties

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The current trend in rice breeding research is directed towards improving the rice varieties with consumer acceptable grain quality traits as it reaches a wider population. Cooking and eating qualities of rice are one of the major components of rice grain quality, in many rice production areas of the world. Amylose content (AC), gelatinization temperature (GT) and gel consistency (GC) are considered to be the most important traits closely related to the cooking and eating qualities of different rice. Therefore understanding the relationship between these parameters and variation due to different environmental conditions are necessary for rice breeding programme in developing rice varieties with consumer acceptable grain quality traits.

Twelve improved Sri Lankan rice varieties [Bg, Bw and At and Basmathi 370, (introduced variety)], cultivated in Yala (2006) and Maha (2006-2007) seasons at the Regional Rice Research and Development Center (RRRDC), Bombuwala were analyzed for AC, GT and GC, for possible variation due to seasonal difference in these parameters and for correlation of GT and GC to AC.

AC of selected improved Sri Lankan rice varieties varied from 23-30 %. Statistically significant differences were observed in AC between rice varieties (P<0.05). However, variation in AC due to seasonal difference was insignificant (P>0.05). Selected Bg, Bw and At varieties had high AC (25-30 %) and Basmathi 370 had intermediate AC both in Yala (23.34 ± 0.26) and Maha (23.44 ± 0.21) seasons. GT of the selected rice varieties varied from high, high-intermediate and low and GC either hard, medium or soft. Little variation of GC was observed between the two seasons. No variation of GT was evident due to the seasonal difference. There was no correlation between AC and GT (r = 0.21), AC and GC (r = 0.12) and GT and GC (r = -0.16) of rice varieties tested in this study.

These findings will be useful in rice breeding when choosing selective germplasms for development of new rice varieties with different functional values including cooking and eating characteristics.

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Problems faced by G.C.E (A/L) students in chemical calculations

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Chemical calculations are used to enhance the students’ ability of applying chemical concepts along with the mathematical concepts to solve numerical problems and thereby improve the students’ thinking ability and logical intelligence. Chemical calculations are frequently used in assessing the students’ achievement in the learning process.

However, it has been found that the performance of students in chemical calculations at G.C.E. (A/L) examination is generally poor. This study was, thus, designed to investigate the problems faced by the students in chemical calculations. In this study two purpose designed instruments each on chemical calculations and mathematical calculations were constructed and validated. These instruments were administered to a sample of 140 Grade 13 students selected from two provinces. The sample was limited by the availability of the students at the time of the study and selected to minimize confounding factors. Only 120 of these students (48% physical science and 52% biological science) who completed all instruments were selected for the data analysis. National schools from two provinces were selected due to their readily accessibility and the willingness of school authorities to allow the students participate in this study. Students, school teachers and national evaluators of G.C.E. (A/L) Examination were also interviewed to get their opinion on chemical calculations.

Descriptive statistics, Spearman rank correlation and two sample t-test (confidence interval 95%) have been used to analyse the student performance. Students’ average mark for mathematics paper was 55.26% where as the average mark for the chemical calculation paper was 42.5%. Many students had made mistakes in addition (43.3%), subtraction (27.5%), multiplication (70.8%), division (83.3%), indices (47.5%), and logarithms (56.7%). Students have also made mistakes relating to the chemical concepts and principles such as atoms (35.7%), molecules (21.4%), molecular formula (17.9%), moles (8.9%), concentration (35.7%), molality (60.7%), mole-fraction (7.1%), stoichiometry (42.9%), Hess’s law (32.1%), Born-Haber cycle (22.6%), gas laws (57.1%), Raoults law (10.7%), pH, $K_a$, $K_b$, $K_{sp}$ (75.0%), electrode equilibrium (25.0%), inorganic reactions (51.2%) and chemical kinetics (14.3%). More than 20% of students didn’t complete calculations. The Spearman rank correlation coefficient of 0.524 showed that a positive correlation exists between the mathematical achievement and the chemical calculations achievement of the students. Students (25%) have expressed that applying chemical concepts along with mathematics is the major problem in doing chemical calculations. Teachers as well as national evaluators expressed the opinion that students made frequent mistakes in simplifying sums and linking the knowledge of chemistry with appropriate mathematical concepts.

The findings of this study suggest that existing chemistry classroom practices need to be re-evaluated with a view to using more appropriate teaching/learning methodologies and strategies to improve students’ logical intelligence.

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Study of interactions of a novel class of vesicular monoamine transporter inhibitors with bacterial cells to investigate the uptake mechanism

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It has been shown that many illicit drugs as well as some antidepressants and psychiatric drugs are good substrates for nerve cell monoamine transporter proteins in brain.

Recent studies show that 3-amino-2-phenylpropene (APP) (Fig.1(a)) and its derivatives are potent inhibitors for bovine vesicular monoamine transporter(s) and cytotoxic towards the SH-SY5Y nerve cells in vitro.

Recent experiments demonstrate that combination of APP with MPP\(^+\) (Fig.1(b)) would produce inhibitors such as 4-phenyl-1-(2-phenyl-allyl)pyridinium bromide (APP-MPP\(^+\), conjugated compound) (Fig. 2), which act as a potent inhibitor for bovine chromaffin granule vesicular monoamine transporter. It is believed that these compounds interact with transporter protein and change its conformation which allows compounds to interact with it. The mode of interaction and the mechanism of binding of these compounds to monoamine transporters are still not well understood. In this work Escherichia coli, Bacillus, Staphylococcus aureus, Klebsiella bacterial cells have been used as models to study interactions of APP-MPP\(^+\) conjugate compounds with cells and to determine their cytotoxic effect. This investigation is focused on studying the interactions of APP-MPP\(^+\) with microorganisms and their uptake mechanism.

These studies further indicate that this novel compound significantly inhibits the growth of Escherichia coli and it has minor effects on other bacterial cells too.

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Quality of water consumed by chronic kidney patients in North Central province of Sri Lanka

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The population of the North Central Province (NCP) is about 1.2 million and geographically it is the largest province in the country. Majority of rural population living in the area are farmers and they largely depend on the ground and surface water sources for their day to day life. At present, over 5,000 patients in NCP are on treatment for Chronic Kidney Diseases (CKD) and the etiology for this disease still remains a mystery.

‘Heavy metals’ are chemical elements with a specific gravity that is at least 5 times the specific gravity of water. Living organisms require trace amounts of some essential metals but excessive levels can be detrimental to the organisms. Toxic metals have no known vital or beneficial effect on organisms, and their accumulation over a period of time in human bodies can cause serious illnesses like CKD. In addition, some potential triggering factors for CKD are PO\(_4^{3-}\), SO\(_4^{2-}\), F\(^-\) and Mg.

According to the surveys done in Anuradhapura and Madawachchiya renal clinics, two affected areas Wewalkatiya and Nikiniyawa villages in Anuradhapura district and a reference village, Kohalwila, where no CKD patients were found were selected for water quality testing. The water distribution reservoir in Kekirawa affected area, Malawa tank, was selected as the surface water source. Sampling was done from ground water wells in patient houses, Malawa tank and reference village in dry and wet seasons by collecting 3 samples at a point totally 20 points from a site. The concentrations of Fe, Al, Zn, Cu, Cd, Cr, Ca, Mg, Ni, Mn and Pb were determined by Atomic Absorption Spectrophotometry (AAS). The concentrations of total phosphorous, available phosphate, available sulphate and fluoride were determined by standard methods, pH was measured and total soluble ions were determined by conductivity measurements.

The mean concentration of the analyzed metals in water samples from Anuradhapura district show very higher values than the reference site. Dissolved metal concentrations in analyzed water samples in affected areas do not exceed the Maximum Contaminated Levels set by the WHO for drinking water except for Al, Mn and Ni. The triggering factors of CKD, Mg, P, SO\(_4^{2-}\), PO\(_4^{3-}\) and F\(^-\) accumulated in water in the affected area are very high compared to the reference site. Although these concentrations reduce in wet season, these values are always higher than the values obtained for the reference site.

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