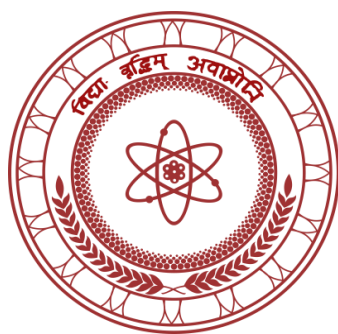


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13 – 18 December, 2020

Part I: Abstracts



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Part I – Abstracts

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Oral Presentations



101/A

Receptive risk of imported malaria cases due to prevalence of vector mosquitoes and selective vector control

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Sri Lanka has a high risk for resurgence of malaria even though it was eliminated from the country since the last indigenous case in 2012. The main risk factors are the prevalent malaria vector population and imported malaria cases. Reactive entomological surveys are carried out to assess the presence of malaria vectors in locations where patient had stayed any night during two weeks prior to onset of fever. If vectors are present, selective vector control is applied to reduce the receptive risk. The results of reactive entomological surveys for the year 2019 and its response through relevant vector control activities were analyzed with the objective of estimating the receptivity associated with imported malaria cases and the need for targeted response. The entomological surveys covered an area upto 1 kilometer radius of the locations and the techniques carried out were larval surveys, Indoor hand collections, human landing night collections and cattle baited net trap collections. Based on the presence of primary and secondary malaria vectors, the appropriate vector control was carried out. A total of 85 entomological surveys were conducted in 15 districts in relation to 53 imported malaria cases during 2019. Of these surveys, 32% and 68% were conducted in previously malaria endemic and nonendemic districts, respectively. Thirteen percent (n=11) of the surveys was positive for larvae or adult of primary malaria vector *Anopheles culicifacies* and all were in previously malaria endemic areas. Both adults and larvae of any secondary malaria vectors *An. subpictus*, *An. annularis*, *An. varuna*, *An. vagus*, and *An. tessellatus* were reported in 18% of surveys. In instances where adults of primary vector were reported (n=7), indoor residual spraying was applied or long lasting insecticidal nets were distributed. Chemical larviciding with Temephos was done when larvae of primary malaria vector was reported. Space spraying was done in 11 instances in five districts when human biting adults of secondary vectors were found. Larvivorous fish were also applied when vector breeding places were confined. Results showed the presence of primary malaria vector in previously malaria endemic areas. Even though most cases were reported from areas where primary malaria vector was not found, 32% of patients were either reported from or visited previously malaria endemic areas. In previously non endemic areas, secondary malaria vectors were present, and they may be important in malaria transmission. As a result, the risk of reintroduction of malaria from imported malaria cases is high in both previously malaria endemic areas and nonendemic areas of Sri Lanka and needs selective vector control.

Keywords: Imported malaria, entomological surveys, vector control

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102/A

Evaluating real-time PCR (qPCR) as a valid method for quantitative malaria diagnosis under field settings in Sri Lanka

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Quantitative PCR assays are becoming increasingly employed in the diagnosis and quantification of malaria. Studies have clearly demonstrated that qPCR methods have improved sensitivity and species identification compared to microscopy. In this study a qPCR assay that amplifies all S and the A types of *Plasmodium* 18S rRNA genes that are distributed in chromosomes: 1, 5, 7, 11, and 13 was validated for diagnosis and quantification of malaria infections. Blood samples obtained from patients reported to Anti Malaria Campaign Headquarters for confirmation of malaria from 2015 to 2018 were used for this study. The technique was validated according to the MIQE guidelines. Optimization of the reaction parameters was done using WHO International standard for *P. falciparum* DNA Nucleic Acid Amplification Techniques (NAAT). Analytical sensitivity was calculated using serial dilutions of reference standard. Diagnostic sensitivity and specificity of qPCR was calculated compared to a previously validated nested PCR (nPCR) based on 18S rRNA gene. Samples from 173 patients with acute malaria infections and 177 malaria negative patients (microscopy and nPCR confirmed) were used to determine the clinical sensitivity and specificity. The agreement and correlation between microscopy and qPCR in quantifying parasitaemia was also evaluated. The standard curve for qPCR assay showed an amplification efficiency of 99.31%. The probit analysis showed an analytical sensitivity/LOD of 30893.2 IU (CI = 5739.04554 - 485423993.99494) of NAAT reference standard for qPCR. The in silico updated BLAST result showed 100% identity to *Plasmodium* 18S RNA genus sequences. The diagnostic sensitivity and specificity of qPCR was 100%. Passing–Bablok regression showed that microscopy and qPCR correlated well within the investigated concentration range without systematic or proportional difference. By Bland-Altman plot a divergence which increased with parasitaemia was seen. At lower parasite densities, microscopy gave higher values and at higher parasite densities qPCR gave higher values. This study showed that qPCR is a valid method for diagnosis and quantification of malaria in patient management and follow up. However, parasite densities obtained by microscopy and qPCR cannot be used interchangeably to monitor parasite clearance.

Keywords: Malaria, molecular diagnosis, validation, microscopy

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103/A

Biochemical parameters in assessing the risk in developing breast cancer in Sri Lanka

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Breast cancer (BC) is the most common carcinoma among women in Sri Lanka. Though various biochemical parameters are reported to be impacted, the exact etiology remains inconclusive. The present study analyzed a panel of selected biochemical parameters in BC patients and apparently healthy women to assess the risk related to develop BC. Newly diagnosed BC patients (n=155) and age matched, apparently healthy females (n=75) were selected and serum lipid profile, thyroid profile, HbA1c levels, lactate dehydrogenase (LDH), oestrogen, progesterone, testosterone, cortisol, uric acid, CRP, vitamin A, D and E status measured and significances identified. Among the significant parameters, ones that were not directly dependent on each other were used to develop a logistic regression model to identify the parameters indicating the highest risk. BC patients had significantly high ($p \leq 0.05$) total cholesterol (TC), low density lipoprotein cholesterol (LDL-C) and TC: high density lipoprotein cholesterol (HDL-C), CRP, cortisol, T3, T4 and HbA1c levels and significantly low ($p \leq 0.05$) uric acid and testosterone concentrations when compared with apparently healthy females. Vitamin A, D, E levels and LDH levels were not significantly different ($p \geq 0.05$). When each parameter was compared against the healthy subjects in univariate analysis, the highest odds were found to be LDL-C >139 mg/dL as having 27 odds (CI 9.19-70.40), followed by TC, HbA1c, and lower serum testosterone. The logistic regression model indicated that having testosterone concentrations below 0.26 ng/mL, LDL-C above 139 mg/dL and uric acid less than 194 $\mu\text{mol/L}$ to be contributory parameters in developing BC. The impact of T4, CRP, cortisol and HbA1c was not observed in the final model even though it was apparent in the univariate analysis. Elevated LDL-C, low serum uric acid and testosterone are the significantly identified biochemical parameters among the study group.

Keywords: Breast Cancer, biochemical parameters, breast cancer risk prediction

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104/A

Clinical, serological and molecular characterization of Dengue cases in the district of Gampaha, 2018 – 2019

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Dengue is an endemic disease in Southeast Asia including Sri Lanka. In this study, hospital-based surveillance was conducted during the period of 2018 - 2019 with the objectives of clinical, serological, and molecular characterization of dengue cases and understanding the molecular epidemiology of Dengue Viruses (DENV) in the District of Gampaha, Sri Lanka. Acute phase serum samples were collected from 300 clinically suspected febrile patients from the District General Hospital, Negombo. The 300 samples were categorized according to the previous WHO clinical classification, where 224 (74.7%) as Dengue Fever (DF) cases, 37 (12.3%) as Dengue Hemorrhagic Fever (DHF) cases, and 39 (13.0%) as other infections with fever. Of the total 300 samples collected, 206 (68.7%) were serologically confirmed to have DENV infection by using DENV IgM capture ELISA. Based on flavivirus IgG indirect ELISA, 152 (73.8%) and 54 (26.2%) patients had primary and secondary infections respectively. An acute or convalescent phase sample with a titer $\geq 1:52,000$ was considered as originating from a patient with a secondary DENV infection. High percentage of primary infection was noted among the patients in this study. From the 300 acute phase blood samples collected from dengue suspected patients, 167 DENV strains were successfully isolated and confirmed by RT-PCR (39 DENV-1, 59 DENV-2, 69 DENV-3, and 2 DENV-4) including two cases with dual serotype co-infection. The present study reveals that all serotypes of DENV had been circulating during 2018 – 2019; DENV-2 was observed as the predominant serotype during 2018, which caused the largest dengue outbreak in Sri Lanka in 2017 and DENV-3 was the predominant serotype in 2019.

Keywords: Dengue fever, secondary infection, serotyping, molecular epidemiology

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Association of serum alpha-amylase with-anthropometric and body composition parameters among students in a Higher Education Institution in Sri Lanka

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The salivary glands and the pancreas secrete alpha-amylase, which digests carbohydrates in the diet. An abnormal increase in serum alpha-amylase level generally reflects an overall dysfunction of the pancreas or salivary glands. Although the clinical importance of high serum alpha-amylase (SAA) levels has been studied extensively, significance of low SAA-levels has not been adequately investigated. A relationship between low SAA activity and non-communicable disorders such as obesity, diabetes and metabolic syndrome has been reported. The present study investigated the association between serum alpha-amylase and selected anthropometric parameters, body fat percentage (BF%) and visceral fat level among students in a Higher Education Institute in Sri Lanka. An analytical cross-sectional study was carried out using stratified random sampling among 353 undergraduates (82 males, 271 females). Participants with previously diagnosed chronic illnesses and pregnancy were excluded from the study. A 2 ml random blood sample was drawn from the participants, and the SAA level was determined on an Automated Siemens Dimension analyzer using an enzymatic method. Weight, height, waist circumference (WC), hip circumference (HC) were measured according to WHO guidelines. Total body fat % (BF%) and visceral fat level (VFL) were estimated using-bioelectrical impedance analysis. Data were analyzed using SPSS version 23. Ethical approval for the study was obtained from the Ethics Review Committee of KIU, Battaramulla. The mean SAA level was 71.86 ± 23.01 U/L, while females and males had 71.85 ± 23.19 U/L and 71.89 ± 22.56 U/L, respectively. Spearman correlation revealed a statistically significant negative correlation between SAA and body weight ($p=0.002$), BF% ($p=0.007$), VFL ($p<0.001$), WC ($p<0.001$), HC ($p<0.001$), BMI ($p<0.001$) and waist to height ratio ($p<0.001$). Our findings indicate a potential role of SAA as a biomarker of adiposity. Future studies are needed to understand the relationship between low SAA and adipogenesis, possibly through impairments in carbohydrate digestion and glucose metabolism.

Keywords: Serum alpha amylase, body fat percentage, anthropometric parameters

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Malaria vectors in two islands of the Jaffna peninsula: understanding the receptivity for malaria re-introduction when coupled with vulnerability

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Sri Lanka is an island nation comprising of a mainland with dozens of offshore islands. Of these, majority are located in the Jaffna peninsula and many of them are tourist attractions and places of pilgrimage. Therefore, they remain vulnerable for malaria due to the close proximity to India and mobile population due to fishing, tourist and pilgrimage. Malaria is an eliminated disease from Sri Lanka since 2012 and can be reintroduced when both vulnerability and receptivity increases. The current situation in relation to receptivity towards malaria in the islands off Jaffna Peninsula is a timely need of the country, as the exotic invasive *Anopheles stephensi* was discovered from Mannar Island which is 50 km away from India. Therefore, this study was carried out to determine the occurrence of malaria vectors of two islands Nedunthivu and Kachchatheevu considering the vulnerability. Two separate entomological surveys conducted in 2017 and 2019 found the presence of seven *Anopheles* species from Nedunthivu and one species from Kachchathivu. A moderate density of primary malaria vector *Anopheles culicifacies* (7.65 per 100 dips) was found in Nudenthivu. Secondary malaria vector *An. subpictus* was common in two islands with high density (37.03 per 100 dips) in Nedunthivu and a moderate density (5.26 per 100 dips) from Kachchathivu. Secondary vectors *An. varuna*, *An. vagus* and potential vector *An. nigerrimus* were found in low densities in Nedunthivu. In the absence of rivers and streams manmade water collections were the identified breeding places of malaria vectors, where 10.4% of the built wells provided breeding for *An. culicifacies* and 81.3% for *An. subpictus* in Nedunthivu. *An. culicifacies* were breeding in 14.5% of burrow pits while 77.5% providing for *An. subpictus*. In Kachchathivu, cemented tanks provided breeding for *An. subpictus*. Adult surveys in Nedunthivu found *An. subpictus* (1.0 per trap), *An. tessellatus* (0.5 per trap), *An. varuna* (2.5 per trap) and *An. peditaeniatus* (0.5 per trap). Therefore, a considerable malaria receptivity was observed in both islands. When receptivity coupled with vulnerability increased risk of malaria transmission potential could be expected requiring regular monitoring and control activities of these islands which is essential to maintain malaria free status of Sri Lanka.

Keywords: Anopheles, malaria, islands, Jaffna

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Evaluation of two molecular-based assays: Quantitative Real-time Polymerase Chain Reaction (q-PCR) and Recombinase Polymerase Amplification (RPA) for early diagnosis of leptospirosis

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Leptospirosis is considered potentially fatal zoonosis caused by pathogenic bacteria of the Genus *Leptospira*. Early and rapid diagnosis is important for prompt treatment and to determine when hospital admission is required to reduce case fatalities. Availability of an accurate disease diagnostic test at the early acute phase enables starting treatment at the most effective time point. This study was designed to evaluate two molecular-based assays: quantitative Real-time Polymerase Chain Reaction (PCR) and Recombinase Polymerase Amplification (RPA) assay for definitive diagnosis of leptospirosis at the early acute phase of infection. Patients fulfilling clinical criteria of the latest leptospirosis case definition 2016 were enrolled for clinical sampling, followed by obtaining written consent. Clinical laboratory information was collected using an interviewer-administered questionnaire. Quantitative real time PCR and RPA assays were established using a reference DNA sample (*Leptospira interrogans* serovar Icterohaemorrhagiae strain RGA) to evaluate analytical sensitivity and specificity. A panel of blood samples collected from laboratory confirmed leptospirosis (n=46) and non-leptospirosis (n=54) patients based on the Microscopic Agglutination Test (MAT), the serological reference standard was used to evaluate accuracy of real time PCR using SYBR Green-I and RPA assays. Lower detection limit (LOD) of quantitative real time PCR and RPA was approximately 314 and 31 genome equivalents per reaction respectively. Analytical specificity of real time PCR and RPA were 100% for both assays with no amplification of *Leptospira* saprophytic sp. and other micro-organisms. Quantitative real time PCR and RPA can effectively detect leptospiral DNA from clinically suspected leptospirosis patients with a diagnostic sensitivity of 67% and 61% respectively. Furthermore, diagnostic specificity of quantitative real time PCR and RPA was (83%) and (79%) respectively. Quantitative real time PCR and RPA could effectively diagnose leptospirosis patients at the early acute phase of the infection assisting most prompt optimal treatment. These two molecular-based assays are promising tools for the early, rapid laboratory diagnosis of leptospirosis over serological diagnostic tests which provide retrospective confirmation of the infection in order to reduce fatality rates.

Keywords: Leptospirosis, Real time PCR, RPA, diagnosis

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Thin layer chromatography and phytochemical analysis of selected antidiabetic medicinal plants in Sri Lanka

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Diabetes mellitus (DM) is a complex metabolic disorder associated with impaired glucose homeostasis due to (a) autoimmune destruction of pancreatic β cells, or (b) insulin resistance. Further progression of insulin resistance gives rise to an established clinical entity; Type 2 DM, initially presented with hyperglycemia and dyslipidemia. Minimizing the complication arising from hyperglycemia and dyslipidemia is the primary focus in the management of Type 2 DM patients. However, current pharmacological approaches in the management of DM have been challenged due to reported adverse effects during their long term uses. Therefore, the search for naturally derived therapeutic leads has been emerged with an expectation of delivering effective and comparatively safe long-term treatment intervention. The objective of the present study was to identify phytochemical constituents of previously reported six anti-diabetic medicinal plants. We investigated three extracts (Dichloromethane, Ethyl acetate, and Methanol) of six selected plants; *Coccinia grandis* (Kovakka)- leaves, *Costus speciosus* (Thebu)- leaves, *Scoparia dulcis* (Wal Koththamalli)- aerial parts, *Gmelina arborea* (Demata)- stem bark, *Spondias pinnata* (Wal amberella)- stem bark, and *Gymnema sylvestre* (Masbedda)- leaves. Each plant material (5 g of dry weight) was sequentially extracted using Soxhlet apparatus in the above three different solvents and then reduced using rotary evaporator at a control temperature of 40 °C. Thin Layered Chromatography (TLC) on normal phase silica was carried out using reconstituted extracts with corresponding solvents to obtain initial finger print using an appropriate solvent system consisting of both polar and non-polar solvents. All extracts were subjected to their phytochemical analysis using previously established methodologies; such as ferric chloride test for flavonoids, lead acetate test for phenols, and Mayer's test for alkaloids, etc. Initial TLC revealed the presence of both polar and non-polar compounds in all extracts. Phytochemical analyses confirmed the presence of phenols, flavonoids, saponins, terpenoids, alkaloids and coumarins. The extraction efficacy of these phytochemicals was more effective with relatively polar solvents. Leaves and aerial parts of four plants and the stem bark of other two plants contained almost similar constituents. Hence the presence of flavonoids, terpenoids, phenols and alkaloids which had demonstrated significance anti-diabetic activity in recent studies, all the tested plants have shown a great potential to be used as therapeutic agents.

Keywords: Anti-diabetic, medicinal plants, phytochemicals

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Comparison of phytochemicals and total antioxidant capacity in leaves of seven sweet oranges (*Citrus sinensis* L. Osbeck) varieties grown in Sri Lanka

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Sweet orange (*Citrus sinensis* L. Osbeck) is one of the most important fruit crops which belongs to the family Rutaceae. In Sri Lanka, sweet oranges are prominently grown in Moneragala, Badulla, Anuradhapura, Kurunegala and Kandy districts in an area exceeding 3,500 ha. Although information on phytochemicals and antioxidant capacity of edible parts of sweet orange are available, similar information on leaves are scattered or lacking. Therefore, the present study was undertaken to compare total phenolic content (TPC), total flavonoid content (TFC) and total antioxidant capacity (TAC) in semi-matured leaves of seven locally available sweet orange varieties; Bibila sweet, Bibila seedless, Maduruketiya dodam (MKD), Maligathenna (MT), Arogya, Jepa and Sisila. TAC, TPC and TFC were determined using Ferric Reducing Antioxidant Power (FRAP) assay, modified Folin-Ciocalteu method and a colorimetric method with modifications, respectively. Results exhibited that all tested leaves of sweet orange varieties contained potent amounts of TPC, TFC and TAC. Out of the tested varieties, the highest TPC (9.17 ± 0.46 mg GAE/ g DW), TFC (26.02 ± 0.17 mg RE/ g DW) and TAC (28.91 ± 0.47 mg TE/ g DW) were recorded in leaves of MKD while the lowest TPC (6.99 ± 0.25 mg GAE/ g DW), TFC (12.79 ± 0.25 mg RE/ g DW) and TAC (13.67 ± 0.79 mg TE/ g DW) were recorded in leaves of Arogya. According to the results, it could be concluded that the leaves of the sweet orange variety MKD are rich in phytochemicals and antioxidants than other varieties. Therefore, it would be more suitable to use the leaves of sweet orange variety MKD as a source of phytochemicals and antioxidants in food and pharmaceutical industries.

Keywords: Sweet orange leaves, total antioxidant capacity, total flavonoid content, total phenolic content

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Determination of functional properties of Sri Lankan Ambarella (*Spondias dulcis* Forst. syn. and *Spondias Cytherea* Sonn.) fruit and development of value-added products

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Ambarella (*Spondiasdulcis*) is a widely distributed plant in Sri Lanka and its fruits are underutilized. The aim of the present study was to determine the functional properties of Ambarella fruits from two varieties (large and dwarf) and to develop value-added products. Ethanolic extracts of two Ambarella varieties were analyzed for 2,2-diphenyl-1 picrylhydrazyl (DPPH) scavenging activity, 2,2'-azinobis-(3- ethylbenzothiazoline-6-sulfonic acid) (ABTS) radical scavenging activity, ferrous reducing antioxidant power (FRAP), total phenolic content (TPC) using gallic acid standard, total flavonoid content (TFC) using quercetin standard and α -Amylase inhibitory activity. Fresh large Ambarella showed a significantly ($p < 0.05$) high antioxidant potential in terms of FRAP (0.712 ± 0.13 mg TE/g) and DPPH free radical scavenging activity (3.571 ± 0.31 mg TE/g) while dwarf Ambarella showed significantly ($p < 0.05$) high antioxidant potential in terms of TPC (3.357 ± 0.10 mg GAE/g). In comparison of ethanolic extracts of vacuum dried powders of two Ambarella varieties with respect to their fresh fruits, vacuum dried powders exhibited higher antioxidant potential in terms of FRAP in large (1.637 ± 0.195 mg TE/g) and dwarf (4.198 ± 0.059 mg TE/g) varieties and ABTS in large Ambarella (4.025 ± 0.274 mg TE/g). Alpha amylase inhibitory activities of fresh fruits of two varieties were $46.30 \pm 4.07\%$ and $49.55 \pm 3.18\%$ while in vacuum dried powders were $27.59 \pm 5.03\%$ and $15.48 \pm 5.86\%$, respectively. An instant soup mixture was developed using 20% of vacuum dried powder from the large variety due its abundance. The carbohydrate, protein, fat, fiber, ash and moisture contents of the soup mixture was 83.5%, $11.59 \pm 0.02\%$, $2.02 \pm 0.06\%$, $4.49 \pm 0.07\%$, $2.89 \pm 0.26\%$ and $9.77 \pm 0.14\%$, respectively. An ethanolic extract of the soup mixture was analyzed for ABTS activity, FRAP, TPC, TFC and α -Amylase inhibitory activity. The results of the above analysis were 1.648 ± 0.06 mg TE/g, 0.035 ± 0.15 mg TE/g, 0.549 ± 0.0015 mg GAE/g, 0.04 ± 0.00 mg QE/g and $39.49 \pm 0.29\%$, respectively. Both types of fresh Ambarella exhibited higher antioxidant potential except FRAP and higher anti-amylase inhibition than vacuum dried Ambarella powder. Dose response activity of ABTS and DPPH in vacuum dried powder has shown significantly ($p < 0.05$) higher values than fresh fruit. Ambarella fruit powder incorporated to soup mixture contained moderate anti-diabetic properties.

Keywords: *Spondiasdulcis*, functional properties, instant soup mixture

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Screening of five banana accessions grown in Sri Lanka for their phytochemical properties and antioxidant capacity

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Banana is used as a functional fruit and a nutraceutical to rectify many ailments around the world due to its high nutritional value and relatively low cost. Banana peel is the main by-product, which is rich in phytochemical compounds, with high antioxidant capacity such as phenolic compounds, anthocyanin, carotenoids, etc. There are many accessions of banana in Sri Lanka and some local banana accessions are not much popular among the people in the country. Therefore, the present study was conducted to evaluate and compare Total Phenolic Content (TPC), Total Flavonoid Content (TFC) and Total Antioxidant Capacity (TAC) in the pulp and peel extracts of five local banana accessions in Sri Lanka; 'Nethrampalam' (AAA), 'Suwandel' (AAA), 'Ratahondarawalu', 'Rathkesel' (AAB) and 'Puwalu' (AAB) at their fully ripen stage. TAC, TPC and TFC were determined in triplicate using ferric reducing antioxidant power (FRAP) assay, modified Folin-Ciocalteu method and a colorimetric method with modifications, respectively. Mean comparisons were done by SAS statistical software. Both pulp and peel of all tested banana accessions possessed marked contents of TPC, TFC and TAC. The significantly higher ($P < 0.05$) TPC, TFC and TAC in the pulp were observed in 'Puwalu' (68.32 ± 0.9 mg GAE/100g FW, 84.48 ± 1.9 mg RE/100g FW and 94.66 ± 2.7 mg TE/100 g FW). Among the tested banana peels, the 'Puwalu' peel was exhibited the highest TPC, TFC and TAC (36.38 ± 0.4 mg GAE/g DW, 33.48 ± 0.4 mg RE/g DW, 15.76 ± 0.1 mg TE/g DW, respectively) at their fully ripened stage. The TAC of tested banana pulps ranged between 5.23 ± 0.4 mg TE/100 g FW and 94.66 ± 2.7 mg TE/100 g. Based on results it could be concluded that significantly different and noticeable TPC, TFC and TAC were available in the pulp and peel of tested accessions. Hence, they could be incorporated in the formulation of banana-based value-added product development. Almost all tested phytochemicals and antioxidant properties were higher in 'Puwalu'. Therefore, 'Puwalu' could be popularized as commercial banana accession for higher economical value, better therapeutic properties.

Keywords: Banana, total phenolic content, total flavonoid content, total antioxidant capacity

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Phytochemicals and antioxidant capacity in young coconut mesocarp of coconut (*Cocos nucifera* L.) forms grown in Sri Lanka

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Cocos nucifera L. (family Arecaceae), commonly known as coconut, is considered as an important fruit crop in tropical countries. Coconut is the most extensively grown and used nut in the world, playing a significant role in the economic, cultural, and social life of over 80 tropical countries. Young coconut is defined as the fruit at the 6-month-old stage. In young coconuts, apart from coconut water and meat, rest of the coconut is discarded as waste. It is assumed that young coconut mesocarp contains high amounts of phenolic compounds which are vitally important due to their potential in performing as antioxidants and antimicrobial compounds. Various components of coconut drupe are used for numerous purposes in human health such as antimicrobial activity, treatment for diarrhea, arthritis, etc. The present study was conducted to analyze the total antioxidant capacity (TAC), total phenolic content (TPC) and total flavonoid content (TFC) in young coconut mesocarp of 15 coconut forms grown in Sri Lanka; namely, *Sri Lankan tall*, *navasi*, *gon-thembili*, *ran-thembili*, *pola pol*, *bodiri*, *kamandala*, *dikiri*, *green dwarf (pumila)*, *yellow dwarf (eburnea)*, *red dwarf (regia)*, *brown dwarf (braune)*, *king coconut (thembili)*, *rathran thembili* and *navasi thembili*. TPC, TFC and TAC were determined using, modified Folin–Ciocalteu method, a colorimetric method and ferric reducing antioxidant power (FRAP) assay, respectively. Young mesocarp of all tested coconut forms possessed marked contents of TPC, TFC and TAC. Significantly the highest TAC (164.73 ± 2.16) and TPC (36.62 ± 1.34) were observed in the mesocarp of the brown dwarf coconut form whereas yellow dwarf coconut form showed highest TFC content (425.39 ± 10.18). As suggested by the results of the study, it can be concluded that in general, young mesocarp of almost all selected coconut forms are rich in bioactive compounds and antioxidant capacity which can be employed to develop any value added products instead of disposing it as waste.

Keywords: Antioxidant capacity, bioactive compounds, young coconut mesocarp

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Bioactive compounds and antioxidant capacity in non-edible tissues of local sweet orange (*Citrus sinensis* L.) varieties

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Non-edible tissues of *Citrus* fruits namely, flavedo, albedo and inner membranes are reported as rich in bioactive compounds and antioxidant capacities with compare to its juice. Thus, disposing of non-edible tissues as waste is a disadvantage. Therefore, the present study was undertaken to evaluate the total phenolic content (TPC), total flavonoid content (TFC) and total antioxidant capacity (TAC) in non-edible tissues of seven local sweet orange varieties. TPC, TFC and TAC were determined using the Folin-Ciocalteu method, colorimetric method and ferric iron reducing antioxidant power (FRAP) assay, respectively. Among tested varieties, the significantly higher TPC in flavedo, albedo and the inner membrane was observed in “*Bibila seedless*” (14.85 ± 0.06 mg GAE/g DW), “*Sisila*” (13.65 ± 0.03 mg GAE/g DW) and “*Maliga thenna*” (12.28 ± 0.06 mg GAE/g DW), respectively, whereas the lowest TPC in flavedo was noted in “*Maliga thenna*” (13.14 ± 0.02 mg GAE/g DW) followed by “*Maduruketiya dodam*” (13.39 ± 0.07 mg GAE/g DW). The highest TFC in flavedo was recorded in “*Arogya*” (19.13 ± 0.33 mg RE/g DW). The highest TFC in both albedo and the inner membrane was noted in “*Bibila seedless*” (11.30 ± 0.17 mg RE/g DW and 8.52 ± 0.38 mg RE/g DW), respectively, whereas the lowest TFC in flavedo was recorded in “*Jepa*” (9.63 ± 0.76 mg RE/g DW). Out of tested varieties, the highest TAC in both flavedo and albedo was observed in “*Jepa*” (33.55 ± 0.14 mg TE/g DW and 16.21 ± 0.08 mg TE/g DW separately). Furthermore, the lowest TAC in both flavedo and the inner membrane was noted in “*Sisila*” (21.22 ± 0.20 mg TE/g DW and 15.22 ± 0.13 mg TE/g DW separately). Accordingly, it can be concluded that bioactive compounds and antioxidant capacities are rich in flavedo than other non-edible tissues, namely albedo and inner membrane and there is a high potential of commencement of newer value-added products using these non-edible tissues.

Keywords: Antioxidant capacity, bioactive compounds, citrus, non-edible tissues, value-added products

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Evaluation of physicochemical and functional properties of soursop (*Annona muricata*) incorporated drinking yoghurt and soursop fruit powder

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Soursop (*Annona muricata*) is an underutilized seasonal climacteric fruit with high perishability. The phytoconstituents present in the fruit exhibit many therapeutic and nutritive values. The fruit is reported to possess the ability of killing cancer cells and high antioxidant potential. The objective of the present study was to develop soursop incorporated drinking yoghurt and vacuum dried soursop powder and to evaluate the nutritive value and potential antioxidant properties in those products. Physical composition of soursop fruit in terms of the edible portion, peel, seeds and central pith were 71.5%, 17.2%, 8.3% and 3.0%, respectively. Soursop powder was developed by blanching followed by vacuum drying soursop pieces at 60 °C for 6 h. Trials were carried out by incorporating soursop flesh (15%, 20% and 25% w/v) in drinking yoghurt and based on the sensory evaluation results, the best fruit content was selected as 20% w/v. The titratable acidity, pH, total soluble solids and syneresis of soursop drinking yoghurt (20% w/v) were 0.85%, 4.5, 15.3°Brix and 29.3%, respectively. The soursop incorporated drinking yoghurts (20% w/v) with added sucralose and sugar were compared separately with normal drinking yoghurt as the control. The soursop incorporated drinking yoghurt with sucralose was selected as the most preferable with regard to all sensory attributes (odour, appearance, texture, taste, aftertaste and overall acceptability) by a panel of 12 trained panelists. Antioxidants potential in terms of Total Phenolics Content (TPC), Total Flavonoids Content (TFC), Ferric Reducing Antioxidant Power (FRAP), radical scavenging activities of DPPH and ABTS of soursop; fresh fruit, vacuum-dried powder and drinking yoghurt (20% w/v) were determined. A significantly ($p < 0.05$) high antioxidant potential in terms of TPC, TFC, FRAP, ABTS and DPPH were shown by the soursop drinking yoghurt (14.13 ± 0.63 mg GAE/g; 3.39 ± 0.36 mg QE/g; 1.32 ± 0.30 mg TE/g; 30.14 ± 3.24 mg TE/g and 25.67 ± 3.38 mg TE/g respectively) while vacuum dried powder had the lowest values (1.80 ± 0.09 mg GAE/g; 0.07 ± 0.01 mg QE/g; 0.12 ± 0.01 mg TE/g; 2.50 ± 0.08 mg TE/g and 0.92 ± 0.13 mg TE/g respectively). Fresh fruit has displayed moderate antioxidant potential. The proximate composition of vacuum dried fruit powder (fibre: 4.23%, total minerals: 3.97%, protein: 8.71% and carbohydrate: 77.21%) had shown better potential in applicability as a nutrient supplement.

Keywords: Antioxidants potential, soursop drinking yoghurt, vacuum-dried soursop powder

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Phytochemical contents and antioxidant capacity of different plant parts of six *Annona* species grown in Sri Lanka

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Annona is a fruit bearing plant in the family Annonaceae which has a wide range of medicinal and nutritional properties. Even though there are several species of *Annona* available in Sri Lanka, there have been no proper investigations to study the presence of antioxidant activity and the bioactive compounds in different *Annona* species. Therefore, the present study was conducted to determine the total antioxidant capacity (TAC), total phenolic content (TPC) and total flavonoid content (TFC) of different plant parts (leaves, seeds, bark and roots) of six *Annona* species; namely, Cherimoya (*Annona cherimola* Mill.), Katu anoda (*Annona muricata* L.), Weli anoda (*Annona reticulata* L.), Sini anoda (Green) (*Annona squamosa* L.), Sini anoda (Red) (*Annona squamosa* L.), Wel aaththa (*Annona glabra* L.) found in Sri Lanka. TAC, TPC and TFC were determined using ferric reducing antioxidant power (FRAP) assay, Folin-Ciocalteu method and colorimetric method, respectively. Out of all tested parts of the species, the highest TPC, TFC and TAC were observed in root extract of weli anoda (82.08 ± 0.74 mg GAE/g DW), root extract of Katu anoda (317.22 ± 3.47 mg RE/g DW) and root extract of Weli anoda (337.70 ± 0.85 mg TE/g DW) respectively. Positive correlations were observed between TAC values and TPCs of leaves, seeds, bark, and roots ($R^2 = 0.78$; $p < 0.001$) and between TAC values and TFCs of leaves, seeds, bark and roots ($R^2 = 0.49$; $p < 0.01$). The results of the study show that the all plant parts of tested *Annona* species can be effectively used for nutraceutical and pharmaceutical industries. Thus, *Annona* is suitable for the formulation of various value-added products rich in medicinal properties with high commercial value.

Keywords: *Annona*, antioxidant activity, bioactive compounds

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208/B

Comparative study on microbial and physico-chemical properties of pineapple (*Ananas comosus*) juice under thermal pasteurization and ozone sterilization

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Thermal pasteurization is the most widespread food preservation technique in the world whereas ozone is an alternative, novel non-thermal sterilization technique which aims to overcome the effects of thermal degradation in thermal pasteurization. The objective of this study was to evaluate the efficacy of gaseous ozone on microbial decontamination and on some physicochemical characteristics of pineapple juice in comparison to the thermal pasteurization. Pineapple juice was prepared using 18% of pineapple pulp with added sugars and water. Ozone treatments were applied under 4 different exposure times as 15, 30, 45, and 60 minutes at 25 °C at a flow rate of 0.2 g/hr. Thermal pasteurization was done at 80 °C for 15 minutes and overall impact on microbial load, colour, pH value, Total Soluble Solids (TSS), Titratable Acidity (TA) and Total Phenolic Contents (TPC) were evaluated. At the exposure time of 60 minutes the reduction of Aerobic Plate Count (APC) was recorded as 2.02 log cycles and the reduction of Yeast and Mould (YM) count was recorded as 2.00 log cycles. However no microbes were detected in thermally treated samples. Considering the chroma-meter color coordinates L^* value (lightness) of the juice was recorded as 15.29 ± 0.03 for 60 minutes ozone treated sample whereas thermally treated sample showed 14.10 ± 0.13 , indicating that ozone has significantly reduced ($p < 0.05$) the colour intensity by oxidizing the color pigments. Considering the pH, TA, and TSS, thermally processed juice sample show a significant increment ($p < 0.05$) due to the concentration of acids and solids during the thermal processing. Results showed that TPC has significantly increased when ozone exposure time increases compared to thermally processed sample. TPC was recorded as 4.33 ± 0.07 for 60 minutes ozone treated sample while 1.65 ± 0.00 for thermally treated sample in mg of gallic acid equivalents. In conclusion, ozonation can be used to reduce the microbial load in pineapple juice and it is recommended to combine other chemical preservative techniques to improve the quality of pineapple juice further.

Keywords: ozone, non-thermal sterilization, pineapple juice

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Comparison of phytochemical contents and antioxidant capacity of ripen and unripen fruits of *Annona* species grown in Sri Lanka

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The present study was conducted to determine the total antioxidant capacity (TAC), total phenolic content (TPC) and total flavonoid content (TFC) of ripened and unripened fruits of six *Annona* species, namely; Cherimoya (*Annona cherimola* Mill.), *Katu anoda* (*Annona muricata* L.), *Weli anoda* (*Annona reticulata* L.), *Sini anoda* (Green) (*Annona squamosa* L.), *Sini anoda* (Red) (*Annona squamosa* L.), *Wel aaththa* (*Annona glabra* L.) grown in Sri Lanka. TAC, TPC and TFC were determined using ferric reducing antioxidant power (FRAP) assay, Folin-Ciocalteu method and colorimetric method, respectively. Out of all tested species of ripen and unripen fruits, the highest TPC, TFC and TAC were recorded in unripen fruits of *Sini Anoda* (red) (2.94 ± 0.01 mg GAE/g FW), *weli anoda* (13.87 ± 0.04 mg RE/g FW) and *Sini Anoda* (red) (6.88 ± 0.0 mg TE/g FW) respectively. The results revealed that TPC, TFC and TAC of *Annona* fruits of all selected species have decreased with fruit ripening. The strong positive correlations were observed between TAC values and TPCs of ripen and unripen fruits ($R^2 = 0.90$; $p < 0.001$) and TAC values and TFCs of ripen and unripen fruits ($R^2 = 0.78$; $p < 0.01$). Based on the results it could be concluded that *Sini anoda* (red) and *weli anoda* were suitable for the commercial cultivation and manufacturing of *Annona* based value added products.

Keywords: *Annona* fruits, antioxidant activity, bioactive compounds

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Impact of hydrogels on early growth of maize (*Zea mays*) grown in sandy regosols

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The impact of prolonged drought conditions with climate change has become a challenge for agricultural production. Low soil water retention in sandy textured soils like Regosols is a major issue faced by the growers in areas like Kalpitiya, Sri Lanka. Super absorbent polymers or hydrogels has gained interest in enhancing water-holding properties of soils. This experiment was carried out to evaluate the influence of four different types of locally produced hydrogels and one commercially available hydrogel on early growth of maize in a sandy soil. The early growth of hybrid maize variety, Pacific 984 was tested with six treatments; T1 (Hydrogel type A-reference gel), T2 (Hydrogel type B- urea incorporated), T3 (Hydrogel type C-without urea), T4 (Hydrogel type D urea incorporated), T5 (commercial hydrogel) and, T6 (Control-no application of hydrogel). The experiment was designed in a Randomized Complete Block Design. Plant height, number of leaves and total dry matter production were recorded as plant growth parameters. Soil properties were determined at the beginning and the end of the experiment. The highest growth performances were given by locally produced hydrogels compared to commercial hydrogels and control treatments. T2 has recorded the highest plant height (128.90 cm), leaf area (1153.3 cm²) and total dry mass production (49.36 g) while, T4 has recorded the highest stem girth (4.87 cm). A significant difference could be observed among soil pH, total N% and available P among treatments. T2 showed the highest total N% (0.19) while T4 showed the highest P concentration (18.94 ppm). Results revealed that locally produced hydrogels have given superior performance over selected commercial hydrogels in enhancing plant growth. Therefore, it can be concluded that locally produced hydrogel formulations used in T2 and T4 have the capacity to enhance growth of maize while minimizing the risk effectively than using imported commercial hydrogels.

Keywords: Hydrogels, regosols, super absorbent polymers

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Genome-scale identification and in-silico expression analysis of late embryogenesis abundant (LEA) genes under abiotic stress conditions in *Musa acuminata* (Banana)

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Late Embryogenesis Abundant (LEA) proteins are a group of unstructured and hydrophilic proteins associated with plant development and abiotic stress. *Musa acuminata* (Banana) is an important crop plant that has many uses to humankind. Eighty four LEA genes, coding for 85 LEA proteins, belonging to eight subfamilies were revealed in *M. acuminata* in a systematic study. Promoter analysis revealed the existence of abiotic stress-responsive elements such as MYC, ABRE and CGCGBOXAT suggesting their role in stress tolerance. A comprehensive *in-silico* transcriptome analysis revealed the differential expression patterns of *MaLEA* genes in two *M. acuminata* genotypes; BaXi Jiao (BX) and Fen Jiao (FJ), subjected to different abiotic stresses such as osmotic, cold and salinity. Raw sequence data (accession number: PRJNA343716) was obtained from the Sequence Read Archive (NCBI-SRA) and analyzed using TopHat, feature counts and DESeq2 tools. Out of 84 *MaLEA* genes, 60 were differentially expressed and showed both up-regulation and down-regulation of gene expression in the two varieties under abiotic stress conditions. In the FJ variety, 25.0%, 11.9% and 31.0% of *MaLEA* genes showed up-regulation under osmotic, salt and cold conditions respectively, while 29.8%, 32.1% and 42.9% of *MaLEA* genes showed up-regulation under the same conditions in the BX variety. Down-regulation was observed in 10.7%, 13.1% and 16.7% of *MaLEA* genes in the FJ variety under osmotic, salt and cold conditions respectively, while 11.9%, 13.1% and 15.5% of genes were down-regulated in the BX variety under same conditions respectively. These results indicated that most *MaLEAs* are induced under cold conditions in both varieties. Almost all members of MaDHNs and MaLEA1s, all MaLEA4s, MaLEA5s, and MaLEA6 subfamilies showed only up-regulation in at least one variety under one condition, while down-regulation was observed in MaLEA2, MaLEA3 and MaSMP subfamilies under all three conditions. MaDHN-3, MaDHN-4, MaLEA1-2, MaLEA2-11, and MaLEA2-51 were up-regulated under all three abiotic stress conditions in both varieties, showing tolerance to a variety of stresses. The MaDHN and MaLEA2 subfamilies may provide genes that contribute to environmental tolerance in *M. acuminata*. These results provide information and robust candidate genes for future functional analysis aimed at improving stress tolerance of *M. acuminata*.

Keywords: Differential expression, bioinformatics, late embryogenesis abundant

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In silico analysis of allelic variation in *Rc* gene involve in rice pigmentation in Sri Lankan rice germplasm

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Rice pigmentation is due to the accumulation of anthocyanin and proanthocyanidin (PAs) in grain pericarp which have antioxidant activity conferring potential health benefits. PAs production in grains is mainly regulated by *Rc* gene (*Os07g0211500*) that encodes basic helix-loop-helix (bHLH) transcription factor. The mutant allele of *Rc* (*rc*) was reported to exhibit a 14 bp deletion within exon 7, causing changes of pigmentation of rice pericarp from red to white. This frameshift deletion suppresses the gene function by knocking out the bHLH domain of the protein. The present study was focused to assess the allelic variation of *Rc* gene, responsible for pigmentation in rice, to be used in rice breeding programmes which target the enhancement of nutritional value in terms of the high level of antioxidant capacity. *Rc* sequences of 41 Sri Lankan rice varieties were retrieved from the Rice SNP-Seek database and allelic variation was assessed by aligning the sequences with reference to the *Nipponbare Rc* sequence using MEGA 7 software. Seed pericarp colour was evaluated based on the standard descriptors of rice. In addition, the functional marker, InDel-Rc developed by flanking the 14 bp deletion within exon 7, was validated by resolving the amplified *Rc* gene products of rice varieties in a 3.4% agarose gel. In pericarp colour evaluation, a wide variation of pigmentation was observed among the varieties. *In-silico* analysis revealed higher allelic diversity in *Rc* gene (16 InDels and 62 single nucleotide polymorphisms (SNPs)) within the Sri Lankan rice germplasm while grouping into four major clusters. All white rice varieties except *Kurulu wee* grouped into one major cluster exhibiting the presence of *rc* allele responsible for white pericarp. All red rice varieties divided into three main clusters indicating wide allelic variations of *Rc* gene in Sri Lankan red rice varieties which may cause different intensities of red pigmentation in rice pericarp. *Pannithi* and *Godawel* red rice varieties clustered separately as they highly deviated by accumulating a higher number of mutations of the *Rc* gene. InDel-Rc marker was validated to be used in the future rice breeding programmes to screen red and white varieties at early stages of the plant development.

Keywords: Basic-helix-loop-helix, InDel-Rc, proanthocyanidin, *Rc* gene, rice pigmentation

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Development of a seaweed-based snack from *Ulva fasciata* in Sri Lanka

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Seaweeds have been used throughout the world for various food and non-food applications in the past as well as in the present. In Sri Lanka seaweed is an underutilized natural resource due to lack of awareness of benefits which can be obtained through consumption of seaweeds. However, there is a potential to develop novel nutraceutical and functional food products utilizing available seaweed varieties in Sri Lanka. Thus, this study has developed a crispy seaweed-based snack appealing to the Sri Lankan taste from *Ulva fasciata* to popularize seaweed consumption in Sri Lanka. *U. fasciata* samples were collected from Matara, Sri Lanka. Snack was developed by the traditional nori making technique. Flavor is enhanced by ginger oleoresin. The moisture content (%), total fat content (%), protein content (%) and ash content (%) of the unroasted snack was determined according to the AOAC procedures and values were found to be 12.52 ± 0.48 , 0.26 ± 0.042 , 19.18 ± 0.53 and 13.91 ± 0.46 , respectively. Total carbohydrate content (%) was analyzed according to the Dubois method and recorded as 9.48 ± 0.14 . Total fibre content (%) was recorded as 44.64 ± 0.23 . The elemental composition of the processed snack was determined by X-ray fluorescence elemental analysis. A higher content (ppm) of Calcium 13700 ± 707 was recorded than the other elements in the unroasted snack. Thus, as the outcome, a nutritious seaweed snack was developed. A sensory analysis was done to determine the best preferred roasted snack by the consumers. The effect on sensory properties such as colour, texture, taste, odour and overall acceptability with the addition of various concentrations 0, 50, 100, 200, 300 ppm of ginger oleoresin was determined by the sensory evaluation using a 5 point hedonic scale. According to the analysis results odour, taste, mouth feel, and overall acceptability is best for the roasted seaweed snack incorporated with 200 ppm ginger oleoresin.

Keywords: Seaweed snack, ginger oleoresin, *Ulva fasciata*, composition

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Bioethanol production from *Hydrilla verticillata* using *Saccharomyces cerevisiae* and optimization of the culture condition

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Ethanol can be produced from diverse materials that contain sugar, starch, and cellulosic substances. Plenty of under-utilized inland plant resources which are rich in cellulosic substrates are excessively available and widely distributed in Sri Lanka. This study was aimed to determine the production of ethanol using different fresh water floral substrates in the Northern Province of Sri Lanka and to optimize the conditions to enhance the higher yield. Fresh water substrates such as *Hydrilla verticillata*, *Salvinia molesta*, *Salvinia minima*, *Salvinia natans*, *Wolffia arrhiza*, *Wolffia globosa*, *Wolffia borealis*, *Wolffia brasiliensis*, *Lemna minor* and *Cabomba caroliniana* were used as substrates for ethanol production using baker's yeast, *Saccharomyces cerevisiae*, under liquid fermentation system. Among the plant substrates, *H. verticillata* yielded a significantly higher amount (0.25%) of alcohol than the other substrates tested, thus *H. verticillata* was selected for further studies. When *H. verticillata* was treated with different alkaline solutions, 50 ml of 3% (w/v) (NaOH and KOH) and acid solutions (H₂SO₄, HNO₃ and HCl), significantly higher yield (0.25%) was obtained with H₂SO₄ pretreatment. Thus 3% H₂SO₄ was selected as the best hydrolysis agent for further studies. When different concentrations of H₂SO₄ (1-10%) were used to pretreat with *H. verticillata*, significantly higher yield (0.3%) was obtained with 4% of H₂SO₄. When the substrates were hydrolyzed with different incubation periods (15 min, 30 min and 45 min), The highest ethanol yield (0.4%) was obtained at 30 min of incubation period. When fermentation was carried out with baker's yeast inoculated with peptone, yeast extract and nutrient (PYN) medium at room temperature and pH 7.0, under the optimized conditions alcohol production from *H. verticillata* was increased by 1.8 times than the non-optimized conditions.

Keywords: Bioethanol, hydrolysis, *Hydrilla verticillata*

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Comparative study on the properties of gelatin from the scales of *Oreochromis niloticus* extracted by ultrasound-assisted and water bath methods

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Fish gelatin has been studied extensively as an alternative to mammalian gelatin since it is not associated with negative health and socio-cultural aspects as in gelatin from mammals. Among fish waste, scales have been reported to be a promising resource to extract gelatin. Hence, the objective of this study was to extract gelatin from the scales of freshwater fish; *Oreochromis niloticus* by ultrasound (US) assisted and water bath (WB) extractions at 60 °C for 3 hours and, to investigate its yield and physicochemical properties (proximate composition, pH, gel strength, melting point, viscosity, FTIR spectra). For the comparison of two samples, t-test was used. US-assisted extraction (14.32%) yielded significantly ($p < 0.05$) higher amount of gelatin than WB extraction (12.15%). The increased yield of US extracted gelatin was mainly due to the mechanical and acoustic cavitation effect of ultrasound. The protein content of US (76.19%) was significantly higher ($p < 0.05$) than that of WB (67.51%) extracted gelatin. Moisture and ash contents of both WB (13.89%, 0.35%) and US (14.19%, 0.98%) extracted gelatins were below the maximum prescribed limits for commercial gelatin (15%, 2%). pH values reported within 4-5, indicated that alkaline pretreatment used during extractions resulted with gelatins in type B category. However, there was no significant difference ($p > 0.05$) in gel strength and melting point between gelatins extracted by US (643 g, 28.8 °C) and WB (670 g, 29.2 °C). But the viscosity of US (5.37 cP) was significantly lower ($p < 0.05$) than that of WB (5.59 cP) extracted gelatin. The major bands of FTIR spectrum of US appeared in amide region (Amide I, II, III, A, and B), shifted to higher wavenumbers compared to that of WB. As revealed by FTIR spectra, the secondary structure of gelatins was affected by extraction methods. Thus, the present study reveals that major gel properties such as gel strength and melting point are not significantly affected by the extraction method performed for a short period of time and ultrasound-assisted extraction is a promising method to increase tilapia scales gelatin yield while achieving better gel characteristics.

Keywords: fish gelatin, tilapia scales, ultrasound

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Preliminary study on length weight relationship in *Penaeus monodon* at early grow out stages and its impact on the final production of Sri Lankan shrimp farms

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Body length and weight relationships vary at different life stages and with the sex of shrimp, and the fact whether they are wild caught or cultured. The sex affects their growth only after the subadult stage; but the culture animals show a higher weight gain per unit length increase irrespective of the sex. However, many other factors govern the shrimp growth even in cultured shrimp. It is believed that if weight gain is retarded at growout stages below 45 days the production will be affected. The present study was conducted to investigate the growth during the early growout stages of shrimp culture aiming to compare the growth of shrimp at life stages between 30 days and 45 days and find any relationship to production, to collect preliminary data on growth conditions of *Penaeus monodon*. Since no studies on the growth relationship with respect to length and weight had been carried out previously in Sri Lanka, this study will provide the needed data for suggesting improvements. The selected farms were in the southern Dutch canal area where the water quality remains optimal for most parts of the year and do not show drastic salinity changes during a single culture cycle, except under severe climate conditions. Fifty farms were used for the study. Water quality, length, and weight of shrimp, at 30-45 days and 100 days were collected. Farm management practices including, aeration, feed use and use of probiotics were recorded. The results indicated that there was no significant difference between farms in water quality ($p < .05$). Pond management was similar in all farms. However, growth variations were clearly observed. Mean weight of 30 day shrimp was 3.0 ± 1.9 g and mean length and carapace length were 7.3 ± 1.7 cm and 2.7 ± 0.7 cm, respectively while mean weight length and carapace length of 45 day shrimp were 8.5 ± 1.6 cm, 3.5 ± 0.7 cm and 4.7 ± 2.8 g respectively. The total length to weight relationship was very strong ($r^2 = 0.939$) while carapace length and weight also had a strong relationship ($r^2 = 0.836$). It was observed that farms with higher weight during the first 45 days had a better production at harvest. A linear relationship was observed between total length and carapace length ($r^2 = 0.898$) and between weight at 45 days and weight at 100 days ($r^2 = 0.79$). Since the water quality and farm management did not show notable differences the growth would have been affected by the different feeds used or the quality of post larvae stocked. The study concludes that weight and length relationship is strongest at the beginning of pond culture while early weight gain has a significant impact on final production.

Keywords: Shrimp growth, shrimp length weight relationship

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Effect of shrimp pond sludge and super absorbent polymer on water retention capacity and microbial population of sandy regosols

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Water retention capacity of soil is an important factor that helps to supply nutrients and water to the plant during dry spells. Regosols are poor in retaining capacity of the water. Therefore, materials that enhance water retention capacity is gaining interest to amend these soils. This study was aimed to evaluate the Water Retention Capacity (WRC) of Shrimp Pond Sludge (SPS) and Super Absorbent Polymer (SAP) incorporated Sandy Regosols. The treatments were normal soil (Control) (T1), soil incorporated with super absorbent polymer at the rate of 0.2% (T2) and 0.4% (T3), soil incorporated with shrimp pond sludge at the rate of 10% (T4) and 20% (T5). Treatments were arranged in a completely randomized design with three replicates. The WRC was evaluated in volume basis. An assay of microbial growth was conducted to evaluate the effect of these amendments on soil microorganisms. Significantly the higher WRC was shown in 0.4% of SAP amended soil throughout the experiment, while the lowest was shown in the control. The WRC of soil has been increased by 29% as a result of adding SAP at the rate of 0.4% soil. The WRC of the shrimp pond sludge added treatment at the rate of 20% has been increased by 8% compared to control. There was no significant difference in microbial content of SAP and SPS. The results indicate the potential of using SAP and SPS as soil amendments to enhance the water retention capacity in soil. However, changes in microbial composition in soils amended with these materials and their effects on the soil and plants should be further investigated before making recommendation.

Keywords: Super absorbent polymer, shrimp pond sludge, water retention capacity

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Improvement of characteristics of selected clay mineral mixture for the removal of nitrate from drinking water

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Nitrate is one of the most widespread groundwater contaminants in the world. Due to its high solubility, it imposes a severe threat to human health and contributes to eutrophication. In Sri Lanka, especially in the Jaffna peninsula, nitrate contamination in groundwater has become an acute problem. Due to drawbacks in conventional methods available for the removal of nitrate from drinking water, there is a high demand for low cost, reliable and straightforward removal techniques. This study investigated the removal of nitrate by raw laterite (RL) and laterite-limestone mixtures. The physicochemical properties of laterite such as morphology, surface functional groups, elemental composition, surface area, and trace element elution were analyzed. Batch adsorption experiments indicated that the highest adsorption capacity observed for RL was 0.567 mg/g, at initial pH 3, after 60 min of contact time, and with an adsorbent dose of 2 g. Pseudo-first-order kinetic model and Langmuir isotherm model showed the best fit for the experimental adsorption data of RL. Further, the study was carried out under different laterite-limestone mixtures. Using a laterite-limestone combination containing 60% laterite (LD60) has been selected based on the maximum nitrate removal efficiency. The highest adsorption capacity of LD60 was 1.212 mg/g, at initial pH 3, after 180 min of contact time, and with an adsorbent dose of 2 g. Pseudo-second-order kinetic model and Freundlich isotherm model showed the best fit for the experimental adsorption data of LD60. The mixture was used to determine the effect of competing anions of fluoride, sulfate, phosphate, on the nitrate removal efficiency. It was found that phosphate ions had the maximum influence on the adsorption of nitrate by LD60. Finally, LD60 was used to test the removal efficiency using real groundwater samples, and the results demonstrate the potential use of laterite soil-based secondary clay mineral mixtures as low-cost adsorbents for the removal of nitrate from drinking water.

Keywords: Nitrate, laterite, adsorption

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Preliminary assessment of chemical properties of soil and nitrate levels of groundwater in Kalpitiya peninsula

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Kalpitiya peninsula contributes to a higher percentage of vegetable and fruit production in Sri Lanka, while generating approximately 33,000 job opportunities. Due to the low water-holding capacity of sandy regosol soil in this area, farmers tend to apply more water at frequent rates along with heavy doses of nitrogen fertilizer. These practices have increased the potential for contamination of shallow groundwater in Kalpitiya area. Therefore, this study was conducted to evaluate nitrate levels in groundwater and chemical properties of soil in Kalpitiya. Water samples were collected from 50 randomly selected wells in five areas, namely, Nawakkadu, Narakkali, Thalawila, Kandekuliya, and Kalpitiya town, with different land uses from 2019-2020 in monthly intervals. To represent each site, water samples were obtained from ten wells and analyzed for nitrate content, separately. A composite soil sample, which was obtained from different agricultural lands in Nawakkadu and Narakkali areas at a depth of 0-30 cm, was analyzed for soil pH, electrical conductivity (EC), organic carbon, total nitrogen, and available soil phosphorous. The spatial variation of nitrate concentration in groundwater was analyzed using the analysis of variance. According to the results, the significantly highest nitrate level of groundwater was reported in Nawakkadu as 61.19 ppm ($P < 0.05$), which was greater than the WHO specified permissible level of 50 ppm for drinking water. Narakkali, Thalawila, Kandekuliya and Kalpitiya town areas showed average nitrate levels of 25.50 ppm, 15.06 ppm, 5.32 ppm and 3.33 ppm, respectively. Total nitrogen and organic carbon of soil were as low as 0.04% and 0.3%, respectively. Soil available phosphorous level was notably high (39.41 ppm), indicating an accumulation of phosphorus in soil. The pH of soil was in the neutral pH range, with a mean value of pH 7.19, while EC was 134.3 μs . The results of this study emphasize that the nitrogen level of soil is extremely low, despite the high nitrate concentrations in groundwater. High level of soil available phosphorous indicates the accumulation of phosphorous in the soil, probably due to intensive phosphorous fertilizer practices. Application of high doses of nitrogen fertilizer together with frequent irrigation and low water and nutrient retention in soil, as indicated by extremely low organic matter content, could have reasoned for the leaching of nitrate into groundwater in the Kalpitiya area.

Keywords: Agriculture, groundwater, Kalpitiya, nitrate concentration, soil

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Assessing the influence of climatic conditions for egg laying and mating behavior of Black Solider Fly (*Hermetia illucens*); natural bio-waste decomposer

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Waste generation and sustainable management is a critical local as well as a global issue and effective, environmentally friendly methods need to be discovered. Biodegradable solid waste management using grubs and worms are in trend where, Black Soldier Fly Larvae (BSFL) is well known for its superior waste decomposing ability than other worms like cricket and mealworms. In addition, its favorable amino acid profile is more suitable for livestock feed crude protein replacement. Locally BSFL cultivation and production is less known and the research intent is to assess egg laying and mating behavior by observing favorable climatic conditions under IM2b Pambahinna area to popularize BSFL mass production. Two experimental setups were kept inside (T1) and outside (T2) of the experimental house to assess different climatic conditions and specially designed bins were used for larvae brooding. The experiment continued from July 2019 to September 2019 and was observed in two-hour intervals from 0800 hrs to 1600 hrs. Temperature, relative humidity, light intensity, and wind speed parameters were measured and recorded. Favorable conditions for their mating and egg laying was recorded at $27.4\text{ }^{\circ}\text{C} \pm 1.00$ and surrounding light intensity was $2.74\text{ kLux} \pm 1.52$. The most favorable relative humidity range was observed as $59.4\% \pm 1.8$. Their attraction and early egg laying preferences were assessed by using the same bin, placing three kinds of substrates, 100% swill (P1), fish offal (P2) and rotten fruits and vegetables (P3) in three different replicates. The adults were attracted to the swill treated bin in both inside and outside experimental houses followed by fish offal and rotten fruits and vegetables in outside experimental houses, respectively. In conclusion, optimized egg laying was recorded and mating under their identified favorable climatic conditions while being attracted to swill substrates was also recorded.

Keywords: Black soldier fly larvae, waste, climate, eggs

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Source IP based entropy computation to distinguish network traffic anomalies

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Network traffic anomaly detection is of paramount importance in distributed computer networks. Distribution of network traffic and their statistical measures are useful in determining the characteristics of certain user behaviour and events. Attacks and heavy usage events known as flash events are notable anomalous behaviours observable through network traffic traces. In this study we use the IP address and packet inter-arrival time as the measurable and observable features to distinguish anomalous events when compared to normal traffic traces. Experiments were performed by using publicly available data sets. As evidenced by the results it reveals that the entropy computed based on the source IP addresses are suitable for characterizing known denial-of-service attack scenarios and flash events.

Keywords: Flash events, IP address

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Development of a mathematical model to forecast solar radiation and validating results using machine learning techniques

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Solar radiation, also referred to as solar power, is the general expression for electromagnetic radiation emitted by the Sun. Direct solar radiation is an important factor in global solar radiation and is very influential in the efficiency evaluation of various applications for solar energy. For countries like Sri Lanka, installing a solar radiation instrument in rural areas is a challenge. Thus, both scientific and economically, measuring solar radiation without installing measuring instruments is an advantage. The aim of this study is to develop a mathematical model to predict solar radiation in instances where solar radiation measurement instruments are not installed. An Artificial Neural Network (ANN) was used to verify the predictions of the mathematical model. Multiple Linear Regression (MLR) analysis was used for the development of a mathematical model to predict solar radiation. The model with the highest R² value (0.5973) was chosen from 127 equations as the best model that describes the solar radiation that reaches the surface of the earth. The dataset used for this study was meteorological data spanning four months from Hawaii's Space Exploration Analog and Simulation (HI-SEAS) weather station and are composed of ten attributes including date, time, radiation (H), temperature (T_{air}), pressure (P), humidity (φ), sunrise time, sunset time, wind direction (D), and speed (S). The angle of declination (δ) and sunshine hours (N) were calculated using the dataset. For the training of the neural network, 80% of the data from the HI-SEAS dataset was used. The remaining data were used for testing both mathematical and ANN models. Results obtained from the multiple linear regression method and the ANN method was compared with the measured values. The experimental results suggested that the mathematical model predicted the solar radiation with $\pm 100 \text{ W m}^{-2}$ tolerance for both measured and ANN values.

Keywords: Solar radiation, machine learning, multiple linear regressions, ANN

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Development of an air quality distribution map with respect to particulate matter in Colombo Municipal Council region

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Clean air is a vital need as well as a basic right of every human being. It is also very important for animals and vegetation for their biodiversity and nutrition generation. However, getting clean air is one of the most difficult tasks in the present situation due to the heavy traffic flow, huge industries and ever-increasing population density. The attention of whole world has turned towards air quality as air pollution is a rapidly increasing issue in global level. The pollution level in urban areas in many countries have exceeded the WHO guidelines. When compare to other air pollutants, particulate matter (PM) is the most significant air pollutant related to high health risks such as respiratory illness, breathing issues, etc. The main environmental problem due to particulates matter are smog and visibility reduction. When considering air pollution status in Sri Lanka, Colombo and suburbs recorded high pollution conditions. Studies reveal that PM levels emitted by vehicular emission, power generators and construction activities cause more pollution in urban areas in Sri Lanka. Therefore, this research sought to map air quality with respect to particulate matter in the Colombo Municipal Council region. Sampling locations were selected considering the traffic condition, residential, commercial, and industrial distribution within the CMC region. PM_{2.5} and PM₁₀ measurements were taken by using the air quality detector Dienmern Model (DM106A) to assess the pollution situation in the Colombo Municipal Council region. PM levels at forty-seven locations were collected to cover the Colombo Municipal Council region and measurement was done using a real time sensor unit. Particulate matter levels were collected under three categories as industrial, commercial, and residential areas of the Colombo city. The highest particulate matter concentration was recorded in Borella North whereas the second highest was recorded in the Bloemendhal region, possibly due to high traffic conditions. In Borella North, concentration of PM_{2.5} varied from 14 $\mu\text{g}/\text{m}^3$ to 105 $\mu\text{g}/\text{m}^3$. Similarly, in the Pamankada East and Thimbirgasyaya region which are considered as residential, a low level of particulate matter concentration was observed. In Pamankada East, concentration of PM_{2.5} varied from 5 $\mu\text{g}/\text{m}^3$ to 9 $\mu\text{g}/\text{m}^3$. In addition, considerable changes in the concentration of PM was noted in high traffic congested areas. In many of the locations, PM levels exceed the Stipulated SL Standards. The developed map will be highly useful for further studies and for policy makers in taking decisions related to air pollution.

Keywords: Air quality, PM_{2.5} and PM₁₀, Colombo Municipal Council region, traffic congestion

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Visual MODFLOW flex for water budget estimation in Wanathawilluwa Deep Confined Aquifer

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Drinking water is a basic component of all biological components that are needed to perform various basic functions. The requirement of water for drinking purpose is further enhanced by the continuously increasing population and the ever-increasing demand at urban as well as rural levels. Hence water for drinking purposes is further considered in this study in a selected region at the North Western province of Sri Lanka. In Wanathawilluwa area, which is considered as one of the most water vulnerable irrigation areas, groundwater is used for everyday purpose of the residents and for agricultural purposes. Climate change threatens both groundwater and surface water sources in the area. Groundwater models play an important role in the management of groundwater resources and in predicting the impact of water management. Computer-based groundwater modeling began in the mid-1960's and has evolved over the years due to their wide applicability. The main purpose of the paper is to present a comprehensive overview of the Visual MODFLOW Flex for estimating the water budget for the deep confined aquifer at Wanathawilluwa which is located in the west coastal zone. The development of the model is a direct outcome of existing physical and measured data. Well inventory and base map created using groundwater monitoring data, lithology, hydro geological parameters, topography, and rain fall data obtained from the Water Resource Board in Sri Lanka and from the Sri Lanka Metrological Department are used to assess surface features, ground water level and direction. Visual MODFLOW Flex is conceptualized as a four-layered deep confined aquifer system, spread over a 247 km² area. Results show that the groundwater budget is low in some areas; hence, strategic control measures were proposed.

Keywords: Groundwater, visual MODFLOW flex, modeling, Wanathawilluwa

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305/C

Can changes in land use and built environment affecting disaster and disease risk be quantified using land survey and Google Earth images?

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Peri-urban Sri Lanka is facing challenges from disasters, infectious diseases and air pollution due to unplanned urbanization. Pinga Oya basin, which is off the main Mahaweli River in Kandy district, was selected as a case study of rapid urbanization and was used for modeling and managing flood and dengue risk. Available surveys and satellite imageries were used for modeling. Google Earth images from 2003 to 2019 having 4800x3025 pixel resolution were used. A special survey for flood risk assessment in Pinga Oya commissioned by the Disaster Management Centre in 2014 was used and information on buildings, bridges were obtained from old maps, consultations with residents and visual examination. Extent of impervious surfaces such as embankments, building of extensions were characterized using standard tools. Surveying, remote sensing and image analysis were used to quantify constructed areas, bridges, river channels and land use density. Initially the Google earth images were geo referenced with the local coordinate system with the use of an open source geographical information system (QGIS). Thereafter, the survey Images and the features in the Survey drawings were overlaid using Drawing software (Autocad). These images were imported to mathematical analysis software with image processing features (Matlab). Edge detection and other tools for estimating properties of areas (Regionprops) were used to extract impervious surfaces and to estimate geometric properties. Special Land Survey maps and Google Earth satellite images available since 2003 were aligned for spatial analysis. Furthermore, feature extraction for bridges, shops and embankments was feasible with the available resolution. Similarly, changing number of buildings including extensions, changes in the number of structures in the river as well as nearby and the extent of urbanization by user defined selected area were quantified.

Keywords: Pinga Oya, urbanization

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Framework on quantitative exploration of carbon emission from building projects in Sri Lanka; a transportation perspective

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Construction activities are known to influence the worldwide carbon emission during almost all stages of its life cycle. Examination of the current performance of their life cycle energy consumption and carbon emission is fundamental to alleviate these carbon and energy outflows. It has been revealed that 94% of the CO₂ emission is indirect. Out of the indirect emissions, transportation of materials on- and off-site consumes a considerable proportion. Only a few studies have been conducted on CO₂ emissions resulting from the building material manufacturing process and on the energy consumption of construction equipment, transportation for materials etc. in Sri Lanka. Therefore, it is vital to analyze methods and means of tackling the transportation sector in the construction industry to reduce the environmental impacts. Therefore, quantification of the carbon emission from the transportation related aspects should be carried out. The objective of the study was to develop a framework that is applicable to construction projects which can quantify the CO₂ emission from transport related activities during construction. Data collected from randomly selected 95 construction projects was utilized to test the framework. Carbon emission factors related to specific types of construction equipment with their engine capacities, loading capacities and running time were used. In the absence of locally generated data, the emission factors considered were derived from published literature in similar context. The necessary input data includes fuel type, vehicle type, running time, distances travelled by vehicle etc. and total CO₂ emission, while Global warming potential and emission from different vehicle categories are the output. The hotspot analysis and optimization analysis provide the user with opportunities for reducing the emission impacts while optimizing the use of their vehicle fleet. Thereby, as a result, a user-friendly tool that can be used industrially to measure the emission specific to each activity or project and in return, develop measures to reduce the carbon output with respect to transportation in construction projects was created.

Keywords: Drawing, image processing, online teaching, smart pen

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307/C

Investigation of indoor and outdoor air quality in urban and rural households in Colombo district

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The quality of indoor air is very important for the wellbeing of inhabitants since they spend more time indoors. If the ventilation of the dwelling is poor or appliances are faulty, pollution can build up to levels which may be detrimental to human health. Therefore, quality of indoor air has increasingly attracted attention worldwide. The indoor air is getting further affected due to the contribution of polluted outdoor air. This study was conducted to investigate the indoor and outdoor air quality in urban and rural households in Colombo district during the two main monsoon periods of Southwest and Northeast, respectively and to identify the indoor and outdoor air pollution sources and ultimately to use the collected data for further studies and extend to other districts in Sri Lanka. Twenty four (24) households were randomly selected in both urban and rural areas and three (03) locations (bed room, living room and compound (ambient)) from each household were selected to monitor the indoor and outdoor air quality. The monitoring was done to cover two seasons; Southwest monsoon (May to September) and Northeast monsoon (December to March). Hourly average (01 hrs) indoor and outdoor air quality were measured with respect to carbon monoxide (CO) using Air Quality Monitor/YES-AIR PID Detector/IAQRAE-Gas Analyzer, Total Volatile Organic Compounds (TVOCs) using Dirmern Air Quality Meter and twenty four hourly (24 hrs) average indoor and outdoor air quality of CO₂ were measured using Intelligent Infrared CO₂ Module – MH –Z19 and Particulate Matter (PM₁₀ and PM_{2.5}) were measured using Light Scattering Sensor Based Techniques. A questionnaire survey was adopted to find out the indoor and outdoor air pollutant sources of the households. The data were analyzed under CO, CO₂, TVOCs and PM₁₀ and PM_{2.5} and the variation of these parameter is greater in urban households than rural households in both monsoon periods.

Keywords: Indoor air quality, outdoor air quality, air pollution, urban dwelling, rural households, PM₁₀ and PM_{2.5}

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Ephemeral and perennial streams during drying; an investigation of water quality and role of sediments

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Not all streams have perennial flows; some undergo drying for a considerable time period due to certain environmental conditions. Although not universally agreed upon, non-perennial streams have several sub-categories such as ephemeral, intermittent and episodic, where “ephemeral” is the commonly used terminology. Drying and rewetting cycles undergone by ephemeral streams (ES) impact nutrient cycling and have shown to result in hypoxic (oxygen depleted) blackwater events during reinstatement of flows after drying and pool isolation. Although blackwater events are considered a natural phenomenon, the frequency and magnitude of such events have increased recently, for reasons that may not be purely natural. This has negative consequences on downstream perennial streams (PS) as the water that flows into them during a blackwater event is hypoxic to a level toxic to aquatic lives. The significance of ES has been recently identified in terms of their contribution to hydrology and nutrient processing but are subject to less study in Sri Lanka and elsewhere. This study explored the temporal water quality variations of ES against hydrologic permanency with comparison to PS of equal magnitudes. To compare the temporal variations continuously, mesocosms of ES and PS were allowed to dry completely during a 14-week period, simulating drying conditions of ES in field. Out of all water quality variables, only electrical conductivity showed temporal dependency in ES, and showed significantly low values than PS when ES was characterized by isolated pools. In the mesocosm study conducted by us, it was observed that there were no significant differences between temporal trends as well as final concentrations of water quality parameters of ES and PS, except for that of EC where the concentration effect during water drying lead to higher values in ES. During the mesocosm study, occurrence of blackwater was not observed and no notable differences were observed in the behavior of sediment of ES and PS. However, the pattern of water quality variations depended on the ratio of sediment, providing direct representation of the effect of organic matter on water during decomposition. This enabled the conclusion that water quality variations seen in ES were purely due to flow regime and organic loading.

Keywords: Sediment, water quality drawing

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Effects of crosswind on an automobile under dynamic conditions

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Road accidents have become one of the critical issues to road users everywhere in the world, most notably to expressway users. The critical circumstance is the fatal damage that it causes the passengers in the vehicle. There are many reasons for accidents on expressways. The wind ahead of a moving vehicle is more than a weather condition as it affects the aerodynamics characteristics of the vehicle. There are many researchers who have studied about the wind ahead of the vehicle whereas only a very few have studied about the crosswind effect on moving vehicles. The effect of crosswind on a moving vehicle is not yet properly understood or quantified. On the other the hand, onset of crosswind can be divided into two types; crosswind created by natural wind flow and the crosswind created by a large vehicle when it is overtaking another passenger vehicle. Therefore, the main aim of the present study is to analyze the pressure coefficient variation on the body of a passenger vehicle when it is overtaken by a large vehicle. The simulations of the problem were carried out, using SOLIDWORKS software by using a model of a passenger car, overtaken by a model of a truck. The pressure was obtained at selected eleven points around the passenger vehicle in two occasions, i.e. when the passenger vehicle was moving alone and when the passenger vehicle was overtaken by the truck. The results show that in the case the passenger vehicle was overtaken by the truck the pressure coefficient of two points out of eleven, changes from positive to negative. The negative pressure coefficient leads to change the aerodynamics characteristics of the passenger vehicle, which in turn affect the stability of the same.

Keywords: Crosswind effect, aerodynamic, pressure coefficient

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Application of anammox bacteria to remove ammonia from landfill leachate

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Landfill leachate caused by the disposal of municipal solid waste into the open dump area has a major environmental impact. Leachate is generated from the water percolating through a solid waste disposal site accumulating contaminants and moving into subsurface areas. Leachate generated through this process contains a significant amount of ammonia which produces undesirable health and environmental effects. Recently, a wide range of physical and, chemical methods have been utilized to remove ammonia from the wastewater. Yet, the use of eco-friendly and low-cost means of ammonia removal is of prime importance. Anammox bacteria can be identified as an efficient source of nitrogen removal from landfill leachate with their natural metabolic pathway of converting ammonia and nitrite to dinitrogen gas under anaerobic conditions. This process, resulting in the conversion of one mole of nitrite and one mole of ammonium directly dinitrogen gas with hydrazine as an intermediate. This research focuses on removing ammonia from the leachate generated in an open dumpsite using anammox bacteria. In order to achieve this, anammox bacteria were enriched by applying 1:10 diluted leachate and set to flow through the anammox barricade while maintaining the temperature of anammox reactor at 35 °C and pH at 7.5 with Hydraulic Retention Time (HRT) of four days. After the successful process in anammox reactor, NH₄⁺-N, NO₂-N and NO₃⁻-N concentration was measured in the influent and effluent of the anammox reactor to estimate the conversion rate. Moreover, zero ammonium nitrogen concentration was obtained after the four days of HRT and also 2% nitrite nitrogen was left in the effluent. The process shows remarkable ammonia removal and similar results were obtained by repeating the process. Ammonia nitrogen and nitrite nitrogen were removed 99% and 98%, respectively. According to the above results, anammox bacteria can be used as an efficient ammonia removal method. It can be used for a wastewater treatment plant as a low-cost biological method with future developments.

Keywords: Anammox bacteria, ammonia removal, landfill leachate, metabolism, anaerobic reactor

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311/C

Investigation of the feasibility of a PANI nanofibre grafted conductive fabric as a strain indicator in seat belts

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A child safety harness has a unique product design mandated legally in most countries and has been designed to serve the primary purposes of the toddler's protection. The purpose of a harness or restraining belt is to protect the toddler from impact, similar to the seat belt that is used by adults in automobiles. However, excessive strain imposed on the harness due to the movement of the toddler could cause physical discomfort and potential muscular injuries to the wearer. This study focuses on the design and development of the existing child safety harness incorporating the principle of a strain indicator, where the imposed strain on the safety harness would be measured relative to the surface resistivity of the developed conductive fabric, thus facilitating the ability to monitor the imposed strain level. Currently, Sri Lanka possesses the capacity to manufacture the necessary safety harnesses in mass scale, utilizing local narrow fabric weaving facilities. In this research, a Cotton Fleecy fabric *in situ* polymerized with polyaniline has been used for the development. Aniline/HCl solution *in situ* polymerized by drop casting ammonium per sulphate/HCl solution was used to obtain conductivity by grafting nano fibrous clumps of polyaniline on the surface of cotton. An Arduino Uno interface has been used to plot the variations of the voltage level in response to the strain at a baud rate of 9600, with an LED indicator triggered at variations of the pre calibrated base voltage level. The end-product demonstrated 35 - 30 Ohm variation in response to 1 cm of the fleecy fabric's elongation due to the imposed strain. Moreover, tests conducted under ASTM standards concluded that the necessary tensile properties, abrasion resistance and wash fastness properties were incorporated in the fabric in addition to the necessary level of conductivity.

Keywords: Nanotechnology, technical textiles, automotive safety, smart textiles

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Dryer for food preservation for Dambulla dedicated economic center

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Dambulla Dedicated Economic Centre (DDEC) is one of the busiest wholesale and retail business centers in Sri Lanka for exchanging vegetables, fruits and cereals where the average volume of sale per week is 26,500 metric tons, the highest exchange rate among the other dedicated economic centers with 30% of high daily wastage rate from the total capacity. This significant wastage of vegetables and fruits not only reduces the farmers income at least by 30%, but also causes numerous environmental hazards both to the flora and fauna by their dumping to nearby sites. Thus, a mechanism to preserve this unsold consumable food is essential. An initiative, 'cold stores project' has been discussed with an investment of Rs. 550 million, which has not materialized yet and this study intends to propose a mechanism to preserve unsold fresh vegetables with an investment of around Rs. 5 million which is much less when compared to the 'cold stores project'. Furthermore, the proposed mechanism does not need any high technological maintenance procedures and skilled manpower requirement. Thus, it fulfills the main aim of introducing a low cost and maintenance-free (or less) food preservation method. It has the capacity to dry 300 kg of vegetables per batch and requires 9 hours to complete one batch. Ten numbers of solar panels (each with 300 W power output) are required to supply the power requirement. The mechanism can be considered as simple with optimum assemblies which could be dismantled at any time for replacements, relocations, service, etc. Moreover, the machine is designed to be cleaned, daily or after a cycle, with ease. The proposed system will increase the income of farmers by allowing them to sell their yield completely for a good price. Furthermore, this can be considered as a pilot project which could be further developed and introduced to economics centers of the country (Narahenpita, Welisara, etc.), not only to preserve the food but also to expand the entire agricultural economy of Sri Lanka. Lastly, this project paves avenues to explore and provide startup business opportunities to investors.

Keywords: Dambulla Dedicated Economic Centre, dryer, preservation, solar energy

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An assistance of computer vision for hydraulic mending of three-wheeler forks

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Three-wheelers are one of the popular transportation methods in Sri Lanka. Approximately, 600,000 three-wheels have been registered (during the past 8 years) with 15.4% annual growth according to the department of motor traffic in Sri Lanka. A damaged three-wheeler fork is a major issue in this method of transportation, and it often leads to severe accidents. This fork is connected to the steering-handle and the suspension assembly that is located at the front of the wheel hub. A slight damage or a deformation in the fork can unbalance the three-wheeler and the driver may entirely lose control of the vehicle. Traditionally, both heat-treating and cold-working manufacturing techniques are used in this mending process. However, manual-labor repairing that is used in this process is tedious, expensive, time-consuming, and less accurate. The present paper proposes a hydraulic operated fork mending machine with an image processing technique for reforming the damaged forks. The main problems of damaged forks and their effects are identified, and a survey is carried out to find out the effects of fork deformation and fork reforming. An image comparator-based imaging technique is used for this machine vision-based visually guided fork repairing process. Three cameras are used to capture the images from three perpendicular directions. A contour sketch of the original fork (before the deformation happens) is compared against the faulty fork, to assist the worker to carry out the repairing process. The worker uses the cold working process to reinstate the original shape of the fork with the aid of the visual assistance given by the proposed technique. Preliminary experimentation has shown that the proposed technique can improve the three-wheeler mending process, by minimizing time consumption, human errors and reducing effects on the fork material properties. In future work, a systematic study will be carried out to quantify the process improvement.

Keywords: Three-wheeler fork mending, machine vision, visually-guided fork repairing

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Social and economic effects of saltwater intrusion at the Kalu ganga lower basin

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Saltwater intrusion can be described as the movement of saline water into freshwater aquifers, which leads to contamination of drinking water sources and other consequences. In the past few decades, saltwater intrusion in the Kalu Ganga has increased considerably due to natural disasters and human activities which has become a significant issue in the Kalutara area. This study mainly focused on identifying the social and economic impact faced by residents of Kalutara, where pipe-borne water supplied by Kethhena water intake is contaminated due to saltwater intrusion. Furthermore, economic impact faced by National Water Supply and Drainage Board (NWS & DB) and sand ferry owners were also assessed. Preliminary data were collected using a questionnaire which was presented to NWS & DB water consumers in Kalutara, Beruwala and Dodangoda Divisional Secretariat Divisions (DSD), where water supply is by the Kethhena Water Treatment Plant. Simple random sampling method was used for data collection. To assess the economic impact on sand miners, information was collected from the sand miners and sand ferry owners in Kalutara, Millaniya and Dodangoda DS divisions where the sand ferry located below the Kethhena water intake. GIS mapping was done with GPS Coordination of data collection area. Data analysis was done using SPSS; 22 and MS Excel. Almost all the people in the area have issues while drinking, cooking, bathing, and washing activities due to saltwater intrusion. Hence, society has to bear a cost for obtaining water. Distributions of fresh water via water bowsers during saltwater intrusion period incur an additional cost on NWS & DB. Restricting sand mining duration become an economic loss to sand miners and the government. It is revealed that saltwater intrusion of the Kalu Ganga have social and economic impact on the society, as well as economic impact on the government. To minimize these issues, it recommended to rehabilitate the eroded sand bars at river mouth, construct a salinity barrier, moving of water pumping points up in the river by few kilometres can be presented. In addition, improvement of water cleaning techniques, control of groundwater extraction and minimizing over-pumping by industries, and conducting social awareness programs on importance of minimizing water wastage, effect of over-pumping and lack of availability of freshwater and importance of rainwater harvesting also can be suggested.

Keywords: Socio-economic effect, saltwater intrusion, Kalu Ganga lower basin, sand mining, Kethhena intake

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Life saving device to alert night-time hypoglycemic events

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Hypoglycemia or low blood glucose is a common and serious side effect of insulin therapy in patients with type-1 diabetes. Severe hypoglycemic events are a consequence of extreme diabetes control such as large quantity of insulin administration, diet control and pharmacological therapy. Worldwide data shows Sri Lanka is among the countries with the highest diabetes prevalence rates and it was estimated that there would be around 2.8 million adults with diabetes mellitus at present. A continuous glucose monitoring systems (CGMSs) were recently introduced in order to minimize the risk of hypoglycemia (Nguyen *et.al.* 2009). These CGMSs are invasive and costly and have been recently demonstrated to be intolerant for most children and adolescents and solely detects one symptom of hypoglycemia, 'low plasma glucose level'. However, none of those devices can detect a 100% hypoglycemic event. Therefore, a simple, non-invasive, convenient, reliable device is required to detect hypoglycaemic events. Such a device should be capable of providing automatic readings and frequent monitoring of several physiological outcomes of hypoglycaemia. These includes excessive sweating, increasing heart rate, elevating blood pressure and unconsciousness. Furthermore, it should also be capable of alarming the user in response to glucose readings below user-selected alert levels since such an alarm could reduce the risk from hypoglycemia, making intensive therapy safer and more acceptable for patients. A novel device was designed, which could detect symptoms of hypoglycemia and at the same time alerting the patient with a loud alarm which requires a manual reset. Further this alarm was coupled with a vibrating alert system which activates if the patient does not respond to the sound alarm. Also, if the alarm was not manually reset the audibility will be further increased to alert a nominated medical professional. Therefore, this device would hold a great promise in becoming an important equipment to help patients suffering from diabetes while minimizing the consequences due to severe hypoglycemic attacks.

Keywords: Hypoglycemia, diabetes, sweating, heart rate, blood pressure, unconsciousness

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Potential benefits and limitations in implementing GHG emissions standard associated with industrial processes in Sri Lanka

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The rate of applying for ISO 14064-1 Greenhouse Gases Standard Certification is generally slow in Sri Lankan organizations compared to other popular management systems certifications like ISO 14001, ISO 9001, ISO 50001 and ISO 45001. The present study is focused on obtaining some data on the potential benefits and limitations in implementing GHG emissions standards associated with industrial processes. At the same time the benefits gained by implementing the ISO 14064-1 and limitations faced by the organizations in implementing and maintaining this certification were also evaluated to get a better understanding on this study. The main objective of the study is Identify the potential benefits and limitations that could be influence the non-certified industries to obtain ISO 14064-1: 2018. In addition identification of present status of ISO standards, environmental impacts in the industries and GHG emission measuring, reporting and verification systems in Sri Lankan industrial processes and introduce an appropriate method to enforce industries which cause GHG emissions associated with industrial processes to measure, report and verify GHG emissions accordance to ISO 14064-1:2018 Standard were undertaken. A questionnaire-based survey was carried out among eighteen industries including fourteen ISO 14064-1 non-certified and four certified industries in Sri Lanka. The results clearly indicated that the first three limitations based on the overall rank in implementing ISO 14064-1:2018 were annual cost of maintaining ISO 14064-1 standard, lack of time to implement the GHG standard and design cost of implementation of standard. The significant benefits of the ISO 14064-1 implementation were identified through calculating the overall rank. From the result obtained, the GHG emission sources, capabilities of the industries, existing environmental efforts also were identified. Once these GHG emissions are determined, solutions can be identified to overcome and mitigate the GHG emissions which were released by the industries. This will help the industries to achieve the low carbon emission status or carbon neutrality.

Keywords: Greenhouse gases (GHG), climate change, carbon footprints, industrial processes, ISO 14064

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Laboratory wastewater treatment by using bio-geo filters

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Wastewater from laboratories are considered less due to their low quantity and decentralization even though it gives a detrimental impact to the human and environment. Scrutinizing the contaminants in laboratory wastewater and finding an efficient and economical treatment for small scale laboratories is utmost need. Prototype model of horizontal flow constructed wetland system with bio-geo filters were designed, constructed, and operated with locally available utilized materials as filter media. The media properties such as media size, hydraulic conductivity, porosity, and reaction constant were considered for scientific design. Locally available geo materials such as Calicut tile, and laterite, and bio materials such as cinnamon biochar, coir were selected as main filter media. Gasified cinnamon biochar by-product of down draft gasifier from a hotel used for the filter media. All the filter media were thoroughly washed several times with clean water to removed impurities, prior to place in the treatment system. Macrophytes wetland plants such as cannas, were planted in series of three tanks in the treatment system while fourth tank is full of slurry, produces biofilm to facilitate the micro-organism presence in operational phase. Diluted Composite sample of laboratory wastewater of the Environmental Engineering Laboratory allowed to pass through the prototype model treatment system at low flowrate with the aid of peristaltic pump. Influent COD, BOD, EC and TDS were 1432 mg/L, 100mg/L, 658 μ S/cm and 641mg/L respectively. The wastewater was diluted to desirable pH with pipe borne water could pass through the treatment system. Influent and effluent from each treatment tanks were undergone for physical and chemical tests for characterization. This effluent quality was analysed against with wastewater discharge standards stipulated by CEA into inland surface waters. Slightly higher pH and Phosphate was observed during passage through the bed due to the filter media of cinnamon biochar. Observed pollutants removal percentage for BOD, COD, TKN, electrical conductivity, and total dissolved solids were 80%, 86%,45%,62%, 66%, and 43% respectively. Higher removal efficiencies of 80% BOD and 86% COD observed in the treatment system may be due to the presence of biofilm in final treatment tank and gasified cinnamon charcoal as filter media. Further, considerable reduction of 43% turbidity,45% TKN, 62% electric conductivity and 66% total dissolved solids observed in the prototype bio-geo filter treatment system. Operating the treatment system of horizontal flow constructed wetland with bio-geo filters gives ecofriendly and efficient solution for small scale, decentralized highly contaminated laboratory wastewater with heavy metals.

Keywords: Decentralized, gasification, constructed wetland, heavy metal, bio-geo filter

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Detection of Cyclists and Motorcyclists in Streaming Traffic Video

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Cycling is an alternative, efficient, economical, environmentally friendly mode of transport. However, an increasing number pedal cycle and motorcycle crashes are reported. It is important to implement techniques that allow detection and tracking cycles to find the countermeasures for reducing these crashes. Detection of pedal cyclists and motorcyclists in traffic video has been a difficult task due to smaller image pixel occupation and irregular movement on the road. The objective of this study is to introduce a novel method of image segmentation of cyclists and subsequent detection with Hu moments using traffic camera video footage. Using image processing techniques, the isolation of motorcycles and pedal cycles with perfect object boundaries has been a challenging problem with respect to other vehicle categories. Usually moving objects are extracted inside rectangular boundaries with additional image garbage pixels from other objects included in the analysed image. These image segments are not favourable for feature extraction to detect the vehicle category. This study deals with irregular shaped image segmentation for motorcycle and pedal cycle identification using a recursive algorithm. Here, the binary threshold image composed of white and black pixels is filtered with a two-dimensional low pass filter to isolate motorcycles and pedal cycles with perfect boundaries. Then a novel recursive image segmentation algorithm is applied on the binary image. Presence of white pixels was used to identify moving vehicles from video sequences. The extraction of all the neighbouring pixels of motorcycles and pedal cycles were done in an efficient manner. Here capturing and extraction of all the pixels of the bicycle, which is a small vehicle in height and width, was achieved using the proposed algorithm. Correspondingly, pixels count, height and the width of the object were recorded. To identify the cycle category the extracted image features using Hu moments as well as pixel count, height and the width of the image were considered. Detection of cyclists with an accuracy of 91.2% was obtained for video footage duration of six minutes. Thus, it can be concluded that image segmentation method was successful in identifying the cycles in traffic video sequences.

Keywords: Image segmentation, image features, irregular shape

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319/C

Choice and validation of evaporation estimation models under Sri Lankan conditions

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Estimates for evaporation is needed for water balance, irrigation, studies and assessing suitability for mosquitoes that transmit infectious diseases. As evaporation data is not widely available, more widely available atmospheric measurements such as temperature, wind, pressure, humidity to estimate evaporation. Evaporation estimation can be done using numerous formulas which falls under temperature and radiation based categories. Here, we assess the Thornthwaite, Hargreaves-Samani and Penman evaporation estimation methods based on temperature to select the most accurate estimation formula under Sri Lankan environmental conditions. Daily minimum, mean and maximum temperature and open water evaporation data for Batalagoda and Peradeniya were obtained from the Natural Resource Management Center of the Department of Agriculture from January 2011 to December 2015. Outliers of minimum maximum and mean temperature measures were removed according to the Inter-Quartile range. Thornthwaite, Hargreaves Samani and Penman formulas were utilized to estimate evaporation using minimum, maximum and mean temperature measurements. The time series of the estimated and measured evaporation were compared. The means of estimates and observed evaporation measurement were considered to be equal in the null hypothesis. To test the hypothesis, one-way ANOVA tables were constructed. According to the p values the null hypothesis was rejected with 95% significant level. For both Batalagoda and Peradeniya, there was no significant difference between estimated Thornthwaite evaporation mean and the actual mean - the null hypothesis was not rejected. For Penman and Hargreaves - Samani estimates, the null hypothesis was rejected with p value less than 0.05 (95% significance level) emphasizing that the estimated means differ significantly from the actual mean. Therefore, the Thornthwaite formula provided values that were closest to the observed evaporation for Sri Lanka.

Keywords: Evaporation, Batalagoda

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320/C

Development of stabilized soil for road pavement materials using despoiled soil of road construction and demolition waste

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Construction and demolition (C&D) waste is, generally defined as solid waste that arises from construction, renovation, and demolition activities. Thus, disposal of demolition waste is becoming a rising problem in Sri Lanka as well as around the world. During the road construction process, huge amount of soil is being excavated and disposed away from the site and huge amount of soil is supplied from borrow pits for filling. Due to this process serious environmental consequences are experienced and the costs due to the negative externalities do not exactly get calculated, though it should be massive in amounts which have serious impacts on the economy. Therefore, this research is aimed to carry out a comprehensive study to stabilize despoil soil in the road construction by using C&D wastes to develop a suitable cost-effective road pavement material. The methodology comprises of preparation of materials and testing for determining engineering properties to use as a road pavement material. Despoiled soil was collected in the construction site with one being high plasticity and other moderately low plasticity. In addition, C & D waste consist of crushed concrete, bricks, waste sand, waste coarse aggregates, and asphalt concrete waste were blended in specified preparation to develop a blended aggregate mix. Using the C&D wastes and the despoil soil to design mixed designs in ordered to develop suitable road pavement materials. The developed mix designs have fulfilled the specific engineering parameters of different road pavement materials for embankment, sub-base, and base. The research findings reveal that the recycle of construction waste can be used to develop a useful road construction material which is environmentally friendly and cost effective. It is further useful to eliminate the construction waste disposal to public places and unauthorized land filling. Furthermore, this research studies recommended-to-use C&D waste, to develop road pavements materials for different layers. This analysis satisfied the Standard Engineering Parameters of the different road pavement layers according to the stranded specification of the road construction.

Keywords: Road pavement materials, despoil soil, construction and demolition waste, mixed design

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321/C

An investigation into circular economy practices in the construction industry of Sri Lanka

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The continuous cradle-to-grave approach of the construction industry has resulted in the world's rising environmental and material-scarcity problem due to its high material-extraction, consumption, and disposal methods. Introducing a circular economy (CE) i.e. cradle to cradle approach, will ensure continuous environmentally friendly material flow, which is economical in the long run. The main objective of this research was to quantify the level of awareness and practices on CE and to develop a framework to implement CE in the construction industry of Sri Lanka. The research was conducted in two-phases, a comprehensive online-questionnaire (for quantitative-analysis) and a structured-interview (for qualitative-analysis) with a random sample consisting of construction industrial activities representatives, consultants, designers, architects, contractors, researchers, building-owners, legislative-policymakers, and sustainable advocates. The results were categorized into 7 key areas which are introduction of CE in Sri Lanka, cultural-aspects, regulatory-aspects, financial-aspects, sectorial-aspects, and future of CE in the construction industry of Sri Lanka. Based on the results obtained, the framework was developed based on the steps that should be taken by each stakeholder in the construction industry to implement CE in the built environment of Sri Lanka. Person R analysis results indicated that easy wins due to business case [0.233], adoption of Circular Business Model [0.234], and energy and water conservation and reduction, and environmental protection [0.223] will encourage the construction industry to adopt CE principals, but introducing financial benefits [0.042] will not ensure it. The "I don't know" data results suggest that architects (7.23%), contractors (10.72%), clients (12.48%), legislative policymakers, and sustainable advocates (19.81%) are the least educated on CE concepts, principles and tools, which is a key challenge for greater adoption. Furthermore, outdated policies, lack of research and development, and lack of support from the central government are the main barriers to implementing CE concepts in the construction industry of Sri Lanka. Having sufficient awareness and understanding of CE principles and practices among all the stakeholders will support to overcome these barriers and adopt CE in the construction industry of Sri Lanka.

Keywords: Construction industry, circular economy

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MMT clay-biochar composite for the removal of hardness and fluoride from drinking water

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Chronic Kidney Disease (CKD) can be considered as a global public health issue. The focus of this study was to investigate the adsorption of hardness and fluoride on to a nano clay which is derived from montmorillonite (MMT) clay from the Murunkan area in Mannar district and biochar which is derived from Cinnamon wood as composite balls developed by combining the biochar with MMT nano clay. Nano clay was obtained using sedimentation and centrifuging method with the addition of sodium chloride (NaCl). The obtained sample was subjected to XRD and particle size analysis to verify the presence of Montmorillonite clay mineral within the nano range. The biochar was prepared by pyrolysis of cinnamon wood at 600 °C at 10 °C min⁻¹, under a low oxygen environment in a chamber furnace. The composites were prepared using obtained nano clay and biochar in the form of balls with an average diameter of 5 mm. To improve the stability of composite balls, a thermal modification was carried out by putting these balls in the furnace at 1000 °C for 7 hours. The water samples were tested for removal efficiency and adsorption capacity of fluoride and hardness on to the nano composite using a column experiment. The colorimetric method and titration method were used to determine the fluoride and hardness concentrations, respectively. According to particle size analysis results of the nano clay sample, the cumulative nano clay fraction percentage has fallen below 200 nm size ensuring that, the isolated clay fraction has considerable amounts of nano particles. The XRD analysis indicated that sample has a considerable amount of Montmorillonite nano particles than other clay minerals. According to the removal efficiencies and adsorption capacities results for fluoride and hardness, there is significant reduction of fluoride and hardness concentration of drinking water. Thus, nano clay–biochar composites could be considered as a potential material for adsorption of fluoride and hardness in drinking water.

Keywords: Montmorillonite nano clay, biochar, nano composite

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Review on the impact of Covid-19 virus to construction projects in Sri Lanka

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The construction industry is characterized by complexity factors due to industry specific uncertainties and interdependences. It has a positive role to accelerate the wheel of economic growth in any country. Pandemics are remarkable global events due to highly contagious virus which spread to all parts of the world very quickly. For the past years, epidemics resembling influenza have been recorded such as AVIAN, Spanish Flu, Hong Kong SAR, H5N1, chicken Ebola and SARS. These viruses directly affected the industries which are education, construction, tourism, semiconductor manufacturing and wedding services industry. Currently the world is experiencing the coronavirus disease 19 (COVID-19), which is a highly transmittable and pathogenic viral disease. The objective of this paper is to understand the effect of Covid 19 on construction projects. This research was conducted with available literature on the effect of pandemic situations, particularly Covid-19, on construction industries in the world and in Sri Lanka. Effects were identified and listed and an attempt was made to find a relationship among those. The direct impacts have ranged from a slowdown of available goods and labor through to suspensions and, in some instances, terminations of parties or entire projects. Therefore, a country's government should support the construction industry to overcome these difficulties now and during the post-covid period.

Keywords: Drawing, image processing, online teaching, smart pen

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324/C

Design and development of double-top user-fix grow tunnel package for low country dry zone of Sri Lanka

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Growing crops inside protected houses is now a concept adopted worldwide to reduce impact from pest, diseases and adverse weather. However, in Sri Lanka, the adaptability is retarded due to high initial cost, temperature buildup and construction complications. Moreover, the extreme daytime temperature rising inside the most popular modified-arch-type protected houses in low country tropical climate in Sri Lanka has reported beyond 8 °C or even 12 °C of the ambient value. This brings about low yields or crop failure due to various heat induced physiological disorders and diseases. Though many attempts of cooling mechanisms are reported, almost all end up with additional operational overhead to the grower. As such, this work presents a readymade component package to be purchased and assembled by an average farmer while achieving four of the most in-demand objectives; (1) easily fixable, (2) reduced heat buildup, (3) low cost and (4) scalable. The package comprises of a complete set of galvanized iron (GI) box bars, all the relevant bracket fixers and nuts and bolts to be used for quick assembling. In this novel design, the growing area of a cubicle (12. x 7.31 m x 2.75 m: approximate 243 m³), is to be covered on all sides (four side walls, lower and roof top) by insect proof net. The special double top design promotes passive air circulation through convection. All the GI bars from the side walls are extending from the first roof level of the cubicle to 0.5 m height, to hold the second roof top (saw tooth type roof covered by UV treated polythene) forming a good ventilation space between the two roofs. The presented design reduces the total cost of construction, material and the labor by 42% while the time of installation is reduced by 35%. The design has also met the expected temperature reduction by rising only 2 °C to 3 °C above the ambient temperature via a conventional modified arch design found to be between 3 °C to 6 °C range. Moreover, the design is scalable (up or down) from the primary model (area; 13.37 m²), which allows flexible best fit innovative solutions to meet customer perception.

Keywords: Low yields, crops, galvanized iron

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401/D

Genetic isolation through geographic distribution suggests an incipient speciation in a ground nesting shorebird *Charadrius alexandrinus* (Kentish Plover)

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Migration results in a wide geographic distribution in many birds across their breeding and wintering grounds. Kentish Plover complex - which consisted of five subspecies, has a distribution range from Eurasia to Africa. Nominated migrant Kentish Plover – *Charadrius alexandrinus alexandrinus* and the breeding resident subspecies of Sri Lanka and south-eastern India – *C. a. seebohmi* have a distinguishable plumage pattern between breeding male birds. Here we assessed divergence between these two closely related taxa using 15 microsatellite markers. Eight samples of *seebohmi* from two localities of Sri Lanka, Mannar Island and Bundala National Park, along with 219 samples of *alexandrinus* from 11 different localities of Chinese coast and Qinghai Lake were used in a Bayesian cluster analysis with STRUCTURE. We obtained a considerable difference in number of repeated motifs of genotyped microsatellite loci of *C. a. seebohmi* from *C. a. alexandrinus* which belong to 13 different populations. The population structure analysis results showed the highest delta K value for the genomic cluster size of 4 ($K=4$), which was able to clearly demarcate the genetic distinctiveness of *C. a. seebohmi* cluster from three other *C. a. alexandrinus* clusters with a mediate level of population differentiation (F_{ST}) of 0.1662. This genetic fixation reveals some degree of isolation between *seebohmi* and *alexandrinus* providing strong evidences for *C. a. seebohmi* to be a distinctive lineage within the Kentish plover complex.

Keywords: Bayesian cluster analysis, Kentish Plover, microsatellite genotyping, population structure

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402/D

Contribution of Polymorphism in DRD4 (a gene associated with personality) in shaping the behavior of Hill Swallows from montane human settlements

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Hill swallows (*Hirundo domicola*) are aerial insectivores that reside in both undisturbed natural environments and in human residential areas. Adapting to human altered landscapes are challenging as resource distribution is altered; natural nesting sites may be removed and novel disturbances are introduced. In order to survive anthropogenic change behavioral and personality trait changes should take place in affected populations. Personality variation is accounted for by genes 20-50% of the time. The rest is attributed to environmental factors, gene-gene interactions and gene-environment interactions. We aimed to identify polymorphism in Dopamine receptor D4 (*DRD4*) gene. *DRD4* gene is associated with personality traits such as boldness, novelty seeking and exploratory behavior in animals. It is an ideal candidate to explore the effect of gene polymorphism in shaping personality and resulting behavioral differences between Hill Swallow populations occupying different landscapes of varying human activity. We sampled the birds from locations with varying degrees of human activity such that populations from least disturbed areas and highly disturbed areas. A region of exon 3 and region of intron 1 of *DRD4* were amplified and sequenced. Two single nucleotide polymorphisms (SNPs) were identified within exon 3 at 9,904th and 10,103rd positions while there were no polymorphic sites in the sequenced region of intron 1. The SNP at 9,904th position had genotypes of A/A, A/G and A/A and was heterozygous in 66.67% of the birds from least disturbed areas while heterozygosity at the locus was 11.11% in birds from highly disturbed areas. The SNP at 10,103rd position had genotypes of G/G and A/G. It was heterozygous in 22.22% of the birds from highly disturbed areas. This study suggests that these variants might contribute towards behavioral changes necessary to adapt to the rapidly changing environment due to human invasion. These sequence data will allow the evaluation of differences in personality traits among birds from less disturbed and highly disturbed areas and its association to genetic polymorphism in *H. domicola*.

Keywords: Animal behavior, personality, DRD4, polymorphism, human activity

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403/D

Effect of urbanization and related anthropogenic interactions on gastrointestinal parasitic infections of urban, suburban and wild toque macaque (*Macaca sinica*) populations in Sri Lanka

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Modification and degradation of wild habitats through urbanization plays an important role in altering the parasitic profile of wild animals. Toque macaques in Sri Lanka have intimate associations and frequent social interactions with humans; this poses a two-way health hazard by the cross transmission of infectious parasitic agents between macaques and human. The few preliminary studies conducted on gastro-intestinal (GI) parasites of toque macaque in Sri Lanka have not differentially focused on urban, sub urban and wild toque populations. Therefore, this study was undertaken to determine the influence of urbanization and anthropogenic interaction on the degree of parasitism in the toque macaque species and to determine the common GI parasites prevalent in them. A total of 180 fecal samples were examined from nine locations representing major climatic zones (60 each from dry, wet and intermediate zones) across Sri Lanka including three types of habitats from each zone: urban, sub urban and wild. Coprological analyses included direct smears, simple salt flotation technique and formol-ether concentration method. Fifteen GI parasite species comprising protozoans (n=4; *Balantidium* spp. *Entamoeba* spp., *Coccidia* spp. and *Endolimax* spp.), nematodes (n=7; *Strongyloides* spp., *Ascaris* spp., *Trichuris* spp., *Oesophagostomum* spp., Hook worm, *Trichostrongylus* spp. and *Enterobius* spp.), acanthocephalan (n=1) and cestodes (n= 3; *Hymenolepis* spp., *Diphyllobothrium* spp., and *Taenia* spp.) were identified. *Strongyloides* spp. was the most frequent helminth followed by *Trichuris* sp. while *Balantidium* spp. was the most common protozoan species detected. In all three climatic zones, toque macaque populations in close proximity to human settlements, i.e. in urban and sub urban areas, had greater parasite prevalence, density and richness compared to their counterparts in wild habitats (p<0.05). Most of the parasite species reported in this study may have public health importance as they can cause zoonotic infections. Therefore, this study demonstrated that habitat modification/ urbanization and human interaction may influence patterns of parasite infection in macaques that may impose a threat to man's well-being.

Keywords: Human- wildlife, GI parasite, Toque macaque, Sri Lanka

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404/D

How the temporal and tidal variation affect the abundance and behaviour of shorebirds in an intertidal mudflat of a globally significant overwintering site of shorebirds in Sri Lanka

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Tidal cycles in intertidal zones regulate water levels and determine the availability of shallow water areas where wading shorebirds can forage. Therefore, understanding how the tidal cycle affect the spatio-temporal distribution of shorebirds is of utmost importance. This study was carried out to determine the effect of tidal level (tidal height) and time of the day on the abundance and behaviour of shorebirds, in an intertidal mudflat (Urumalai mudflat) located in the base of the Rama's Bridge in Taleimannar of northwestern Sri Lanka – a globally significant overwintering site of migrant shorebirds in Central Asian Flyway recognized by the Convention of Migratory Species (CMS) of the United Nations. Monthly shorebird surveys were conducted in the mudflat (~1 km²), from June 2018 to March 2020. The bird counts were conducted in systematically placed point count stations (r=100 m) of the mudflat, throughout the daily tidal cycles (high, ebbing, low and rising tides) at different day-time intervals of the day (0600-0800 h, 1000-1200 h, 1300-1500 h, 1500-1700 h, 1700-1900 h). The data was analyzed using Ms Excel and Minitab 14. Forty-five species of waterbirds (average density = 2093 individuals/km²) were recorded within the sampling plots, over the study period. A significant difference in waterbird abundance (Mann-Whitney test; $W = 1268.0$, $p < 0.0001$) and their foraging activity ($W = 1113.0$, $p < 0.0001$) was observed between high and low tides. Relatively higher numbers of birds were observed in low tide peaks and ebbing tide in compared to the rising tide, even though the differences were not statistically significant (Kruskal Wallis test; $p > 0.05$). The bird numbers were lowest at high tide. Foraging (75.4%) was the key behavioural pattern recorded during low tides. A two-way ANOVA which was conducted to determine how tidal level and time of the day affect the abundance, revealed a significant effect caused by tidal level ($S = 0.881978$; $p < 0.05$) but not by time of the day ($p > 0.05$). Therefore, this study shows that the tidal level is the major factor, among the parameters tested, that influences the shorebird abundance and behavior in this tropical intertidal habitat.

Keywords: Tidal cycle, shorebirds, abundance, behaviour, intertidal habitat

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405/D

Fishery and reproductive biology of *Amblygaster sirm* (spotted sardinella) distributed in the Eastern coastal waters of Sri Lanka

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The fishery and reproductive biology of *Amblygaster sirm* (spotted sardinella) were studied in Kalmunai and Batticaloa fisheries districts in the Eastern Coastal Waters of Sri Lanka from October 2018 to September 2019. *A. sirm* is mostly landed as the main catch in small meshed gillnet fishery. Field visits were conducted at six landing sites on monthly basis. During the field visits, total catch of the boat by species and fishing effort in terms of number of operated boats in the landing sites were recorded. Moreover, random samples of *A. sirm* taken from the catch were examined, measured and recorded at the laboratory for the total length, standard length, body depth, head length, total weight, gonad weight and somatic weight of the fish. Gonadal development of fish was examined after dissecting the fish and then sex and maturity stages of *A. sirm* were determined. The estimated CPUE was significantly different between fishing months ($p < 0.05$). However, the CPUE was not significantly different between fish landing sites ($p > 0.05$). The period from January to July could be considered as the lean fishing season in gillnet fishery in the Eastern coastal waters. The estimated mean standard body length of *A. sirm* males (16.1 cm) were higher than females (15.9 cm). Gravid females were observed throughout the year, confirming that they are continuous spawners. Females were dominant in the fish catch throughout the year. The size at 50% of sexual maturity (L₅₀) was estimated at 13.8 and 14.0 cm (standard length, SL) for males and females, respectively. Present study revealed that spawning season of the *A. sirm* in the Eastern coastal of Sri Lanka occurs from June to August. This study revealed further that *A. sirm* in the Eastern Coastal waters are matured early when compared with the same species found in the Western Coastal waters of Sri Lanka. The findings of this study provide some baseline information that can be incorporated to manage *A. sirm* resource in the Eastern Coastal Waters of Sri Lanka.

Keywords: *Amblygaster sirm*, eastern coastal waters of Sri Lanka, reproductive biology, Ganado Somatic Index (GSI)

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406/D

An assessment on drinking water quality in Medirigiriya; a CKDu prevailing area in the lower Mahaweli basin in order to identify any possible impacts of trace and heavy metals with recharge mechanisms

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Though many studies have been carried out in multiple disciplines to explain reasons for the Chronic Kidney Disease of unknown aetiology (CKDu) in Sri Lanka, a definite causative factor is yet unknown. The current study was designed to identify nephrotoxic elements that are present in trace levels in groundwater, the widely used drinking water source in CKDu prevailing zones. Stable Isotope and chemical techniques with laser mass spectrometry and inductively coupled plasma mass spectrometry were adapted for the study. Surface water, shallow and deep groundwater (n=23) were collected from Medirigiriya; a CKDu prevailing area. Results show that, electrical conductivity (EC) of surface water (471.3 $\mu\text{S}/\text{cm}$) is relatively lower than that of groundwater (735.7 $\mu\text{S}/\text{cm}$). Also, it revealed that the average concentrations (AC) of Ca^{2+} , Mg^{2+} , K^+ , Na^+ , Cl^- , SO_4^{2-} and HCO_3^- are 38.5mg/L, 19.4 mg/L, 2.4 mg/L, 25.5 mg/L, 39.7 mg/L, 19.5 mg/L and 291.9 mg/L, respectively. F^- , Fe, Mn, Se, pH and EC of some groundwater samples were not within the World Health Organization (WHO) maximum allowable limits. As and Cd concentrations in groundwater were 0.14 and 0.13 $\mu\text{g}/\text{L}$ respectively and they are lower than the WHO permissible levels. Most abundant rare earth elements (REE) found in the study area were Nd (AC=15.8 $\mu\text{g}/\text{L}$) and Ce (AC=14.7 $\mu\text{g}/\text{L}$) which are known to cause kidney damage. Most other elements in the lanthanide and actinide series were found below the detection levels of ICP-MS analysis. Stable isotope analysis revealed that groundwater in this area is recharged with different mechanisms; by direct rain (GW-DR) and by a significant contribution of surface water (GW-SW). With enrichment of heavy isotopes in water (^{18}O and ^2H) in GW-SW group, a positive correlation indicating evaporative enrichment of K^+ , Mg^{2+} and Cu and a negative correlation indicating dilution of chloride, lithium and barium were observed. A comprehensive study, with seasonal and temporal variations of trace elements and REEs in all water sources in CKDu prevailing zones is recommended in order to understand the impact of elements in drinking water sources for human health.

Keywords: CKDu, elemental analysis, recharge mechanisms, lower Mahaweli basin

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407/D

Assessment of Cd, Cr, and Pb concentrations of compost applied *Alternanthera sessilis* Cultivations in Padaviya area in Anuradhapura District

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This study was conducted to assess the Cadmium (Cd), Lead (Pb) and Chromium (Cr) concentrations in *Alternanthera sessilis* (Mukunuwana) harvested from compost applied cultivation sites in Padaviya area in Anuradhapura District during rainy and dry seasons. Heavy metal concentrations in soil (Cd_{soil} , Cr_{soil} , Pb_{soil}), roots (Cd_{root} , Cr_{root} , Pb_{root}), and leaves (Cd_{leaves} , Cr_{leaves} , Pb_{leaves}) of *A. sessilis* were analyzed using atomic absorption spectrophotometer (graphite furnace method) after acid digestion. Heavy metal concentrations during the rainy and dry seasons were compared using student t-test at 95% level of significance. MINITAB 14 software was used for statistical analysis. Mean Cd_{soil} and Cr_{soil} in the dry season (0.38 ± 0.1 mg/kg and 22.01 ± 1.1 mg/kg respectively) was significantly higher than that of the rainy season (0.05 ± 0.01 mg/kg and 18.68 ± 3.06 mg/kg respectively). However, mean Pb_{soil} during the dry season (4.51 ± 0.25 mg/kg) was significantly lower than that of the rainy season (5.51 ± 0.32 mg/kg). Soil heavy metal concentrations were below the EU recommended safe limits (Pb :300 mg/kg; Cr : 180 mg/kg; Cd :6.4 mg/kg) during both sampling events. Variation of metal concentrations in the roots and leaves of *A. sessilis* showed a different pattern. Mean Cr_{root} , Pb_{root} during dry season were (12.20 ± 1.16 , 4.26 ± 0.88 mg/kg respectively) significantly higher than those in rainy season (86 ± 2.22 , 3.26 ± 1.02 mg/kg respectively) and mean Cd_{root} in dry season (0.35 ± 0.08 mg/kg) was significantly lower than that of rainy season (1.99 ± 0.27 mg/kg). Cr_{leaves} and Pb_{leaves} during dry season (5.35 ± 0.52 mg/kg, 3.64 ± 0.63 mg/kg respectively) were not significantly different from that of rainy season (6.19 ± 0.88 mg/kg and 3.30 ± 0.68 mg/kg respectively). However, significantly high Cd_{leaves} during rainy season (1.88 ± 0.08 mg/kg) were recorded compared to dry season (0.9 ± 0.2 mg/kg). Mean metal concentrations of leaves exceeded the WHO safety limits for the consumption of green leafy vegetables. Variations of heavy metal concentrations during rainy and dry seasons can be ascribed to the chemical and physical characteristics of soil and atmospheric deposition which may be affected by numerous environmental aspects such as temperature, moisture content, and wind velocity.

Keywords: Heavy metals, bio-concentration factor, translocation factor, green leafy vegetables

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408/D

Domestication of a wild strain of *Ganoderma lucidum* mushroom growing in Sri Lanka

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Ganoderma lucidum is a medicinal mushroom cultivated in many countries and has a high commercial value. In the present study the possibility of cultivating a wild strain of *Ganoderma lucidum* collected in Sri Lanka was observed with the aim of future commercial cultivation. The mushroom was collected from Polgahawela (GPS location - 7°22'03.3"N 80°20'03.8"E), Sri Lanka. After identifying using morphological characters, obtained a pure culture of the mycelium on malt extract agar medium. Mushroom spawn was prepared using paddy seeds. Paddy seeds were washed, boiled until they split and drained. These seeds were then mixed with CaCO₃ and CaSO₄ and sterilized the mixture filling in glass bottles. These bottles were inoculated with *Ganoderma lucidum* inoculum grown on malt extract agar medium and incubated at 28 °C until mycelia fully covered the medium. The cultivation medium was prepared by using rubber saw-dust. For 1 kg of dry rubber saw-dust, 100 g of rice bran, 25 g of CaCO₃, 10 g of CaSO₄ and 2 g of MgSO₄ were mixed and then filled the mixture into polypropylene bags of size 24x18 cm and steamed for 3 hours. After cooling, the bags were inoculated with spawn inoculum and incubated at 28 °C in complete darkness and in 60-75% relative humidity. The bags were fully colonized after 21-23 days and then they were introduced into the fruiting chamber (Temperature - 22-28 °C, Light (daytime) - 50-250 lx, Relative humidity - 90-99%) to initiate fruiting. Initiation of fruiting was observed within 4-7 days with 16-18 days of maturation of the fruiting bodies. At the maturity, the white colour of the margin of the mushroom disappeared and reddish-brown coloured spores dispersed. The mushrooms were harvested at this stage. The yields obtained were 18.7±1.2 g (n=10), 9.4±1.5 g (n=8) and 6.3±1.9 g (n=8) on 23, 46 and 72 days respectively after introducing to the fruiting chamber. The biological efficiency of total mushroom yield was 17.2%. Based on the results it can be concluded that this mushroom can be successfully cultivated in rubber saw-dust based medium but further optimizations should be carried out for the commercial level cultivation.

Keywords: Wild mushrooms, mushroom cultivation, Reishi, medicinal mushrooms

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409/D

Optimization of the culture conditions for enhanced production of antimicrobial compounds and biomass by *Aspergillus fumigatus* isolated from a Sri Lankan underground cave

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Production of fungal bioactive metabolites is highly influenced by many physicochemical factors and thus optimization of the culture conditions is a crucial task in industrial applications to achieve higher yield in the production processes. In this study an underground cave wall isolated *Aspergillus fumigatus* strain (SKW 404) from Sthreepura Cave - Kuruwita, Sri Lanka was investigated to optimize the culture conditions including both chemical and nutritional parameters for the enhanced productions of both biomass and antimicrobial compounds. Optimization of the culture conditions was performed using Potato Dextrose Broth (PDB) basal media with necessary modifications for the determination of their enhanced antimicrobial activity (AMA) against *Staphylococcus aureus* (ATCC 11778) and assayed by Kirby-Bauer disk diffusion assay using cell-free culture filtrates. Maximum AMA was achieved after the ninth day of incubation and with the initial pH of 9, at 150 rpm of periodic shaking under room temperature. Furthermore, inoculation volume of 2% (v/v) (6×10^8 spores/ mL) with sucrose (2% w/v), beef extract (1% w/v) and dolomite (0.1% w/v) were identified as the best carbon, nitrogen and mineral sources for higher AMAs respectively. In contrast, highest biomass production was obtained on the sixth day of incubation and starch (2% w/v), while all the other optimum conditions remained the same.

Keywords: Antimicrobial activity of fungi, culture media optimization, fungal isolate, Kirby-Bauer disk diffusion assay, *Staphylococcus aureus*

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410/D

Functional analysis of Two Pore Potassium channels (OsTPK) for drought tolerance in rice (*Oryza sativa* L.)

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Drought is a major abiotic stress that challenges the expansion of rice (*Oryza sativa* L.) cultivation to meet the escalating demand world over. Rice is, in general, sensitive to drought stress which inflicts growth retardation and yield loss. However, rice cultivars show differential sensitivity to drought stress indicating that they adopt different mechanisms of drought tolerance. The most favoured drought tolerant trait of rice is yield under drought. Several Quantitative Trait Loci (QTLs) and associated genotypes have been identified for this trait. Two pore potassium channels (OsTPK) are type of K⁺ transporters of which genes are localized in this QTL regions. This study was envisaged to analyze a spectrum of phenotypic characters associated with yield under drought trait in rice using TPK overexpression line. When selecting the genotypes for the study, the donor and recipient types of the respective QTL were selected along with the TPK over expressed (ox) line. In addition, other genotypes were also selected on the basis of their high similarity in the particular QTL region which is similar to near isogenic lines (NILs). The positive and negative drought checks, Moraberic and Swarna, were also included. In this experiment, under drought stress TPKox line showed an increment in growth than other genotypes. Same response was seen in the panicle count showing that there may be a positive effect of over-expressed TPK for drought tolerance.

Keywords: Rice, drought, TPK, physiology

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411/D

Chemical composition and identification of antioxidant compounds in essential oil of *Ageratum conyzoides* (AEO)

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Antioxidant compounds prevent oxidation and protect body from diseases. Invention of new antioxidants and improving the existing ones is an emerging research field. Natural antioxidants are mainly targeted as they are eco-friendly than synthetic materials. The essential oil of *Ageratum conyzoides* (AEO) is used in pharmaceutical and food industries as they contain secondary metabolites with antioxidant properties. Although sufficient information is available on the antioxidant activity of *A. conyzoides* plant extracts, the investigation on essential oil of the plant is limited. We have extracted AEO from the shoots collected from Walmilla, Bandaragama (6.7501°N, 79.9724° E) by using Clevenger- type apparatus which yielded 0.15% (v/w), yellow oil with a strong odor and a density of 946 kg m⁻³. AEO exhibited appreciable *in vitro* antioxidant activity as assessed by 2, 2'-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging method. Mean IC₅₀ value of AEO was 532.3 ± 0.9 µg/ml while that of the standard; ascorbic acid was 4.4 ± 2.3 µg/ml. Compared to the standard, antioxidant level is very low in *A. conyzoides*. The Gas Chromatography-Mass Spectrometry (GC-MS) of AEO (Split ratio -20:1, run time -15.733 min, oven temperature - 50- 300 °C) led to the identification and quantification of 23 major compounds accounting 94.559% of the total components. Their matching percentages were equal or higher than 80%. Molecular weights of every chemical compound were lower than 300 g/mol. Most abundant compounds were precocene II (33.156%), caryophyllene (17.979%), precocene I (13.224%), delta-amorphene (6.355%), beta-cubebene (5.262%), and germacrene D (5.106%). The AEO is dominated by monoterpenes, sesquiterpenes, and chromenes. TLC bioautography guided isolation of antioxidant compounds by TLC-DPPH assay of AEO (TLC mobile phase was petroleum ether: acetic acid / 4:1) indicated a separate zone with antioxidant activity (R_f = 0.59). This zone was eluted in hexane and the elute was subjected to GC-MS analysis. The analysis indicated that the antioxidant zone consists of aromatic chromenes; precocene I, (2H-1-Benzopyran, 7-methoxy-2,2-dimethyl), (retention time - 8.525 min, matching percentage - 91%) and precocene II (2H-1-Benzopyran, 6,7-dimethoxy-2,2-dimethyl), (retention time - 9.731 min, matching percentage - 97%). Further confirmation of the identity of these two compounds by NMR is proceeding. According to our knowledge this is the first record of antioxidant compound identification of AEO.

Keywords: *Ageratum conyzoides*, essential oil, antioxidant compounds, TLC-DPPH assay

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412/D

Incorporation of selected tropical spices to hinder glycaemic impact of dairy yoghurts

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The prevalence of diabetes is increasing all over the world. Hence, it is a risk to consume sugar incorporated desserts after the main meal. Blood glucose responses can be controlled by the incorporation of tropical spices. In this study; two different types of dairy yoghurts were prepared using cinnamon (*Cinnamomum zeylanicum*) and Turmeric (*Curcuma longa*) oleoresin in aim to suppress their glycaemic impact. This study mainly compared the glycaemic responses of a control yoghurt (typical dairy yoghurt without spices) against two novel yoghurt products with added spices (cinnamon and turmeric, respectively) using 16 healthy volunteers in a randomized crossover study. Blood glucose concentration was measured at fasting state and 30, 45, 60, 90, 120 min following the ingestion using the PRODIGY blood glucose monitoring system (USA, FDA approved). Glucose response curves were plotted for individuals. Furthermore, shelf life, nutritional, and physiochemical properties of novel dairy yoghurts also were determined. All the tested microbiological, physiochemical and nutritional parameters for developed yoghurts were within the acceptable range according to Sri Lanka Standards (SLS) and no significant difference ($p > 0.05$) was observed between all three yoghurts in the above parameters. The significant reduction ($p < 0.05$) compared to control yoghurt were observed in peak glucose concentration and area under the curve for both novel yoghurts. Mean peak glucose concentration for the control yoghurt, cinnamon yoghurt and turmeric yoghurt were 113.38 ± 6.39 , 102.50 ± 6.00 , 102.88 ± 5.38 mg/dL, respectively and mean area under the curves were 11951 ± 523 , 11012 ± 611 , 10941 ± 530 ((mg/dL) *min), respectively. Peak reductions of glucose concentration for cinnamon yoghurt (9.61%) and turmeric yoghurt (9.26%) were considerably lower compared to the control yoghurt. Peaking times of glucose response curves were similar for all yoghurt (30 min). The results of this study indicated that significant reductions in glycaemic impact were observed for cinnamon and turmeric oleoresin incorporated novel dairy yoghurt products and they are proven to be excellent sources in reducing postprandial blood glucose levels without affecting the overall quality. This study is registered with the Ethics Review Committee, Faculty of Medical Sciences, University of Sri Jayewardenepura as 56/19.

Keywords: Cinnamon, turmeric, glycaemic impact, dairy yoghurt

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413/D

Screening of histamine forming bacteria along some stages of supply chain of *Thunnus albacares* in Sri Lanka

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Histamine poisoning due to consumption of *Thunnus albacares* (Yellowfin tuna) having high histamine content is a major concern in international fish trade. Abused temperature along cold chain triggers the formation of high histamine levels in yellowfin tuna by specific natural and contaminant bacteria. Since histamine is formed due to the presence of histamine forming bacteria, this study is based on detection and identification of histamine forming bacteria and their occurrence in fish processing establishments with an aim of identifying ways of controlling histamine formation in fish. Isolation of histamine forming bacteria (HFB) was carried out by drawing fish, ice and swab samples. Swabs were taken from surfaces where fish directly get contacted from fish processing factories. Samples were drawn as follows from May 2018 to June 2019; Ice from fish transporting chill trucks (n=18), swabs from fish surface (n=18), fish samples (n=15), swabs from processing floor (n=18), swabs from fish transporting chill truck (n=18), ice from processing plant (n=18) and swabs from rejected fish surface (n=6). Samples were enumerated on Niven's medium to isolate HFB and plates were incubated at 35 and 22 °C. Based on colony characteristics presumptive HFB were selected and were confirmed by analyzing their DNA for histidine decarboxylase gene and by testing for the ability of histamine formation in 1% histidine broth by using AOAC 977.13 Fluorometric method. Cultures that gave positive results were further confirmed by amplifying and sequencing approximately 1400 bp of the 16S ribosomal DNA (rDNA) for bacteria. Of the isolates obtained from this study majority were (11 isolates) *Aeromonas salmonicida*. Other isolates were comprised of species of Enterobacteriaceae, Psychrobacter, *Pseudomonas* sp., *Citrobacter freundii*, *Shwenella baltica* and *Rahnella* sp.. Those bacteria were isolated from surface of fish skin, surface of rejected fish skin, ice samples collected from chill trucks, swabs collected from chill trucks and fish samples. Isolated bacteria were able to form histamine in 1% histidine broth in the range of 4- 200 ppm. Since histamine forming bacteria were isolated from ice and swabs from chill trucks, care should be taken to clean and sanitize fish contacting surfaces thoroughly, use clean ice when handling fish and cleaning of the skin of fish effectively in processing plants.

Keywords: Histamine, yellowfin tuna, histamine forming bacteria

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414/D

Spatial distribution of leishmaniasis patients reported from 2020 January to 2020 July in Kegalle District and identification of possible sand fly vectors

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Cutaneous leishmaniasis (CL) became a public health issue in Sri Lanka and was included in the list of notifiable diseases in October 2008. The disease is endemic to north-central, north-western and southern regions of the country. Though Kegalle district is considered as a non-endemic region for the leishmaniasis disease, the numbers of reported cases increase annually. The vector of leishmaniasis is identified as sand fly belonging to genus *Phlebotomus*, still little is known about the sand fly fauna and distribution of species throughout the country. District data on leishmaniasis cases from 2020 Jan - 2020 June were marked using portable GPS receivers. Sand flies were collected from a range of sampling sites using cattle-baited traps (CBTC) and with mouth aspirators (IRC) in and around the houses. The total number of patients reported with leishmaniasis during the study period was 14. Highest number of patients were reported from Rambukkana MOH (11) followed by Warakapola MOH (02). Though CL cases were scattered throughout the Rambukkana MOH, the highest number of patients were reported from Deliwala and Imbulgasdeniya PHI ranges. Indoor resting collections of sand flies were high in numbers (n=1052) in areas where leishmaniasis cases were reported. The highest number of sand flies were collected in toilets (n= 511) followed by bedrooms (n=314). The least number of flies were collected from storerooms (n=37). There for its evident that there is high risk of Leishmaniasis transmission where indoor dwelling sandflies are found than where outdoor dwelling sandflies are found.

Keywords: Cutaneous leishmaniasis

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415/D

Utilization of crushed tile aggregate (CTA) and rice husk ash (RHA) in concrete

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The present study evaluates the feasibility of using both crushed tile aggregates (CTA) and rice husk ash (RHA) as partial substitutes for natural coarse aggregates and binding material (cement) respectively in producing G20 concrete. In the first step, CTA was used to replace coarse aggregates by weight with the percentage replacements of 0% (C00 and control), 10% (C10), 20% (C20), 25% (C25) and 30% (C30). In the second step, Ordinary Portland Cement (OPC) was replaced by RHA in the range of 0% (C00R=C20=control) 5% (C05R), 10% (C10R), 15% (C15R) and 20% (C20R) by having the CTA as constant (20%) which was found as optimum usage percentage from the first step. Standard procedures were applied for materials and material properties prior to prepare concrete. The workability for fresh concrete and compressive strength and bulk density at various ages were evaluated. The significantly highest compressive strength (22.43 ± 0.01 MPa at 28th day: $p \leq 0.05$; One-way ANOVA) and the second lowest water absorption was observed for the samples incorporated with both 20% of CTA and 5% of RHA. Results further revealed that the mean bulk density of concrete increased gradually as curing age increased while the mean bulk density decreased with the increasing RHA. The study therefore concludes that both CTA and RHA could be used as partial substitutes for natural coarse aggregates and cement respectively and the replacement of natural coarse aggregates and cement could be done up to 20% and 5% CTA and RHA respectively for acceptable compressive strength in producing G20 concrete.

Keywords: Crushed tile aggregates, rice husk ash, compressive strength, G20 concrete

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501/E1

Dependence of sliding angle on sessile droplet volume in surface wettability studies

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Contact angle measurement has been an indispensable tool for surface characterization and wettability studies due to its simplicity and versatility. Industries such as digital printing, paint, bio-medical devices, cosmetics and pharmaceutical drug manufactures use contact angle measurement as a tool to both optimize and as a quality control of their products. The information obtained from dynamic contact angle measurements which include advancing, receding and sliding angles are more descriptive than the limited information that can be obtained from static contact angle measurements. Nevertheless, the area of study has been plagued by a lack of standardized methods and additional dependent information. This makes direct comparison of research both impossible and misleading and therefore limits progress in the field. In this study, critical procedural details including sessile-drop dispensing, drop size, drop profile capturing, and image analysis were considered. It was found that the general rule-of-thumb that is followed in the field where a 5 μl droplet volume is used for contact angle measurement is not particularly suited for sliding angle measurements. This was demonstrated using a range of materials where a variation in droplet volume from 8 μl to 20 μl resulted in a variation in contact angle from 31° to 22° for a glass slide, and 67° to 21° for a polycarbonate surface. Therefore, it is strongly recommended to refer the droplet volume alongside the contact angle when reporting sliding angle measurements. In addition, it was also shown that the calculation of the droplet diameter can also provide insight into the material's wettability behaviour. These steps could provide guidance towards drawing up standardized procedures on sliding angle measurements. However, further procedural consent among the scientific community on standardized methods of determining surface wettability need to be achieved to enable progress in the field.

Keywords: Wettability, sliding angle, hydrophobicity, standardization

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502/E1

Temporal variation in leaf moisture content at different heights in vascular plants: Capacitive technique

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The plant water status in plants depend on many combined effects such as soil moisture availability, uptake capacity of plant root interface, internal hydraulic resistance and evaporative demand. Water uptake by roots of a vascular plant are transported through xylem and phloem to leaves via a cohesion-tension (CT) process. For the present research, Gotu-kola (*Centella asiatica*) and rose balsam (*Impatiens balsamina*) plants were grown from healthy roots of plants and seeds, respectively in $18 \times 18 \times 15$ cm pots which contained $\sim 3,000$ cm³ of soil. During the growing period, day/night temperature and humidity were 27 ± 5 °C and $70 \pm 15\%$, respectively. Plants were irrigated at 2-day intervals and provided adequate sunlight. Temporal variation in gravimetric moisture content (GMC) in leaves of these plants at three different height ranges (mature bottom leaves, middle leaves and newly grown leaves at the top) were measured/recorded using a capacitance-to-digital converter (FDC1004, Texas Instruments) interfaced with a microcontroller board (Arduino UNO) with continuous and simultaneous monitor readings of 3-capacitance sensor outputs using a real-time clock module (DS 1307, Adafruit). Furthermore, temporal variations in GMC of leaves as a function of soil moisture level (SML) of these plants were also measured using a soil moisture sensor. Experiments showed that the capacitance vs. GMC followed the relationship, $y = a \exp(bx)$, where y is the capacitance, x is GMC, and for Gotu-kola plant ($a = 4.47$, $b = 0.0084$) and Balsam plant ($a = 6.32$, $b = 0.0046$). The study of temporal variation in GMC in Balsam plant leaves provided information of the uptake rate of moisture through a CT-process, as a function of the maturity stage of leaves and water storage time efficiency of leaves. Temporal variations in GMC of leaves of Gotu-kola plant was carried out as a function SML after plants were irrigated before initiating the experiment and allowed free water to drain during the experiment. The study revealed that the wilting point of soil is $\sim 20\%$ or less, at which point the plant is unable to absorb water from the soil. Further studies are in progress to establish a general relationship between plant water status and relevant parameters.

Keywords: Cohesion-tension process, gravimetric moisture content, *Centella asiatica*, *Impatiens balsamina*

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Study of Fourier techniques and wavelets for audio denoising

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In general, most audio signals are contaminated with various types of noise. This paper presents three new methods for eliminating noise in audio signals using Fourier and Wavelet transforms. Fourier transforms have been applied to a digitized audio signal in WAV (waveform audio file) format for noise reduction by trial and error method in frequency domain. Wavelet transforms have been used as an alternative to explore new ways to reduce computational complexity and to achieve a better noise reduction performance. Wavelet transform method removes the noise in a signal while preserving its vital characteristics. Haar wavelet is the simplest and first introduced wavelet and Daubechies wavelet is the orthogonal wavelet in the wavelet family. These Wavelet transforms could also be applied to direct data sets using a suitable threshold value. After using above techniques, the denoised signal could be reconstructed using either inverse Fourier or inverse Wavelet transforms. Wolfram Mathematica software package was used throughout the research. It was observed that the Fourier technique fails to remove noise when the audio data set has a data point which lies completely outside the rest. However, this is not a serious drawback as audio signals normally do not contain such noise. Haar wavelet transform could only be used for the initial removal of noise. Comparing all these facts, it can be concluded that the Daubechies wavelet transform is the best transform for audio denoising.

Keywords: Fourier transform, Haar wavelet transform, Daubechies wavelet transform, audio signals, noise reduction

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504/E1

A computational study of small Hubbard clusters of the two-leg ladder at quarter filling

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Throughout history many theoretical models have been put forward for the deeper understanding of various properties of condensed matter physics. The Hubbard model offers one of the simplest ways to get an insight into how onsite and inter-site interactions between electrons give rise to insulating, magnetic, and even novel superconducting effects in solids. This led to the synthesis of real materials such as organic charge transfer salts and inorganic materials that interpret this special behaviour of solids. The Lanczos method associated with exact diagonalization was used to solve the Hubbard model for strongly correlated electrons systems analytically in arbitrary dimensions for 1D and 2D clusters. A two-leg ladder system is considered as the simplest form of any 2D models associated with the Hubbard model. The exact Hubbard cluster calculations, carried out at quarter filling for different 2D finite ladder clusters, show an instability which translate either to a phase transition, Mott transition or superconducting nature at $T=0$ K. A variety of properties are demonstrated in these small clusters which could be tuned by extending the calculations to large clusters and by including new parameters. The energy variation of electrons at ground state is used to determine the charge gap of 2D small cluster systems such as 2×4 , 2×6 , 2×8 and 2×10 . The results obtained at Quarter filling for 2×4 and 2×8 small clusters are favorable for instability. The negative charge gap for 2×4 and 2×8 clusters indicate that at low onsite interaction (U) values the paired electron states are more stable compared to the unpaired state. Most of these quarter-filling structures are relevant for organic charge transfer salts (CTS). So, the study of different properties of different quarter filling structures would lead to the synthesis of different organic salts and inorganic materials with special properties such as superconductivity.

Keywords: Hubbard model, quarter filling, instability, charge gap, two-leg ladder

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505/E1

Supercapacitor assisted wireless chargers for moving electric vehicles

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Electric vehicles (EVs) use dynamic wireless power transfer (WPT) methods to charge the battery of the vehicle while it is moving on the transmitter track. Due to low charging speed of the battery, longer transmitter tracks need to be built; as a result, vehicles need to spend longer durations on the transmitter track. Furthermore, a considerable amount of energy is wasted in the transmitter track because it always powers up, irrespective of whether the vehicle is in the transmitter track or not. In this work, a method to increase the charging speed of the EV in the dynamic WPT method as well as a method to reduce the wasted energy of the transmitter track are proposed. To increase the charging speed of the system, a supercapacitor-battery hybrid charging system is proposed. It was experimentally observed that a charging efficiency of 50% can be realized with the proposed system. In the proposed method, the supercapacitor bank will be charged while the vehicle is moving on the transmitter track, and after the battery is fully charged, the vehicle will be out of the track. Subsequently, the fully charged supercapacitor exchanges its charge to the battery while the EV is moving. Since the charging speed of the supercapacitor is higher than the battery, this will effectively reduce the time that the EV spends on the transmitter track. To reduce the power waste of the transmitter track, an automatic power on-off system is proposed and constructed. There are two vehicle detector sensors employed, one at the beginning and the other at the end of the track. The control circuitry is programmed to detect a vehicle and power on the track when a vehicle enters the track. When the vehicle leaves the track, the sensor at the end of the track detects it and turns off the power of the track.

Keywords: electric vehicle (EV), wireless power transfer (WPT), supercapacitor

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506/E1

Characterization of a developed material using granite/ clay/graphite for roof tiles

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Roof tiles are mainly designed to make a secure shed against the rain, sun and wind. There are various types of roofing tiles such as flat tiles, imbrex and tegula, Roman tiles, pantiles, mission or barrel tiles, and interlocking roof tiles. Sufficient strength to withstand normal handling stress and foot traffic on the roof for maintenance purposes are very important factors. This study aims to increase the strength of roofing tile material and reduce the porosity. For this study, granite, graphite, and clay were obtained from Barawakubura, Sri Lanka which is a place that produces roof tile specimens. Granite, graphite, and clay were sieved using a sieve with a pore size of 180 μm . The mixture consists of 15% of granite, 85% of clay and 5, 7, 10, 13 and 15% of graphite by weight of the mixture. Each material was kneaded to obtain a homogeneous mixture. Next, the roof tiles were cast using a wooden mould with dimensions 105 mm \times 24 mm \times 16 mm. The mixture was filled into the mould and compressed until it occupied the entire volume. After drying at room temperature, tiles were led to an oven for drying at 105 $^{\circ}\text{C}$ for 24 hours. Finally, the tiles were fired in a furnace at 900 $^{\circ}\text{C}$ for 2 hours. Materials were characterized using X-ray diffraction (XRD; RigakuUltima IV) and Scanning Electron Microscopy (SEM; LEO 1420 VP). XRD spectra showed that quartz consisted of the roof tile specimens after firing. According to the SEM images, clay has not uniformly dispersed. A graphite pattern was observed with an average size of 30 μm chips in a uniformly dispersed manner. The surface of the granite consisted of a tuberculate surface. Roof tile specimen after firing with clay and granite clearly showed a spiral nature and roof tile specimen after firing with granite, clay, and graphite showed a less porous nature. The developed material provides a promising platform for roof tiles with cost effectiveness. It is anticipated to measure the breaking strength, water absorption, and porosity in future studies.

Keywords: Homogeneous, tuberculate, porous

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Characterization of structural properties of recycled tire dust/latex material composite for noise absorption applications

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Noise pollution is an identified health hazard. The major contributors to this are identified as industrialization and noise created due to vehicles and the demand of noise absorption applications plays a vital role in industrial and social living styles. Accumulation of tires after usage is a major issue worldwide due to vulcanized tires showing extreme resistance to biodegradation, photochemical decomposition, chemical reagents and high temperature. Therefore, the management of used tires has become a serious technological, ecological as well as an economic challenge. In this study the main objective is to characterize the composite materials developed using tire dust and latex. Since tire dust alone do not possess adequate mechanical strength, it is necessary to mix it with a binder to obtain a consolidated structure that gives a porous structure. Cracks, cavities and channels of porous material allow sound waves to enter the material and the friction between pore walls and air molecules convert sound energy to thermal energy facilitating noise absorption from the environment. This study focuses on the development of a composite using tire dust and latex for sound absorption applications. Latex is used as a binder and a tire dust sample was mixed with locally available natural latex. Preliminary samples were prepared by altering the latex percentage from 40 - 80%. Latex and tire dust were mixed using a mechanical mixer and compacted by applying a 60 N load for 15-20 min. Compacted samples were then dried in an oven at 110 °C until a constant sample weight was obtained. Using sieve analysis, particle size of tire dust was determined as < 0.2 μm. Material identification was done by Fourier Transform Infrared Spectroscopic (FT-IR) analysis. Surface morphology and porosity were observed using Scanning Electron Microscopy (SEM) and tensile properties were measured using a tensile testing machine. Out of the characterization so far, samples with latex content of 40, 50, 60 and 70% show almost identical porous structures and those with latex content of 50, 60 and 70% have adequate strength. Porous structure test samples with latex content of 40, 50, 60 and 70% can be developed as sound absorbing materials which have minimum 0.6 N/mm² and maximum 1 N/mm² tensile strength. Since, the pores were not uniformly distributed throughout the material; measuring tensile strength will have slight variations. However, the acoustic studies need to be performed to get an overview of the developed composite.

Keywords: Absorption, acoustics, binder, recycled tire dust

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Comparison and characterization of developed grease and graphite grease

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Graphite is a naturally occurring form of crystalline carbon found in metamorphic and igneous rocks. The layered structure of graphite makes it an ideal source of lubricants. This research focuses on improving the quality of grease with the addition of graphite which is very important as it can add different properties to conventional grease. Preparation of the grease is by incorporating stearic acid, lithium hydroxide monohydrate (LiOH·H₂O) and paraffin oil (base oil). Grease formed after thickening of the base oil and stearic acid was added into specified paraffin oil and heated while stirring to about 80 °C – 100 °C until the acid completely dissolved in the base oil. Then lithium hydroxide solution was prepared with m(LiOH):m(water) = 1:6.7 ratio and carefully added to the acid solution as the temperature was raised to 140 °C and kept for 2 hours. The temperature was raised to 160 °C and maintained for 30 minutes to evaporate moisture. Then base oil was added consecutively to dilute the thickness while temperature was raised to 200 °C until a clear base semi solid formed. Preparation of the graphite grease was done by crushing graphite to a size less than 75 µm, and graphite percentages of 5%, 15%, 25%, 35%, and 45% by weight of grease was mixed with the developed grease. Localizing agent (5%) was used with natural latex by the weight of graphite for each sample. Characterization comparison of developed grease and graphite grease was done using Fourier transformation infrared spectroscopy (FTIR) and Scanning Electron Microscopy (SEM). Microstructures of a fresh grease sample displayed very clear and highly entangled fibrous structures where as other samples were seen with high agglomeration of particles with increase in graphite percentages. The peaks obtained by FTIR spectroscopy for developed grease corresponded for 2921 cm⁻¹ (asymmetrical stretching vibration of C-H group), 2852 cm⁻¹ (symmetrical stretching vibration of C-H group), 1579 cm⁻¹ (asymmetrical stretching vibration of COO group of Thickener) and 1459 cm⁻¹ (asymmetrical deformation vibration of CH₃ group of Thickener, 1377 cm⁻¹ (bending vibrations of C-H group) and 721 cm⁻¹ (overlapping of the CH₂ rocking vibration and the out-of-plane vibration of cis-disubstituted olefins). Apart from these characteristic peaks, additional peaks were observed in graphite containing grease samples at 862 cm⁻¹, 1154 cm⁻¹, 1304 cm⁻¹, 1559-1561 cm⁻¹, and 2953 cm⁻¹. The characterization of the developed graphite grease seems to yield positive results for it to be a probable lubricant for specific applications although further tests are warranted.

Keywords: Graphite, grease, characterization

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Patterns of discourse: case of continuous functions

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This study reports on some patterns identified in the discourse of continuous functions of first year university students who do not specialize in mathematics but take Calculus courses. The topic of continuous functions is an important one in Calculus 1 courses, which are often offered in the first year of undergraduate study. In literature pertaining to mathematics education, this topic has been found to be a particularly challenging one for students. The purpose of this study was to gain a better understanding of why this is the case. Continuity related researchers have largely adopted theoretical constructs that are based on cognitive theories that assume an acquisitionist metaphor of learning. Theories such as Piaget's cognitive development, Skemp's relational and instrumental understanding and Tall and Vinner's concept image and concept definition were recurrent among researchers interested in continuity. This study adopts the commognitive theory of learning as opposed to different cognitive theories that have been used in previous studies on learning continuous functions. Students' communication about continuous functions and the process of discourse along with its patterns and mechanisms is observed under the commognitive lens. The participants of the study were 54 first year university students taking a Calculus 1 course. The data consisted of written questionnaire answers from all 54 students and video recordings of semi-structured interviews from four selected students out of 54. Analysis involved the construction of 'realization trees' for the four interviewed participants for the signifier 'Continuous Function' and analysing the discourse around these realizations using constructs in commognitive theory. The study has also identified different definitions used for continuous functions and continuity of a function at a point in textbooks which in some cases lead to inconsistent conclusions with respect to continuity of a given function. This paper discusses how some realizations are challenged when functions with different domains are presented in terms of different patterns in the student discourse. In particular, I focused on how two definitions for continuous functions (and for continuity at a point) give rise to certain 'switching' between reflections due to commognitive conflicts that take students to inconsistent conclusions with respect to the continuity of a given function.

Keywords: Commognitive theory, realization trees, signifier, commognitive conflicts, continuity

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Oscillation frequencies of two Delta Scuti stars; KIC 4077032 and KIC 8623953

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Delta Scuti stars are intrinsic pulsating stars located where the instability strip crosses the main sequence of the Hertzsprung Russell (HR) diagram. The main pulsation period of Delta scuti stars is less than one day and typical mass range is 1.5 – 2.5 solar mass. Delta scuti stars show a very complex pulsation nature with a prominent radial pulsation mode called the fundamental radial mode and more complex non-radial asymmetric pulsations modes. One-minute exposure short cadence Kepler light curves of KIC 8623953 and KIC 4077032 obtained through *Kepler Asteroseismic Science Operations Center (KASOC)* data were analyzed to determine the oscillation frequencies of these two stars. Nine dominant independent oscillation frequencies were found in KIC 4077032 with a radial fundamental frequency of $93.031 \pm 0.003 \mu\text{Hz}$ which is denoted by $l = 0$ in three dimensional stellar oscillations. The pulsation constant, Q , for fundamental radial modes of Delta Scuti stars has a well-defined range $0.0327 \leq Q \leq 0.0332$. The determined Q value, 0.0330, for the frequency $93.031 \mu\text{Hz}$ is confirmed the existence of this fundamental radial mode of KIC 4077032. Among the set of frequencies, several non-radial oscillation frequencies were observed. $167.613 \pm 0.004 \mu\text{Hz}$ was identified as non-radial dipole mode, which is denoted by $l = 1$. This dipole mode is confirmed by observing two almost equally spaced peaks detected alongside at $171.280 \pm 0.004 \mu\text{Hz}$ and at $162.724 \pm 0.004 \mu\text{Hz}$. The Delta Scuti star, KIC 8623953, consists of relatively higher frequencies in its frequency spectrum. Among the 10 dominant frequencies with relatively higher amplitudes, none of the frequency is consistent with the range of Q value of fundamental radial mode. Nevertheless, a frequency, $135.877 \pm 0.006 \mu\text{Hz}$ with relatively low amplitude, results pulsation constant, Q of 0.0320 which is close to the range of fundamental radial mode. Along with the set of independent frequencies, we noticed that the frequency of the highest amplitude, $315.475 \pm 0.005 \mu\text{Hz}$ has two equally spaced peaks at $335.022 \pm 0.005 \mu\text{Hz}$ and $298.864 \pm 0.005 \mu\text{Hz}$. This combination was identified as presence of non-radial mode with $l = 1$.

Keywords: asteroseismology, Delta Scuti stars, stellar oscillations

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A numerical model that could determine the evolution of shape and rotation of cometary nuclei due to sublimation of cometary ice

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A new model is developed to evaluate the mass loss of a cometary nucleus to understand the behavior of the changing shape and the rotational state of a comet nucleus. The scheme presented here incorporates relevant physics required for calculating these changes and it includes (a) the shape changes due to volatile sublimation, and (b) the rotational changes due to torques caused by outgassing and the evolving shape of the nucleus due to mass loss. In order to evaluate shape and rotational evolutions of the nucleus, the surface of the comet is divided into triangular facets based on longitudes and latitudes and calculations need to be carried out for all triangular facets. The equation of energy balance is obtained by equating the incident energy to the sum of re-radiated heat and energy used up for sublimation of ices in the nucleus. An equation is derived for the rate of change of radius vector as a function of the temperature, heliocentric distance, and the solar zenith angle for each surface facet and this equation is used to evaluate the changes to the shape of the nucleus. The nucleus of the comet is assumed to be a rigid body and the rate of change of moments of inertia due to changing shape of the nucleus and Euler's equations of motion are used to evaluate the spin state changes. The calculations must be carried out for each time step as the comet moves in its orbit. Some simplifying assumptions, which have secondary effects on the final results, were made to reduce the computational time. The numerical results from this model will be discussed in future.

Keywords: Comet, nucleus, sublimation, rotation

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512/E1

Constraint of a light curve simulation to measure weighted cross correlation of MeV and GeV Fluxes

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During the past four decades, a number of scientists have been implementing models for AGNs (Active Galactic Nuclei) which are emitting electromagnetic radiations. The relativistic Jet model was the most popular and acceptable model introduced by Blanford and Rees in 1978. However, the construction of that model is still not complete. When a relativistic jet is directed toward earth, it is known as a Blazar. Often Blazars have high energy flares. They are the most active extragalactic sources which are a cause for the CMBR (Cosmic Microwave Background Radiation). There are four processes for these flares; synchrotron, IC (Inverse Compton), SSC (Synchrotron Self Compton), and EC (External Compton). To understand these processes, there are a few light curve analyzing methods, but the amount of available data is limited. Therefore, astrophysicists have been building simulations. In this research, a light curve generator was built using a python script, and the weighted cross-correlation was measured to verify the accuracy of the simulation. The maximum correlation (≈ 1) was observed in the zeroth lag for both experimental data (MRK 421 and MRK 501) and the data taken from the simulation. Hence, real-time results and the results of the simulation were similar. As the next part of the research, the simulation can be used to find the weighted cross-correlation between high energy flares and jet morphology.

Keywords: Correlations of MeV and GeV fluxes, light curve simulation, weighted cross-correlation

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EM pollution in the proximity of a transmission tower located in a highly residential area: A case study

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As technology develops, most people tend to use high speed wireless data transfer methods as well as different wireless multimedia technologies which use wireless devices. These devices emit Electromagnetic (EM) radiation within the range of radio and microwave frequencies. Exposure to high intensity plane wave power densities of radio frequency (RF) radiation may end up with heating of biological tissues and increase in body temperature. Due to the relative lack of blood flow to regulate the temperature, the eyes and testes are highly vulnerable to this radiation. In this study the EM pollution is evaluated due to radio/microwave frequencies within a 300 MHz - 3 GHz range by using spectran HF 6065 spectrum analyzer in an area located in Pannipitiya, Colombo, Sri Lanka. A transmission tower is located in this area at 6°51'22.31"N, 79°56'30.91"E within a highly residential region. The main objective of this research is to identify locations having higher plane wave power densities in the vicinity of this transmission tower as a case study. According to the results, few locations to the North-East, North and South directions from the tower shows slightly high equivalent plane wave power densities. Among these locations, a location at the coordinates 6°51'24.14"N, 79°56'31.52"E shows the highest plane wave power density of 9.24 mW m^{-2} corresponding to a frequency of 500 MHz and it is nearly 0.36% of the maximum permissible level for general population/uncontrolled exposure published by ICNIRP (International Commission on Non-Ionizing Radiation Protection) for 30 min duration. According to the results obtained, plane wave power densities are still well below the permissible values, but people living in this area may have some effects due to daily exposure to this radiation. Further studies are underway to study about these effects and to increase the accuracy of the results.

Keywords: EM pollution, wireless data transfer, transmission

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514/E1

Analysis methods of gaseous air pollutants – drawbacks and elucidation

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Air pollution is one of the common problems faced by rapidly expanding metropolitan environments. It is created by humans as a result of adding chemicals, particulate matter and biological material into the environment. Air pollution causes deaths and respiratory related problems to humans as well as to other living organisms. There are many methods used in monitoring air pollutants such as CO₂, CO, SO₂, NO_x, CH₄ and particulate matter. These can be detected either using chemical or solid-state sensors. Many emission detectors use the waveform principle with the Beer-Lambert Law. It says that the intensity of the light, which goes through a medium with absorption, decreases exponentially. Furthermore, this law facilitates the calculation of the concentration of absorbing species from the ratio of the intensities of the incident and transmitted intensities of radiation. There are many optical analytical methods available to trace gaseous pollutants using the X-ray, ultraviolet, visible light and Infrared regions of the electromagnetic radiation spectrum. Simple non-dispersive infrared (NDIR) analyzers are relatively low-cost, reliable as well as robust. However, the main disadvantage of this instrument is positive interferences for the target gas concentration measurements being created due to other absorbing matter, such as water vapour and carbon dioxide in the same spectral region in IR. This absorbing matter must be removed from the sample before the gas enters the analyzer. One solution for this problem is to arrange absorption cells serially, as available in the Luft detector. Many countries use a dual beam analyzer as the standard measurement technique. A single beam analyzer with Luft detector is also available since recent times. The main disadvantage of this analyzer is that it creates more vibration than other analyzers with solid-state detectors. The solution for the above problem is to introduce micro-flow sensors. In the photoacoustic detector technique, it directly measures the absorption of light energy. These detectors produce pressure pulses only for light absorbing gases. Light passing through the reference cell in Gas Filter Correlation (GFC –NDIR) Analyzer has less energy, just because more energy has been absorbed by the sample cell, which contains gas that is to be measured. The energy difference in the light is the concentration of the measured gas. This technique is more advantageous than earlier ones. Gases having absorption wavelengths in the same regions, as the measured gas would not affect the measurement. This analyzer uses a robust method, has a very low sensitivity on vibration effects and is relatively low in cost compared to previous analyzers. The latest design in Differential Optical Absorption Spectroscopy (DOAS) is that it is equipped with infrared diode lasers which can emit light with different wavelengths by varying the voltage or temperature through the diode laser. Fourier transformation, a mathematical procedure is applied to the travel distance of two beams together with software to enable the analysis of pollutant concentration.

Keywords: Beer-Lambert Law, infrared methods, non-dispersive infrared (NDIR) methods, Luft detector, differential optical absorption spectroscopy (DOAS)

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515/E1

Was the spike in air pollution in Sri Lanka from 3-5 November 2019 due to transboundary transport or inland sources?

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There was an unexpected spike in air pollution over Sri Lanka during 3rd - 5th November 2019. During the same time duration, air pollution in the north of India reached a significant level. Whether the pollution from India carried over to Sri Lanka or whether there were local sources of pollution is tested here. Hourly particulate measurements for Colombo and other Indian cities have been obtained with an EPA accredited BAM-1020, PM2.5 monitor. Gridded wind data at different pressure levels were obtained from the National Oceanic and Atmospheric Administration (NOAA). Seasonality for observations for 2017, 2018, 2019 and 2020 was compared. Long range transport was estimated using NOAA's HYSPLIT atmospheric transport model which allows us to assess the trajectories of air masses arriving up to 7 days prior, at three altitudes. The year-on-year comparison shows that when the winds are from the North-East (November to March), there tends to be twice as high levels of air pollution as that during May to September. Considering the seasonal changes, when the wind comes from North and East, there is higher air pollution than when it comes from the South and West. Back trajectories were undertaken for Colombo to determine the origin of air masses. Air masses reaching Colombo during 3rd -5th November had trajectories that started in North-Western India and tracked eastwards along the Himalayan trough towards the Bay of Bengal before arriving in Western Sri Lanka over Norochcholai. By 7th November, air masses were carried over the Indian ocean rather than over the Indian sub-continent and with that the pollution levels in Colombo dropped. Thus, the sources for the spike in air pollution are from Northern India and possibly the Norochcholai Coal Power Plant. The fact that air trajectories are coming from the Indian sub-continent is a cause of concern in Sri Lanka as there has been an extreme rise in air pollution over recent decades in these countries.

Keywords: Air pollution, pollution source attribution, air trajectories, transboundary pollutants

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601/E2

Conversion of protein and cellulose extractions from two selected waste materials into potentially degradable polymer films

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Economic development, urbanization and rapid population growth have caused resource consumption to increase, thereby tons of non-biodegradable and biodegradable waste materials are released to the environment. Some wastes contain various reusable substances, which can be utilized to produce biodegradable products. This study was mainly focused on using extracts from rice bran and coconut husks to develop potentially degradable polymer films (DPF). Isoelectric precipitation was used to isolate proteins from rice bran. Cellulose was isolated by carrying out several treatments including alkali, bleaching, and acid treatments to coconut husk fibers. Furthermore, cellulose acetate (CA) was synthesized from isolated cellulose. Extracted compounds were used to fabricate DPF directly without further purification. Briefly, different combinations of protein, cellulose, cellulose acetate, and aqueous polyvinyl alcohol (PVA) were used to find the optimal fabrication conditions of DPF. Fabricated films were named to highlight the contents; namely, **A₃P₁V** (Protein 3 g, PVA 1 g); **B₃P_{1/2}V** (Protein 3 g, PVA 0.5 g); **C₃P₁C₁V** (Protein 3 g, Cellulose 1 g, PVA 1 g); and **D₃P₁CA₁V** (Protein 3 g, CA 1 g, PVA 1 g). Solvent casting method was used to fabricate DPF at pH 9 and 70-80 °C. Tensile strength (TS), moisture absorption, water vapor permeability, water solubility, lipid solubility, thermal properties, and opacity of fabricated films were investigated. Film **A₃P₁V** showed the highest TS (27.36 ± 1.20 MPa) whereas cellulose containing films **C₃P₁C₁V** and **D₃P₁CA₁V** showed relatively lower TS values (4.47 ± 0.71 MPa, 4.40 ± 1.02 MPa, respectively). All the films showed more than 100% moisture absorption while **C₃P₁C₁V** showed the lowest moisture absorption percentage, and low solubility in water and dil. acids. All films were insoluble in oils. Films containing protein and PVA were fully transparent than the films containing cellulose. Based on TGA and DSC studies, films were started to decompose at around 200 °C. Fungal growth on films were observed after a two-month period under normal atmospheric conditions in the absence of antifungal agents; however, they were stable for more than six months when sodium benzoate is added. Fabricated films were found to be completely disintegrated after one month when films were submerged in soil indicating their potential towards degradability. Our studies demonstrate that the extracts from selected wastes can be fabricated into polymer films, which are more stable in dry conditions and oily environments. Further optimization of films is underway to improve the properties to use these films as packaging materials.

Keywords: Degradable, polymer film, protein, cellulose, polyvinyl alcohol

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Novel NNN donor ligands with pendant piperidiny groups having different chain lengths and their platinum complexes towards potent anti-cancer applications

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Dipicolylamine (dpa) provides a symmetric polypyridyl moiety towards chelation of metals and has received much attention due to its coordination versatility. The central nitrogen may be functionalized to facilitate interactions with biological targets. The objective of this study was to incorporate piperidiny groups with different chain lengths to the dpa moiety due to the ability of piperidiny group to target sigma receptors, which are overexpressed in breast cancer cells. In this study, two novel ligands; N((CH₂)₂piperidine)dpa (L1), N((CH₂)₃piperidine)dpa (L2) and their corresponding platinum complexes; [PtCl(N((CH₂)₂piperidine)dpa)]⁺ (C1), [PtCl(N((CH₂)₃piperidine)dpa)]⁺ (C2) were synthesized. Structural data obtained from single crystal X-ray diffraction for C1 confirms that L1 serves as a tridentate donor ligand. In the UV visible spectra of ligands, absorption peaks due to intra ligand $\pi \rightarrow \pi^*$ transitions and $n \rightarrow \pi^*$ transitions could be observed in 200-300 nm range and above 300 nm, respectively. As expected, no absorption peaks corresponding to $n \rightarrow \pi^*$ transitions were observed in UV visible spectra of complexes due to lack of lone pairs in coordination complexes. Methylene protons observed as a singlet (3.87 ppm) in the ¹H NMR spectrum of L1 in DMSO-*d*₆, and appear as two doublets (4.91, 5.38 ppm) in the ¹H NMR spectrum of C1, which confirms the presence of magnetically non-equivalent methylene protons upon coordination to Pt²⁺ ion. IR spectra of all ligands and complexes gave no transmittance peaks in the region 3310-3350 cm⁻¹ indicating the absence of the N-H group which confirms the formation of ligands and complexes. Both ligands displayed intense fluorescence in methanol (excitation and emission wavelengths for L1: 300 nm and 421 nm; L2: 340 nm and 442 nm). However, fluorescence spectra of platinum complexes showed lower intensities than the respective ligands, possibly indicating static quenching of fluorescence upon coordination to metal ion. Biological target predictions carried out for the two ligands by using "SwissADME", "molinspiration", "SwissTargetPrediction" servers indicate their potential use as anticancer drugs because sigma receptors are one of the main potential targets of the two novel ligands. None of the ligands violate the Lipinski rule of five, which indicates the druglikeness of the ligands. Therefore, these ligands and complexes can be explored towards treatment of breast cancer.

Keywords: Dipicolylamine, piperidiny, platinum, synthesis

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603/E2

The use of sodium silicate prepared from rice husk ash as a corrosion inhibitor for mild steel in acidic medium

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Mild steel is extensively used in a large number of industries and it is susceptible to corrosion as a result of being constantly exposed to harsh environmental conditions. In order to prevent corrosion in metals, an effective and low-cost method is to use natural corrosion inhibitors. Silicates have been used as corrosion inhibitors since the 1920s and extensive research has been carried out to test its ability to inhibit metal corrosion. However, conventional methods of sodium silicate production are very energy intensive and use high temperatures (1100-1200 °C). This abstract presents the production of sodium silicate from rice husk ash and investigation of its ability to inhibit corrosion in mild steel in 0.1 M HCl medium. Production of sodium silicate from rice husk ash requires low temperatures and it utilizes rice husk which is a widely available waste product of rice processing. In this research, rice husk was calcined at 700 °C in order to obtain rice husk ash (RHA) with minimum carbon residue. Sodium silicate was prepared by reacting NaOH with amorphous silica which was extracted from RHA and the formation sodium silicate was confirmed by FTIR analysis. The ability of sodium silicate to inhibit corrosion of mild steel was tested by mass loss method, open circuit potential (OCP) measurements, Tafel polarization test and electrochemical impedance spectroscopy (EIS). The highest inhibition efficiency was obtained for 60 mM sodium silicate concentration. For mass loss test, Tafel polarization test and EIS test, inhibition efficiency values of 95.58%, 76.42%, and 81.88% were obtained respectively for 60 mM inhibitor concentration. The OCP values changed towards positive direction with increasing inhibitor concentration, indicating an anodic inhibition. However, the anodic (β_a) and cathodic (β_c) Tafel slopes of the Tafel plots did not vary in any significant order. Based on the results it was concluded that sodium silicate prepared from RHA is effective in corrosion inhibition and it inhibits corrosion of mild steel in 0.1 M HCl by acting as a mixed inhibitor.

Keywords: Rice husk, silicate, corrosion, inhibition, mild steel

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604/E2

Fatty acid profiles of selected new improved rice varieties (*Oryza sativa* L.) cultivating in Sri Lanka

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Rice contains lipids rich in monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs) which are beneficial to human health. The present study evaluates fatty acid (FA) profiles of eight selected pigmented and non-pigmented new improved rice varieties (NIRVs) widely cultivated in Sri Lanka. Fat was extracted from whole grain rice flour by Soxhlet fat extraction, extracted fat was derivatized to fatty acid methyl esters and analyzed by gas chromatography-flame ionization detector (GC-FID) analysis. Results showed statistically significant ($p < 0.05$) differences in FA profiles among the studied rice varieties. Major FAs found were palmitic (C16:0), oleic (C18:1), and linoleic (C18:2) acids ranging from 6.43 ± 0.12 - 4.69 ± 0.05 , 14.08 ± 0.01 - 9.15 ± 0.10 and 9.91 ± 0.07 - 6.97 ± 0.03 mg/g of rice on dry basis, respectively. Total FA, MUFA, PUFA and saturated FA (SFA) contents varied from 32.30 ± 0.12 - 22.36 ± 0.04 , 14.55 ± 0.01 - 9.49 ± 0.10 , 10.32 ± 0.07 - 7.23 ± 0.01 and 7.42 ± 0.05 - 5.18 ± 0.05 mg/g on dry basis, respectively. The highest quantities of MUFAs, PUFAs and essential FA, linoleic were found in red rice variety, Bw 272-6b. On the other hand, SFA, which is considered unhealthy was highest in Bw 272-6b and lowest in white rice variety, At 307. Highest content of total FAs were also found in Bw 272-6b. All the tested varieties have shown a PUFA/SFA ratio higher than 0.4 the minimum value recommended for a healthy diet and highest (1.63 ± 0.02) in At 307. Generally whole grains of studied rice varieties can be considered as a nutritious and healthy diet. Rice varieties with healthy and nutritionally important FA profiles could be used as raw materials for developing functional food products and also may use as genetic sources for breeding new varieties with high nutritional qualities. Furthermore, data generated may also contribute to the development of national food composition database in Sri Lanka. Additionally to the best of our knowledge, this is the first study conducted in Sri Lanka on FA profiles of NIRVs.

Keywords: Fatty acid profiles, new-improved rice, polyunsaturated fatty acids, monounsaturated fatty acids, whole grain rice

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Adaptation and optimization of cloud point extraction procedure to determine Aluminium content in aqueous solutions

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Cloud point extraction (CPE) has been used as the pre-concentration step for the determination of Aluminium in aqueous solutions prior to its detection from atomic absorption spectrometry and UV visible spectrometry. This study involves the use of a nonionic surfactant namely polyethylene glycol tert-octylphenyl ether (Triton X-114) and a chelating agent Eriochrome cyanine-R (ECR). Mainly two CPE methods were developed. These developed methods are based on the complexation of Aluminium ions with ECR and then entrapped in Triton X-114 at a higher temperature (70 °C) and room temperature. As Method 1; general CPE procedure was followed according to literature. Since the expected recovery percentage was not obtained, as Method 2, the general cloud point extraction procedure which used previously was carried out with minor changes. The minor changes are omitted heating step, increased concentration of Triton X-114, and except 0.2 M sodium sulfate other solutions were added in a different order. In Method 1 at 70 °C, the recovery percentage was in the range of 7.5% - 31%, but in Method 2 at room temperature, the recovery percentage was in the range of 12% - 58%. In these methods, the Aluminium ion concentration was investigated in the range of 4-15 ppm. Since Method 2 gave the maximum recovery percentage values, chemical variables affecting the Method 2 cloud point extraction procedure were optimized in order to find the optimum operating conditions. Optimum conditions were pH = 6.5, Triton X-114 volume = 10 mL, and Triton X-114 concentration = 0.25% (v/v). Under the optimization of ECR concentration maximum recovery percentage was obtained, when a neutral metal-ligand complex is formed in the medium which is $\text{Al}(\text{ECR})_3$. In order to form that complex, 0.5% (m/v) ECR concentration is needed in the medium. The obtained method needs to be further improved by optimizing factors such as salt concentration, centrifugation rate, and diluting agent, and a better recovery percentage is required before this method is used to determine Aluminium content in commercial beverages and vinegar samples.

Keywords: Cloud point extraction, aluminium, ECR, recovery percentage

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Determination of Cu^{2+} and Ni^{2+} ions using an electrochemical sensor based on a Schiff base modified silica nanoparticles

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With the industrial development, metal pollution is increasingly becoming the focus of concern around the globe. A new carbon paste electrode (CPE) modified using 2-hydroxy-5-((2-hydroxyphenyl)diazinyl)benzaldehyde (HPDB) immobilized on silica nanoparticles was fabricated and used for the determination of trace amount of Ni^{2+} and Cu^{2+} ions using anodic stripping voltammetry. This is the first reported use of the HPDB ligand in the electrochemical detection of Cu^{2+} and Ni^{2+} in combination with silica nanoparticles. Nanosilica is expected to improve the response and the mechanical properties of the CPE. The complexation reaction of the HPDB ligand with selected metal ions in ethanol was studied. HPDB ligand reacts with Ni^{2+} and Cu^{2+} in ethanolic medium to form 2:1 complexes having absorption peaks, 405 nm and 428 nm and stability constants, 4.53 and 7.24, respectively. Due to the higher stability constants obtained for Ni^{2+} and Cu^{2+} , HPDB ligand was used as a suitable modifier for the determination of Ni^{2+} and Cu^{2+} . The electrochemical properties and applications of the modified electrode were studied in comparison with the bare CPE. A significant increase in the stripping current was observed in the HPDB modified CPE in comparison with the bare carbon electrode. Metal detection using the modified electrode was carried out using a three electrode system (Reference electrode - Ag/AgCl; working electrode - modified CPE; counter electrode - graphite pencil) under the optimized conditions (Deposition potential, -1.00 V; supporting electrolyte, pH 5.0 acetate buffer; deposition time, 180 s; sweep rate, 0.25 V s^{-1}). The detection limits based on three times the background noise were $0.13 \mu\text{M}$ and $0.22 \mu\text{M}$ and the limits of quantification based on ten times the background noise were $4.49 \mu\text{M}$ and $7.37 \mu\text{M}$ for Cu^{2+} and Ni^{2+} , respectively. It was observed that the change in concentration of Ni^{2+} decreases the Cu^{2+} peak current but there was no influence on Ni^{2+} peak current when the Cu^{2+} concentration was varied. Despite these mutual interferences, these ions can be reliably determined simultaneously with micromolar detection limits. Therefore, HPDB immobilized silica nanoparticles are shown to be a good modifier, which improves the detection ability of carbon paste electrode and shows stability during the measurements.

Keywords: Silica nanoparticles, Schiff base, electrochemical, simultaneous detection, sensor

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Scalable electrochemical process to produce multi-layered graphene dispersion using Bogala vein graphite

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Graphene the “wonder material” in the 21st century, exhibits amazing properties; hence, the mass production of high-quality graphene is vital to enable the world to harness its applications. Graphite is a commonly existing mineral in Sri Lanka. Therefore, it will be extremely useful if graphite can be directly converted to graphene. In this work, an eco-friendly, electrochemical method was used to convert graphite into exfoliated graphite followed by mechanical exfoliation to obtain multi-layered graphene dispersion. Anodic electrochemical exfoliation was elaborated as an electrochemical method in the entire research work due to its environmental friendliness and higher yield. Production of multi-layered graphene dispersion was optimized using different parameters such as voltage, electrolyte system, concentration and the dispersion medium. Among aqueous inorganic salts investigated, nitrates and chlorides did not display apparent exfoliation. However, sulphate shows the best anodic electrochemical exfoliation with a yield of 4.4215 g hour⁻¹, in the medium of 0.9 mol dm⁻³ ammonium sulphate at 6 V. As reported earlier, reduction of crystallinity of the graphene is a good indication for verification of the synthesized graphene. Our results indicated 25% crystallinity compared to the value of 85% for Bogala vein graphite. Exfoliated graphite images obtained from Scanning Electron Microscope (SEM) data further supported the successful exfoliation of graphite. However, re-stacking of graphene layers was observed via SEM images after evaporation of the solvent. Therefore, graphene was suspended in Dimethyl Formamide (DMF) to keep its integrity. This suspension was subjected to both UV-Visible and FT-IR spectroscopy. Absorption maximum at 280 nm confirmed that the production of the multi-layered graphene as a stable DMF dispersion and FT-IR band around 3500 cm⁻¹ provide further evidence for the intercalation of graphite. This method exhibited a promising pathway of producing multi-layered graphene dispersion via electrochemical exfoliation. This can be further developed to attain single layer graphene sheets in future.

Keywords: Bogala vein-graphite, multi-layered graphene, intercalation, electrochemical exfoliation, dispersion

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Nano zirconia and zirconia incorporated biopolymer nanocomposites for water purification

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Lack of safe drinking water is considered one of the most burning issues all over the world and the consumption of polluted water with different types of contaminants can cause adverse health effects. The chronic kidney disease with unknown etiology (CKDu) which is very common, specially among the farmers of the agricultural areas, has been identified as a water born disease and the long term consumption of water containing inorganic contaminants such as Pb(II), Cd(II), F⁻ and As(V) has been identified as some of the major possible causative factors even though the exact cause is still unknown. As far as the removal methods of these contaminants are considered, adsorption has been identified as one of the most cost-effective methods and the use of inert, nontoxic materials with interesting chelating properties towards both cations and anions can be used as potential adsorbents. In this work, nano zirconia was synthesized using a simple, microwave assisted, one pot precipitation method and nanocomposites of zirconia embedded in chitosan (CTS) and carboxymethylcellulose (CMC) were synthesized using a simple *in-situ* precipitation method in order to compare the adsorption properties towards the target pollutants. The synthesized products were named as ZO-CTS and ZO-CMC. They were characterized using Fourier transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM) and X-ray diffraction (XRD). Separate adsorption studies carried out for Pb(II), Cd(II), As(V) and F⁻ indicated that incorporation of CMC at any percentage cannot improve the adsorption properties towards any considered contaminant. However, some nanocomposites of ZO-CTS showed improved adsorption properties towards F⁻ and As(V) and ZO-CTS with 30% CTS was identified as the best composition for both F⁻ and As(V) adsorption. Therefore, ZO-CTS with 30% CTS was selected for further adsorption studies to investigate its feasibility in the removal of F⁻ and As(V) ions in water.

Keywords: Zirconia, chitosan, adsorption, fluoride, As(V)

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Comparative cytotoxicity of seeds of a purely ornamental tree - for further exploration

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Liver and breast cancers are deeply unsettling diseases among humans globally as these affect major organs of the body. Anticancer drugs discovered from natural products are important in the treatment of these diseases and many plant drugs are being used to treat cancer. Therefore, the aim of the present study was to compare the activity of crude methanolic extract (CME) and an isolated fraction (MPLCBA-3) of CME from *Barringtonia asiatica* seed kernel against HepG2 and MCF-7 cells. *B. asiatica* is a species of *Barringtonia* native to mangrove habitats on the tropical coasts and islands of the Indian Ocean and is grown as an ornamental plant in Sri Lanka. Crude methanolic extract (15 g powder/40 mL MeOH; 24 hours; dried at 45 °C) and MPLCBA-3 fraction obtained by medium pressure liquid chromatography (MPLC) from *B. asiatica* seed kernel were tested against human mammary cell line (MCF-7) and human hepatoma cell line (HepG2). Cytotoxicity assays SRB and LDH were carried out using standard procedures and the mechanisms were analyzed using Caspase Glo 3/7 assay, DNA fragmentation analysis and fluorescence microscopy analysis using acridine orange/ethidium bromide (AO/EB) standard procedures. Both CME (34.13 ppm with MCF-7 and 37.30 ppm with HepG2) and MPLCBA-3 fraction (11.32 ppm with MCF-7 and 7.40 ppm with HepG2) indicated significant cytotoxic effect (IC₅₀) against both MCF-7 and HepG2 cell lines in the SRB assay. MPLCBA-3 fraction produced an IC₅₀ that was comparable to the positive control (thymoquinone, 8.98 ppm) with HepG2 cell line. The cytotoxic effect of MPLCBA-3 was higher compared to the CME in both cell lines. A higher percentage of LDH was released from HepG2 cells by both fractions when compared to MCF-7 cell line indicating high cytotoxicity against liver cancer cells. However, MPLCBA-3 fraction was more toxic against HepG2 cells when compared with MCF-7 cells. All tested concentrations of CME and MPLCBA-3 fraction demonstrated a significant percentage of caspase activity ($p \leq 0.05$) and produced fragmented DNA and showed positive results with fluorescence microscopic analysis. These confirmed that both cell lines undergo apoptosis, while HepG2 cells being more susceptible to MPLCBA-3 fraction. The MPLCBA-3 fraction showed higher cytotoxic effects compared to CME indicating its potential use as a cytotoxic agent. MPLCBA-3 fraction thus has a high potential to be developed as an anticancer drug lead.

Keywords: *Barringtonia asiatica*, caspase Glo 3/7 assay, MCF-7 cell line, HepG2 cell line, DNA fragmentation, LDH assay

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Metal bioremediation ability of *Staphylococcus warneri* TWSL_6 and cloning and expression of Metallothionein in *E. coli*

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Heavy metal contamination has become a major threat to the environment as well as to the balance of the ecosystems. It is considered as one of the major problems interfering with the health and wellbeing of mankind. Bacteria have successfully evolved mechanisms to tolerate environments contaminated with heavy metals. These mechanisms can successfully be utilized in the contamination detection and as a bioremediation technique. The genes responsible for *in vivo* heavy metal removal in microorganisms/strains can successfully be utilized to create strains having an enhanced metal removal capacity than in the original strain or in construction of biosensors, which were the main aims of this project. A Gram-positive bacterial strain with Cu^{2+} , Cd^{2+} and Pb^{2+} ion tolerance was isolated from an industrial effluent and identified as *Staphylococcus warneri* strain TWSL_6 (Accession No: KR027924.1) using 16S *rRNA* gene sequences analysis. The highest metal removal percentages were 99.99 ± 0.00 for Cr^{2+} and Pb^{2+} ions and 79.48 ± 0.15 and 100 ± 0.00 for metal ions Fe^{2+} and Zn^{2+} , respectively. A gene (~163 bp) encoding bacterial Metallothionein (MT) was isolated and cloned into the cloning vector, *pGEM-T Easy*. (Accession No: MK900456.1). The sequence confirmed metallothionein gene was then cloned into the vector *pET 21a(+)* and transformed into *Escherichia coli* BL21(DE3). Over expression of the recombinant MT protein upon IPTG induction was clearly observed in the SDS - PAGE of the cell lysate. The Histidine- tagged MT protein was purified from the cell lysate using a Ni-NTA purification column for further analysis and characterization. MT has been identified as a protein with Cysteines and metal sequestration ability in previous research.

Keywords: Bioremediation, heavy metals, metallothionein, *Staphylococcus warneri*

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Fluoride enhances the antibacterial activity of selected Na⁺/K⁺ carrier ionophore antibiotics

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Fluoride enhances the antibacterial activity of selected Na⁺/K⁺ carrier ionophore antibiotics. Antibiotic resistance has become a major public health problem with the emergence of multi-drug resistant bacteria and with the limited availability of new antibiotics. For example, low permeability of the bacterial cell envelope limits passage of the antibacterial agent fluoride, consequently preventing the use of low doses to attain sufficient antibiotic effect. The membrane destabilizing ionophores such as valinomycin and monensin exert their antibiotic activity by conducting ions through the cell membrane, but can cause host toxicity by perturbing intracellular ion homeostasis. Therefore, combination therapy provides an ideal solution to minimize the adverse effects of such antibiotics. In this study, we demonstrate that fluoride enhances the antibacterial activity of the carrier ionophores, valinomycin and monensin. Cell growth assays were performed by incubating *B. subtilis* at 37 °C with monensin (0.2 µg/ml) and valinomycin (50 µg/ml) with varying NaF concentrations. The absorbance readings at 600 nm were obtained after 16 hours of incubation. Our results demonstrate that the potency of monensin was increased by 5-fold in the presence of NaF (100 mM). Similarly, the antibacterial potency of valinomycin was doubled in the presence of NaF (80 mM). In contrast, valinomycin did not exert any synergistic effect with fluoride against the Gram-negative bacterium *E. coli*. Overall, it can be concluded that the two ionophore antibiotics may increase the cellular uptake of fluoride to exert synergistic bacterial growth inhibition by enhancing intracellular fluoride toxicity. This study provides new opportunities to design antibacterial compounds when combined with varying sub-inhibitory concentrations of small ions.

Keywords: Valinomycin, monensin, fluoride, *B. subtilis*, carrier ionophore

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Development of smart textile with mosquito repellent and medicinal properties using clove oil microcapsules

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Due to many health issues, people are looking for smart textiles having medicinal values. In this regard, antioxidant, antimicrobial and mosquito repellent properties have received the most attention. Therefore, this study focused on clove oil as a herbal remedy to obtain these properties. The main drawbacks of clove oil are high volatility, oxidation and skin irritation. In order to overcome these problems, microencapsulation technique was employed to entrap clove oil within a capsule. The complex coacervation method was used with 2:1 ratio of gelatin sodium alginate mixture. UV-visible, SEM and FT-IR spectroscopy were utilized for the verification of clove oil microencapsulation. Throughout the study 282 nm wavelength was used to verify the presence of eugenol (λ_{max} 282 nm) since it was the main constituent of clove oil. The morphology of the capsules was characterized using an optical microscope and SEM. The synthesized microcapsules were spherical in shape within the diameter range of 1.5-100 μm . The loading of microcapsules was 367 $\mu\text{L/g}$ with 59% of loading efficiency. It was found that the clove oil microcapsules have a significant amount of antioxidant activity as 64% with DPPH radical scavenging assay and 2004 ± 8 $\mu\text{g GE/ml}$ (GE-Gallic acid Equivalent) with Folin-Ciocalteu assay. The synthesized microcapsules were stable under dark, natural sunlight and artificial light. In addition, it has a considerable thermal stability as well as pH stability over a pH range of 2-11. Microcapsules were then successfully impregnated to the cotton fabric by pad dry cure method and binder methods using succinic acid and acrylic acid binders. The binding and formation of new ester bond was verified using SEM and FT-IR. Both synthesized microcapsules and developed fabric showed a considerable antibacterial activity against both gram-positive and gram-negative bacteria and a significant mosquito repellent activity against *Aedes aegypti* mosquitoes. Even after washing of developed fabric, compared to pad dry cure method 63% of the repellent activity was retained by binder method. According to the result, clove oil microcapsules impregnated cotton fabric exhibits a promising approach for smart textile on personal care in a controlled release manner.

Keywords: Clove oil microcapsules, complex coacervation, medicinal smart textile, mosquito repellency, antimicrobial effect

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Kinetic and thermodynamic analysis of fluoride removal by lanthanides incorporated hydroxyapatite

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Access to clean water has become a worldwide thorny issue as its continuous contamination with chemicals of different nature such as Pb(II), Cd(II), arsenic and fluoride. In this study, three lanthanides incorporated composites namely HAP-CeO₂, HAP.CeO₂.La(OH)₃ (2:1), and HAP.CeO₂.La(OH)₃ (3:2) were synthesized and analyzed for its fluoride removal kinetics and thermodynamics. The prepared composites were used to study the fluoride removal kinetics and thermodynamics. It was found that the pseudo second order kinetic model is the best model for fluoride ion adsorption onto all the composites. The thermodynamic profile of the fluoride adsorption follows same pattern for all three composites that is, Gibbs free energy change (ΔG°) < 0, enthalpy change (ΔH°) > 0, Entropy change (ΔS°) > 0. According to thermodynamic profiles of three composites, the ΔG° values of HAP.CeO₂.La(OH)₃ (3:2) at 300 K, 333K temperatures are -0.57 and -7.31 kJ/mol respectively and that values for HAP-CeO₂ are -0.18 and -2.92 kJ/mol and HAP.CeO₂.La(OH)₃ (2:1) are -0.33 and -5.47 kJ/mol respectively. These results suggest that the incorporation of lanthanum ion into the HC increases the degree of feasibility towards fluoride. Also both HAP.CeO₂.La(OH)₃ (2:1) and HAP.CeO₂.La(OH)₃ (3:2) show positive ΔH° values (44.3 kJ/mol and 55.2 kJ/mol) indicating the endothermic nature of fluoride adsorption onto these composites. Compared to the entropy change of HAP-CeO₂ (66.23 J/K), the entropy changes of both HAP.CeO₂.La(OH)₃ (2:1) and HAP.CeO₂.La(OH)₃ (3:2) systems show more than two fold increment of randomness at the solid solution interface (148.14 J/K and 184.5 J/K, respectively). These results suggest that the incorporation of lanthanum ion into the HAP-CeO₂ increases the degree of feasibility towards fluoride.

Keywords: Fluoride, kinetic, thermodynamic, lanthanides, hydroxyapatite

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The synthesis and characterization of copper doped sodium titanium phosphates for the catalytic reduction and removal of 4-nitrophenol textile dye

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4-Nitrophenol (4-NP) is considered to be amongst the most prevalent and persistent organic pollutants in wastewater. 4-NP is also utilized as a synthetic intermediate for industrial products such as dyes, pharmaceuticals, agrochemicals, photographic chemicals. Removal of 4-NP from fresh water has added difficulties due to its high chemical stability and water solubility. We report an application of semiconductor photocatalyst, $\text{Cu}/\text{Na}_2\text{Ti}(\text{PO}_4)_2\text{H}_2\text{O}$ for the reduction of 4-NP under UV-Vis light irradiation. In the first step, α -titanium bismonohydrogen orthophosphate monohydrate ($\text{Ti}(\text{HPO}_4)_2\cdot\text{H}_2\text{O}$; hereafter denoted as α -TOP), was prepared by digesting ilmenite (FeTiO_3) in 85% phosphoric acid (H_3PO_4). Gravity separation was used to isolate α -TOP from soluble iron complexes in the H_3PO_4 acid mixture. The prepared α -TOP was characterized and further used to prepare $\text{Cu}/\text{Na}_2\text{Ti}(\text{PO}_4)_2\text{H}_2\text{O}$, which was confirmed by XRD analysis. Elemental analysis using XPS further confirmed the presence of copper in the +2 oxidation state. The prepared catalyst; $\text{Cu}/\text{Na}_2\text{Ti}(\text{PO}_4)_2\text{H}_2\text{O}$ was thermally stable up to 790 °C as determined by thermal analysis. Surface area and porosity measurements using BET analysis confirmed that the total surface area was 7.144 m²/g. Catalytic experiments on the reduction of 4-NP under UV-Vis light over $\text{Cu}/\text{Na}_2\text{Ti}(\text{PO}_4)_2\text{H}_2\text{O}$ shows reduction efficiency with k_{app} value of $1.344 \times 10^{-3} \text{ s}^{-1}$. Results also indicate that the catalyst was reusable up to 3 cycles without a significant loss of activity.

Keywords: 1,4-Nitrophenol reduction, sodium titanate, cupric oxide impregnation, catalyst

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Development of chitosan based drug delivery system for the delivery of antifungal, tioconazole

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Tioconazole is a broad-spectrum imidazole antifungal that is indicated for the topical treatment of superficial fungal infections. The absorption and the solubility of a drug is lesser in topical delivery due to the anatomical and physiological barriers, low drug retention and unfavorable physicochemical properties in conventional topical formulations. The objective of this research is to develop a drug carrier, employing microencapsulation method. The particles were synthesized by ionotropic gelation using Sodium Tripolyphosphate (TPP) (0.5% w/v) as the cross-linker and chitosan (0.1% w/v) as the wall material in the presence of the drug tioconazole. The synthesized particles (drug carrier) were centrifuged, washed and lyophilized for the separation. Particles were characterized using SEM, FT-IR, XRD and UV-Visible spectrometry. The size range of the synthesized particles was 400 nm - 2 μ m. The particles were irregular in shape, both spherical and rectangular with smooth surfaces. FT-IR data suggested the formation of particles by electrostatic forces between chitosan and TPP. These particles (drug carrier) were subjected to mechanical crushing to identify encapsulation efficiency and loading capacity. UV-visible absorbance at 287 nm was used to verify the entrapment of drug within the chitosan walls. The encapsulation efficiency was recorded as 97.17% with a loading efficiency of 40.48%. Antifungal and antibacterial susceptibility assays conducted with agar well diffusion method against *Staphylococcus aureus* and *Candida albicans*, demonstrated that the inhibitory activity of particles containing tioconazole is significantly high in comparison to the inhibitory activity of pure tioconazole. Enhancement of the antifungal and antibacterial activity of the developed drug carrier can be attributed to the cationic nature of chitosan with inherent antifungal and antibacterial activity in addition to the drug, tioconazole. According to the results, tioconazole loaded particles show potential in the delivery of tioconazole for topical delivery.

Keywords: Tioconazole, ionotropic gelation, chitosan microparticles, drug delivery, microencapsulation

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Ammonium nitrate incorporated *Wrightia zeylanica* (Wal-idda) wood chips as a new biomass fertilizer system

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Plants mainly obtain nutrients from soil and inadequate levels of nutrient in soil can affect the growth of plants. Fertilizers are used to supply these lacking nutrients to the soil. However, fertilizer leaching can cause severe soil and water pollution and lead to considerable resource and economic loss. Therefore, slow release fertilizers, inorganic fertilizers with low solubility and coated fertilizers are used. The commonly used coating material is polymers. However, the polymer coating has a low degradability in the environment. Therefore, the usage of ecofriendly biodegradable coating material is required. Present study is focused to determine the nitrogen (N), phosphorous (P), potassium (K), ash and moisture contents in leaf, root, bark and stem of the *Wrightia zeylanica* (Wal-idda) plant and to study the capability of using ammonium nitrate incorporated Wal-idda wood chips (combination of stem and bark due to their capillary structures) as a slow releasing biomass nitrogen fertilizer. The new fertilizer system was prepared treating Wal-idda wood chips (< 5 mm) with saturated ammonium nitrate (NH_4NO_3). Soil columns were prepared using soil matrix (200.0 g) and ammonium nitrate incorporated wood chips (10.0 g) to study the leaching of nitrogen in aqueous medium (pH 6.5). Nitrogen leaching was studied for 19 days. Parallel studies were carried out to evaluate the leaching patterns of a commercially available nitrogen fertilizer sold in Sri Lanka in the soil matrix using the same experimental method. Control reactions were carried out with ammonium nitrate in a soil matrix alone and soil matrix alone. Each experiment and analysis were carried in triplicate. According to the experimental results, the level of nitrogen in different parts of the wal-idda plant varied from 6230 mg kg^{-1} to 18620 mg kg^{-1} . It was found that phosphorous and potassium content in wal-idda plant varied from 40 mg kg^{-1} to 530 mg kg^{-1} and from 1700 mg kg^{-1} to 13600 mg kg^{-1} , respectively. According to the leaching experimental results 98% of nitrogen from the applied commercial fertilizer was leached during the studied period. When NH_4NO_3 was directly applied to the soil 26% of nitrogen was leached out and when NH_4NO_3 was incorporated with wood chips, 16% of nitrogen was leached out after 19 days. Therefore, the present investigation indicated that Wal-idda wood chips has increased the retain ability of nitrogen fertilizer in the soil matrix by 10% with a slow release pattern. According to the experiment results ammonium nitrate incorporated Wal-idda woodchips can be used as a potential nitrogen incorporated slow release biomass fertilizer system.

Keywords: Biomass fertilizer, slow release, ammonium nitrate, Wal-idda, wood chips

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Molecular dynamics simulations study of membrane deformations by combined effects of membrane potential and protein concentration

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The single strand, positive RNA genome of viruses in family *Flaviviridae* is bound with many capsid proteins to make a nucleocapsid complex. Almost all the *Flaviviridae* family capsid proteins have a high charge density and are thus termed supercharged proteins. Among them, dengue virus capsid protein carries +2/kDa charge-to-mass ratio, and an experimentally proven ability to penetrate cell membranes thereby turning capsid proteins into potential cell-to-cell genome carriers. However, the role of the dengue virus capsid protein in infecting neighboring cells has not been fully described to date due to lack of mechanistic details of the membrane translocation process of capsid proteins. Therefore, an understanding of the membrane deformations which are induced by capsid proteins is important to explain the mechanistic progression of the capsid protein involved cell penetrating process. We performed atomistic and coarse-grained molecular dynamics simulations using GROMACS simulation package. Our atomistic free energy calculations by steered molecular dynamics simulations showed an energy barrier of 429 kcal mol⁻¹ for direct translocation of capsid protein through the membrane indicating the presence of an alternative low energy translocation pathway. Furthermore, dependency of membrane stability on external factors such as trans-membrane potential and protein/peptide concentration was tested. The results of the coarse grain simulation with 0.05 V/nm transmembrane potential and eight proteins showed an increased membrane curvature of -0.01 Å⁻¹ compared to the curvature of the control simulation, -0.001 Å⁻¹. Moreover, area per lipid, acyl chain order parameter, and membrane thickness were also changed with increasing number of proteins on the membrane. A transmembrane pore was observed after 60 ns with 18 peptides on the DPPC bilayer in the presence of 0.02 V/nm membrane potential. These findings strongly suggest a collective effect of proteins/peptides with transmembrane potential to induce extensive membrane deformations, ultimately paving the way for charged protein or peptide to cross the membrane without actively interacting with the hydrophobic membrane core.

Keywords: Dengue virus, capsid protein, membrane potential, protein concentration, molecular dynamics simulations

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618/E2

Investigation of the thermodynamics of hydration of hydrophobic surfaces: A computational approach

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Interactions of water with hydrophobic surfaces play an important role in orchestrating molecular-scale phenomena in living systems, such as protein conformation, lipid self-assembly, and binding of a ligand to an active site of a protein. It has been shown experimentally that, when a hydrophobic solute is dissolved in water, the hydrogen bonds of the water molecules in the first hydration shell around the hydrophobic solute are disrupted. This breakdown of the hydrogen bond network creates a void to which the hydrophobic solute is pushed in. This study sought to investigate thermodynamic, structural and dynamic parameters of hydrophobic solutes (amino acids with hydrophobic side chains) in water at 300 K temperature and 1 bar pressure using 2 ns long molecular dynamics simulations performed via GROMACS software under Kirkwood-Buff derived Force Field. The molecular dynamics trajectories obtained for different amino acids were analyzed by calculating structural and thermodynamic parameters such as radial distribution function (RDF), potential of mean force (PMF), solvation free energy and hydrogen bond lifetime decay. Based on the results, it was observed, that the thermodynamic parameters were in agreement with the literature values on hydrophobic hydration that would give negative solvation free energy. These thermodynamic parameters were supported by hydrogen bond dynamic parameters found from the hydrogen bond lifetime decay analysis. A bi-exponential behavior of the lifetime decay was used to connect translational and rotational relaxation details to the thermodynamic parameters. Furthermore, hydrogen bonds per water molecule inside the first hydration sphere was calculated to be very close to one, which reveals that water structure around the hydrophobic solute differs from that of in bulk water.

Keywords: Molecular dynamics, KBFF, hydrophobic hydration, structural properties, H-bond lifetime

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619/E2

The effect of temperature and salt concentration on the stability of dengue virus capsid protein: A molecular dynamics simulations study

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Dengue is a widespread flaviviral disease affecting mainly the tropical and sub-tropical regions of the world. The virus constitutes of envelope (E), membrane (M) and capsid (C) proteins as the structural proteins, and a few other nonstructural proteins. Recently, the C protein dimer has garnered attention for developing a common vaccine against all four serotypes of dengue. Latest studies have revealed the propensity of the hydrophobic segment of the C protein to provoke membrane ruptures followed by a conformational change of the dimeric C protein. This study focuses on the impact of temperature and salt concentration for exposing the hydrophobic segments of the C protein by dimer dissociation to interact with the membrane. The temperatures 300 K and 350 K were selected as, one to be below and the other to be above, the phase transition temperature of the selected lipid bilayer. No significant conformational change was observed below 0.1 M salt concentration within 100 ns simulation time. Therefore, 0.1 M salt concentration was selected as the lower limit of the salt concentrations. Atomistic steered molecular dynamics (SMD) simulations were performed for each combination of the temperature and the salt concentration. Potential Mean Force (PMF) along the reaction coordinates (RC) were calculated by SMD simulations followed by umbrella sampling. The Gibbs free energy of dissociation (ΔG) was calculated with the aid of PMF vs. RC graphs. The ΔG calculations at each combination of temperature and salt concentration spectated that the structural stability of C protein dimer depends mainly on the salt concentration, and the role of the temperature was negligible in destabilizing the dimer. Overall conformational change of the C protein to expose its hydrophobic segments to the surrounding medium was largely facilitated in the system with 300 K temperature and 1 M salt concentration.

Keywords: Dengue virus, capsid protein, temperature, salt concentration, molecular dynamics simulations

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701/E3

Detection of hate speech content in Sinhala text using Fast Text: A case study using Kaggle Dataset

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Social media has been identified as a propagation mechanism between online hate speech and real-life incidents. Since social media can initiate as well as incite violent activities, exponential growth in hate speech on social media platforms has become a threat to society. Thus, social media platforms have taken certain measures such as: 1) improving user awareness by introducing hate speech definitions into their policies and, 2) eliminating hate speech content based on the reports filed by users to prevent publication and dissemination of hate speech. Social media shutdown to prevent the spread of hate speech during recent ethnic conflicts in Sri Lanka indicates the inefficiency of the existing measures taken by social media platforms to detect Sinhala hate speech and prevent hate speech dissemination. Furthermore, there are only a few research studies involving Sinhala hate speech detection. These facts highlight the necessity of a Sinhala hate speech detection approach. In this research, we have explored the detection of Sinhala hate speech text using supervised word n-gram model of FastText which has shown promising performance in text classification. The dataset used to test the proposed approach consists of comments extracted from Facebook. Results of this research indicate that the proposed approach is effective in detecting Sinhala hate speech text. Out of the n-gram models considered, the bigram and trigram models demonstrated a greater performance.

Keywords: Sinhala text, hate speech, Natural Language Processing (NLP), FastText

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Separation of Sinhala and English scripts in social media images

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Social networking services are online platforms which build relationships between two or more people who share information, personal and career interests, activities, real life connections and other forms of expression. Most popular social media services are Facebook, YouTube, Twitter, Instagram, LinkedIn, etc. On social media, users can create, share, and modify content such as text, images, audios, videos and comments. Facebook, which is very popular among different ages of people, has a massive number of users in comparison with other social media services. In the Sri Lankan Facebook community, most of the user generated posts are in Sinhala and English. Sometimes these posts cause a problem due hate speech and misinformation they may contain. To analyze the text on image posts or video thumbnails, separation of Sinhala and English scripts in images is an essential section. In this research, image posts and video thumbnails are analyzed to extract Sinhala and English words separately in Facebook. Proposed methodology has five main sections; image acquisition, preprocessing, text extraction, segmentation and Sinhala and English word extraction. Image posts and video thumbnails are acquired from public groups and pages of Facebook. Acquired images are preprocessed from noise removing and thresholding. Then text contents are extracted from the image using gradient and closing morphological operations. Basic segmentation has three tasks, such as line, word and character segmentations. Horizontal projection profile method, blob creation and connected component extraction method and connected pixel labeling method are used to line, word and overlap character segmentation, respectively. This research introduced a novel algorithm for the extraction of Sinhala and English words separately which used the contour-based method, water reservoir-based method and topological features analyzing method. According to test results, Sinhala word extraction accuracy and English word extraction accuracy were 88% and 80%, respectively with an overall accuracy of 85.51%.

Keywords: Social media, Sinhala and English word extraction, topological features, contour-based method, water reservoir-based method

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703/E3

Wearable human detection system with image processing for blind persons

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The increased occurrence of visual impairment is a very sensitive issue in this world. Blind people also need to carry out their daily activities, nevertheless, in a different manner with many difficulties and challenges. Among these difficulties, moving in complete autonomy and the ability to seek and recognize objects are two crucial problems that must be overcome by this segment of persons. Many blind persons are self-employed and some of the most helpless, sing in public places to earn their day to day living. Therefore, detecting the presence of humans in the surrounding is a vital requirement for blind persons. Hence this research proposes a low-cost system that can be used by blind persons to detect humans in close vicinity. The developed wearable system is capable of detecting humans through a captured video stream and if a human is detected, the system makes a vibration. The system extracts the moving objects by background subtraction and Hue Saturation Intensity color space model is used to subtract the background. After subtracting the background, the humans need to be detected and canny edge detection is used to identify the edges of humans. The Hough Circle Transformation is used to detect the faces of humans. At present the system is capable of detecting humans with 80% accuracy. The total cost for the wearable band is around five thousand rupees. This wearable band enables blind people to identify whether there are humans in close proximity.

Keywords: Human detection, background subtraction, edge detection, blind

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704/E3

Blockchain technology in smart food supply chains: A case study of Sri Lankan organic food industry

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Blockchain refers to an emerging disruptive technology that enables the creation of decentralized information systems with immutable and trustworthy data. Having first come to prominence in 2008 as the backbone of the cryptocurrency system called Bitcoin, it has been developing steadily since then to become what it is today. Currently, blockchain technology is adopted to create information systems in a myriad of domains where the transparency and trustworthiness of transactions are of prime importance. The goal of adoption of blockchain technology in the organic food industry is enhance the transparency of the supply chain. In this research, the potential of blockchain technology is studied with the objective of making the organic food supply chain in Sri Lanka more transparent and trustworthy. As the consumption of organic food is getting popular worldwide, cultivation of organic food targeting the export market has been increased. Even in the domestic market, there is a growing demand for organic food among the consumers who are concerned about the health issues that can arise with modern chemical fertilizers, pesticides and weedicides. Hence, the development of trustworthy information systems that can ensure the credibility of organic food products in the market is a necessity for the growth of the industry and the blockchain technology seems promising in this endeavour as the underlying architecture. As the first step of this research, the existing 'consensus mechanisms' in the blockchain architecture were studied as a desk review to determine the most appropriate consensus mechanism for the given context. Moreover, the domain experts were interviewed to understand the structure and behaviour of the organic food supply chain in Sri Lanka. According to the analysis of outcomes of the desk review and the interviews, the 'Proof of Stake' and 'Delegated Proof of Stake' consensus mechanisms were found to be recommendable as the most appropriate consensus mechanisms to develop this system. These findings will be used to develop the first prototype of the targeted information system.

Keywords: Blockchain, consensus mechanisms, smart food supply chain, proof of stake

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705/E3

Impact of COVID-19 on micro, small and medium enterprises; a survey in Sri Lanka

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COVID-19 has had a major impact on the economy beside its influence on public health. The Sri Lankan Government has put in place several measures to contain the spread of the virus. An all-island curfew from mid-March onwards followed and in addition the country's main airports were closed for arrivals, leading to several difficulties within micro, small and medium enterprises in Sri Lanka. Therefore, research on the impact of COVID-19 on micro, small and medium enterprises are of prime importance. The study adopted a questionnaire as the research instrument and the sample size considered for the study was 334. Data were analyzed with the utilization of SPSS and descriptive and inferential statistics were utilized in making conclusions. As per the findings it was revealed that 1) layoffs and closures have already occurred: 43 percent of enterprises are temporarily closed, and enterprises have, on an average, reduced their employee count by 60 percent relative to the month of March, 2) according to previous literature, it was observed that many small enterprises are financially fragile, 3) enterprises have varying convictions about the presumable time duration of COVID related disruptions and 4) majority of enterprises planned to seek funding through the banking sector. The deadline to apply for the concessions granted under two Government circulars (No.4/2020 and No.5/2020) was given as 30th April 2020. Among those who succeed in this venture, many anticipated problems connected with accessing loans, such as bureaucratic hassles and the difficulties of establishing eligibility. The findings also highlighted the importance of implementing well-designed and sustained economic policy measures, while the loss of sales targets for the New Year season and non-receipt of payments for goods delivered to shops and wholesalers were observed. However, more opportunities in the IT service sector and new opportunities for some innovative entrepreneurs were the benefits attained. The key discoveries of the study were explained by comparing with the existing literature. Accordingly, administrative ramifications and conclusions were drawn in order to provide more extensive comprehension.

Key words: COVID-19, micro, small and medium enterprises, enterprises

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801/F

Impact of continuous assessment scores in determining the subject performance of finance students of University of Kelaniya

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The rationale behind Continuous Assessment (CA) is to enhance students' subject performance by ensuring that students do not wait till the end of the semester to evaluate their performance. The aim of this study is to see the impact of CA on academic performance which in turn, is measured by the grades in the final exams and grades in the CA in the relevant subject. Data were collected from one hundred and nineteen first year undergraduates from the Department of Finance, University of Kelaniya as a single case study. Secondary data were collected from final exam test grades, CA performance including individual and group assignments, mid exam grades, group projects, individual projects and continuous skills development projects. Students' grades in the English subject were also included to attest the impact of English test grade on their subject performance and four different first year subjects were selected for the study. Descriptive, regression and correlation tools were used to measure the significant correlation and impact among the selected variables. Findings revealed that the weight of CA varied from 25% to 50% depending on the number of assignments and intended learning outcomes of the subject via CA. Findings also highlight that there is no relationship between CA performance scores and final test scores in selected subjects. Results from the regression analysis proved that there is a significant impact of CA performance and English test grades on their final subject performance. The study concluded that the CA has an impact on both the students' results and their methodologies of learning. The proportion of success in CA is more than in the Final Assessment. Hence, careful attention should be directed towards the tools that are used in evaluating the CA and more attention should be focused on improving written and communication skills to enhance students' final test performance. Findings of this study can be used to educate the students to emphasize the importance of both summative and formative assessment to enhance their performance.

Keywords: Continuous assessment, summative, formative, English test grade, final exam performance

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802/F

Developing a conceptual framework to describe the organizational conflicts and related aspects in Sri Lankan State Universities

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Conflicts which occur inside an organization can be caused by organizational structure, communication, personal variables, limited resources, socioeconomic characters, personality traits, etc. They are categorized such as intra-individual conflict, inter-individual conflict, intra-group conflict, inter-group conflict and so on. Common conflict management styles include competing, collaborating, avoiding, accommodating and compromising. There are 10 different roles, categorized into three groups as interpersonal, informational and decisional roles, which are performed by managers / administrators. The researches revealed that there are relationships among the aspects of organizational conflicts, conflicts management, roles of the managers and their personality traits and socioeconomic characters. A recent study, also conducted in Sri Lankan state universities, revealed that a sizable level of organizational conflicts exists among different administrative groups which could affect their performances. Therefore, the importance of developing a suitable conceptual framework to identify the above mentioned aspects in the university system was identified. Accordingly, the main objective of this study was to develop a Conceptual Framework to investigate the relationships among the aspects of organizational conflicts (including causes of conflicts), conflict management, roles of the administrators and their personality traits and the socioeconomic characters in Sri Lankan state universities. The methodology followed in this investigation were secondary data (literature) collection and analysis, primary data collection by personal interviews, developing conceptual framework (research model) and developing hypotheses for further investigations based on secondary and primary data. In conclusion, the conceptual framework and hypotheses were developed. The independent variables are identified as organizational conflicts and dependent variables as managerial roles of the administrators. The conflict management strategies, personality traits and socioeconomic characters of the administrators also are identified as intervene variables. It is recommended to further develop the conceptual framework by receiving comments from experts and by literature review as more specific for a Sri Lankan context.

Keywords: Organizational conflicts, conflict management, roles of administrators, personality traits

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803/F

The impact of climate variability on economic growth in Sri Lanka

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Sri Lanka's Gross Domestic Product (GDP) is service-oriented with a subsidiary industrial contribution (26.4%) and a small agriculture-related contribution (7.0%). Although the value of agricultural output (AGDP) has been increasing over time, the weight of agriculture GDP declined from 36% in 1950 to 7% in 2019 (CBSL). Similarly, the contribution of hydropower to electricity generation dropped from approximately 80% to 40% over the last three decades. Here, we investigate whether the GDP and its growth are related to climate variability so that we can better understand the role of climate shocks and climate change. We analyzed annual data for GDP and its growth from 1962 - 2019 and quarterly GDP growth from 2004 - 2019. Monthly data for the main stations of the Department of Meteorology were used to construct an average rainfall using these well distributed stations. We employed descriptive statistics, correlation analysis, graphics and time series regression models, to assess the relationship between the economic growth rate and rainfall. The relationship between GDP and rainfall is not clear cut. However, the agricultural component of GDP (AGDP) shows a relationship with quarterly rainfall. There is a significant negative correlation between rainfall and AGDP (0.27 with P-value 0.0067). In correlation with rainfall lagging, the GDP growth showed an inverse relationship. The relationship between economic growth rate and rainfall is seasonal and varies by region. There are statistically significant inter-annual relations between climate variability and economic growth indices for agriculture. The impact of climate variability on GDP diminishes in recent decades as other sectors assume greater weightage in the economy. Thus, while the economy is getting decoupled from climate shocks of late, the direct and indirect impact of climate on the economy remains significant.

Keywords: Economic growth, agriculture, hydropower, climate variability, climate shocks

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804/F

A silverline in dark clouds? An assessment of the status of Halgolla Tea Smallholding Development Society as a farmer organisation

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Farmer organizations (FOs) were formed to tackle the production and market-related challenges faced by smallholders. Successful FOs undertake multiple tasks such as organizing activities, providing production support, marketing related activities, processing, financing, extension services as well as training and welfare activities for the benefit of members. Tea Smallholding Development Societies (TSDS) were established to address similar issues. However, studies have revealed that the majority of the TSDSs do not perform well due to various reasons. Yet, the Halgolla Tea Smallholder Society (HTSS) is reported to be a successful organization. The present study attempts to understand the status of HTSS and identify the reasons for its success for possible wider applications. Data were collected using qualitative interviews with various stakeholders of the society (views of 28 respondents were recorded) and thematically analysed, following the methodology suggested by Strauss and Corbin in 1990. Small member growers living in Polpitiya, Neluwathukandha, Weergalla and Nawata, Grama Niladhari Divisions of the Yatiyanthota divisional secretary area participated. The Society assists the production process of members by providing various production support packages such as input, extension service and credit facilities. The Society maintains a resource pool for the members. HTSS maintain a close link with the extension agent and caters to the extension and training needs of its members. When there is a severe price fluctuation in the market, HTSS interferes by buffering the effects. The Society has initiated a mechanism to provide a long-term credit facility for agriculture work through a bank. The Society collects the members' production, sorts them based on the quality and supplies to the agreed processing centres and achieves a competitive price. Moreover, HTSS offers a vast array of welfare facilities. The leadership, good governance, commitment of the members, systematization, cohesiveness among the members and members' attitude are the key features for their success. If other TSHDS can learn from HTSS, they would also be able to improve themselves. Although HTSS appeared to be a successful FO, it is not comparable with some other successful FOs due to its failure in value addition, marketing and commercialization. However, HTSS has laid a good foundation, and if they attempt to move forward, they have the potential to achieve greater success.

Keywords: Halgolla, tea, smallholders, society, farmer organisation

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805/F

An assessment on women entrepreneurship in agro-based enterprises in Karadeniya DSD, Southern Sri Lanka

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Women entrepreneurship is crucial in converging under-utilized and unutilized women skills into the production process. Numerous programmes have been introduced to incorporate women skills into the agri-business sector. “Govi Kantha” is one such programme initiated to enhance women entrepreneurs in floriculture and mushroom ventures launched by the Karadeniya DS Division (DSD), Southern Province. This study was designed to evaluate the impact of this programme with respect to household economy, social mobilization and women empowerment. A simple random sampling technique was adopted to draw an equal number of units from each enterprise (n=30). A list of beneficiaries, which is available at the Karadeniya DSD, was used as the sampling frame. A semi-structured questionnaire was administered to obtain primary data. Descriptive methods were used for data analysis. Results unravel that the technological adaptability is higher in floriculture industry (72%) than mushroom (40%), yet both groups demonstrate substantial adaptability to the modern technology. Due to a positive attitude on further expansion, 25% to 40% of income is re-invested in the business. Family cooperation and support is high as 80-90% for both groups. Knowledge dissemination, sharing skills and experience have a significant impact ($\chi^2(1) = 7.50$; $p=0.006$) on creating job opportunities (23%) and business ventures within the community. Thus, community harmony is ascertained through social relationships and networks. Farmer cooperatives have been established to address limitations pertaining to the supply of raw materials and sales. These enterprises have a positive impact on the future generation where 25-30% of the income is invested on children’s education, confirming direct contribution to the household economy. Main problems are lack of improved planting materials (60%) such as tissue culture and Bangkok varieties, limited access to capital (54%), lack of sales outlets (43%), pest and disease attacks (33%), competitive markets (31%), and health related issues (19%). Advanced technology (75%), imported varieties (55%), market links and sales outlets (52%) are requested for further expansions. The scope and positive perception towards women entrepreneurs in agribusiness enterprises are well-communicated through this study. Hence, more programmes at rural and regional level are recommended to enhance household economy, social relationships, and women empowerment with sufficient training and monitoring.

Keywords: Women entrepreneurs, agribusiness enterprises, social relationships

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806/F

Fetus in the light of modern technology: a legal perspective

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In discussion of the legal regimes pertaining to the termination of pregnancy, a fetus is considered as an entity dependant on the autonomy of the mother. Recent developments in the fields of fetal medicine have accentuated the fact that, the fetus is entitled to deserve attention on par with the matters of the pregnant woman. The advent of the ultrasound and related technologies has emphasized that, a fetus does possess certain sensory perceptions and also the status of a patient can be granted. The termination of pregnancy is predominantly based on the viability of the fetus. A viable fetus is a patient who has the capability to survive outside the womb of the pregnant woman and also to survive with the support of the technology. This is contrary to the pre-viable fetus. A pre-viable fetus is dependent on the decision of the mother as to the survival. In addition to the recognition of fetus as a separate entity, the procedures of fetal surgery have been implemented for the curing of defects in the fetus. The different cultural notions have involved in defining the status of fetus and its personhood, whereas the bio-medical technology has accepted the 'anti-cruelty principle, which has its roots on the protection of sentient beings. In this study, the author has adopted the desk research methodology. There are primary and secondary sources utilized. As the primary sources, the legal enactments have been perused and the texts, publications and academic work have been utilized as the secondary sources. The study basically concerns on the fetal personhood, the developments related to it and the manner it affects to the legal reformations.

Keywords: Fetus, autonomy, fetal medicine, legal reformations, anti cruelty principle

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Poster Presentations



901/A

Physical parameters and correlation between glycaemic responses of less commonly consumed traditional rice (*Oryza sativa* L.) varieties of Sri Lanka

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Glycaemic index (GI) is a factor to determine whether a food raises blood glucose level quickly, moderately or slowly. There is proven evidence that traditional rice elicits low or medium GI (< 70). Physical parameters of rice are critical among breeder, seller and consumers to select the desired varieties. However, data on physical parameters of traditional rice are scarce. This study aimed to determine the physical parameters and their correlation with reported glycaemic responses (GI and glycaemic load (GL)) of 22 less common traditional rice varieties; namely Pokkali, Murugakayan, Rathdel, Madathawalu, Kuruluthuda, Pachchaperumal, Suduheenati, Suwadel, Kaluheenati, Mavee, Masuran, Gonabaru Kahawanu, Kahamala, Hetadawee, Godaheenati, Batapolael, Dikwee, Dahanala, Unakola samba and Hangimuththan. Length, width, thickness, pericarp colour, diameter, volume, and length/width ratios (shape) were determined according to standard methods. Length of varieties varied between 4.0 - 6.4mm and grain length varied as short (<5.0mm), intermediate (5.0 - 5.99 mm), long (6.0 - 6.4 mm). Width and thickness of varieties varied between 2.2 - 2.9 mm and 1.5 - 2.2 mm, respectively. Rathdel, Suwadel, Kahawanu, Kahamala, Unakola samba and Hangimuththan were white in colour while others were red. Diameter and volume of the rice varieties varied among 2.4-3.3 mm and 10.5-3.8 mm³ respectively. The length/width ratio of rice varied between 1.5 - 2.2 and accordingly Rathdel, Kuruluthuda, Suwadel, Kahawanu, Hetadawee, Unakola samba and Hangimuththan were categorized as round and others as bold in shape. The results revealed that there is a positive significant ($P=0.002$) correlation between diameter and length. Increased length of the seed makes the grain bolder in shape as there was significant ($P=0.000$) positive correlation between length/ width and length. Traditional Sri Lankan rice varieties studied were short or medium either round or bold. However, no significant correlations were observed for length, width, thickness, diameter, volume, shape or pericarp colour (red or white) with GI of the studied rice varieties.

Keywords: Traditional rice, glycaemic index, pericarp colour, physical properties

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902/B

Evaluation of nutritional composition and antioxidant activity of two different banana varieties (*Musa acuminata* cv. Pisang awak and *Musa acuminata* cv. Red dacca) using banana flour and banana cookies

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The present study was conducted to evaluate the nutritional composition and antioxidant activity of both dried banana flour and banana cookies. The moisture, ash, fat, protein and carbohydrate contents of both flour were ranged as 8.00 ± 0.15 - $8.84 \pm 0.43\%$, 3.03 ± 0.21 - $3.25 \pm 0.31\%$, 1.24 ± 0.05 - $2.16 \pm 0.14\%$, 4.81 ± 0.31 - $5.88 \pm 0.19\%$, 74.28 ± 0.37 - $77.14 \pm 0.46\%$, respectively. Carbohydrate content was significant ($p < 0.05$) in "*Pisang awak*" while other nutrients were significant ($p < 0.05$) in "*Red dacca*". Total phenolic content (TPC) and antioxidant content (DPPH assay, ABTS assay and FRAP assay) of banana were investigated. TPC, DPPH, ABTS and FRAP of both flour were ranged as 3.58 ± 0.10 - 4.95 ± 0.49 mg Gallic Acid Equivalent (GAE)/g, 0.15 ± 0.02 - 0.68 ± 0.10 mg Trolox Equivalent (TE)/g, 59.65 ± 5.02 - 68.06 ± 1.20 mg TE/g, 25.35 ± 1.34 - 28.75 ± 1.02 mg TE/g, respectively. Cookies were developed incorporating "*Pisang awak*" flour and "*Red dacca*" flour with wheat flour in different ratios. The best two formulations of the two different cookies were selected through a sensory evaluation test and the proximate composition and antioxidant contents of the two cookies were investigated. The moisture, ash, fat, protein and carbohydrate contents of "*Pisang awak*" flour incorporated cookies were ranged as $3.62 \pm 0.03\%$, $1.62 \pm 0.09\%$, $15.00 \pm 0.15\%$, $9.22 \pm 0.18\%$, $68.96 \pm 0.44\%$ and in "*Red dacca*" were ranged as ($3.79 \pm 0.05\%$, $1.87 \pm 0.06\%$, $15.60 \pm 0.41\%$, $10.73 \pm 0.26\%$, $66.21 \pm 0.39\%$, respectively. TPC, DPPH, ABTS and FRAP of "*Pisang awak*" incorporated cookies were 1.10 ± 0.08 mg (GAE)/g, 0.04 ± 0.01 mg (TE)/g, 37.92 ± 3.25 mg TE/g, 3.39 ± 0.30 mg TE/g and in "*Red dacca*" incorporated cookies were 3.99 ± 0.07 mg (GAE)/g, 0.15 ± 0.02 mg (TE)/g, 56.80 ± 0.64 mg TE/g, 7.32 ± 0.57 mg TE/g, respectively.

Keywords: Banana, cookies, proximate composition

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903/B

Screening of leaves of *Citrus* varieties grown in Sri Lanka for their essential oil contents

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Citrus, a genus with many species of family Rutaceae, is considered as a medicinally important plant with high value for its importance as a fruit crop. Among the great variety of essential oils, *Citrus* essential oils have an impressive range of food and medicinal uses because of its broad antimicrobial abilities against a wide range of pathogenic microbes. Even though, Sri Lanka has many *Citrus* varieties, information on essential oil contents in leaves of those varieties are scattered or lacking. Therefore, the present study was undertaken to screen the leaves of *Citrus* varieties for their essential oil contents. Essential oil content was determined by the hydro distillation method, using the mature leaves of twenty-eight *Citrus* varieties including seven sweet orange varieties (*arogya*, *bibila sweet*, *bibila seedless*, *sisila*, *jepa*, *Maduruketiya dodam* (MKD), *Maligathenna* (MT)), three mandarin varieties (*rahangala*, *indu*, *madu*), two grapefruit varieties (white and red), two lemon varieties (long and round), two pomelo varieties (white and red), lime, *nasnaran*, *abuldodam*, *calamansi*, rough lemon, *kudalu*, *sidaran*, *thahiti*, *heennaran*, *naththaran*, *kondanaran* and marmalade. Of the *Citrus* leaves varieties tested, mandarin variety *Indu* reported the highest essential oil content followed by Ambuldodam and mandarin variety *Rahangala* (2.61 ± 0.10 ml/ 100 g DW, 2.11 ± 0.10 ml/ 100 g DW and 1.89 ± 0.19 ml/ 100 g DW, respectively). The lowest essential oil content was recorded by grapefruit variety white (0.14 ± 0.04 ml/ 100 g DW) while grapefruit variety red did not show a detectable amount of essential oil. According to the results, it could be concluded that the leaves of mandarin variety *Indu* can be used as a potential source of essential oils useful in food, pharmaceutical and chemical industries.

Keywords: *Citrus* leaves, essential oil

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904/B

Comparison of matured fruits of *Solanum melongena* L. and *Solanum violaceum* Ortega by means of proximate composition

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Genus *Solanum* has more than 1500 plant species worldwide with different uses. *Solanum melongena* L. (“wambatu”) is the most commercially available species, while several edible underutilized species are available in different areas of the country. *Solanum violaceum* Ortega (“Thiththa Thibbatu”) is one among these underutilized species. The nutritional importance of this species is not fully discovered and remains underutilized. Therefore, the current study was carried out to screen proximate parameters such as moisture, crude ash, crude fat, and crude protein contents. Edible fruits of both species which were grown in same climatic and soil conditions were harvested and tested in triplets. Standard Association for Official Analytical Chemists (AOAC) methods were followed in all tests. Results generated from the mean comparison done by SAS statistical software, discovered that proximate parameters were significantly different ($p < 0.05$) from each other. *S. melongena* L. recorded the highest total moisture content ($92.10 \pm 0.71\%$). *S. violaceum* Ortega recorded the highest crude ash content ($5.74 \pm 1.45\%$), crude protein content ($17.15 \pm 0.72\%$) as well as the highest crude fat content ($0.65 \pm 0.01\%$). Based on the results, all tested physicochemical parameters except total moisture content were superior in *S. violaceum* Ortega. Therefore, *S. violaceum* Ortega could be suggested as a fruit with higher nutritional composition with compared to frequently available commercial crop *S. melongena* L. for dietary uses as well as for value added product development.

Keywords: *Solanum melongena*, *Solanum violaceum*, proximate composition, underutilized

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905/B

Proximate composition of two cooking type banana accessions at their ripe and unripe stages

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Plantain or cooking banana constitute an important energy source as a staple food in the tropics. Even though, Sri Lanka has many accessions of cooking type banana, information on nutritional composition of existing accessions are scattered or lacking. Therefore, the present study was undertaken to compare the proximate composition (moisture, dry matter, crude ash, crude protein and crude fat contents) of the flesh of two cooking banana accessions namely; 'Alukesel' (ABB) and 'Atamuru' (ABB) at their ripe and unripe stages. The proximate composition of samples was analyzed in triplicate according to the methods of Association of Official Analytical Chemists (AOAC,1990). Statistical comparison of mean values was performed by General Linear Model (GLM) of ANOVA followed by Tukey Multiple Range Test using SAS software. All tested unripe and ripe banana fleshes exhibited a considerable amount of moisture, dry matter, crude ash, crude protein, and crude fat. The moisture, dry matter, crude ash, crude protein contents were significantly higher ($P < 0.05$) in both accessions at the ripe stage. The fat content was significantly not different at the two maturity stages of both accessions. While maturity progressed moisture, crude ash, crude protein contents of both banana accessions at their ripe and unripe stages increased, and the dry matter content decreased. A significantly higher moisture, crude ash, crude protein content were recorded in 'Alukesel' at the unripe stage ($66.29 \pm 2.6\%$, $3.50 \pm 0.0\%$ and $4.20 \pm 0.2\%$, respectively) as well as the ripe stage ($72.07 \pm 1.7\%$, $3.70 \pm 0.0\%$ and $4.29 \pm 0.1\%$, respectively) than 'Atamuru'. Crude ash content of ripen and unripen banana pulps ranged between $3.24 \pm 0.1\%$ and $3.70 \pm 0.0\%$ whilst crude protein contents varied from $1.34 \pm 0.1\%$ to $4.29 \pm 0.1\%$. In conclusion, the results implied that 'Alukesel' pulp is rich in nutrients at both ripe and unripe stages followed by 'Atamuru'. Hence, they could be incorporated in the formulation of banana-based value-added products. The proximate composition of both 'Alukesel' and 'Atamuru' is significantly higher at the ripe stage. Therefore, they could be promoted to consume as a dessert at the ripe stage.

Keywords: Banana, proximate composition, banana flesh

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906/B

Proximate compositions in young coconut mesocarp of coconut (*Cocos nucifera* L.) forms grown in Sri Lanka

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Cocos nucifera L. (family Arecaceae), commonly known as coconut, is an important crop in the tropical countries. Coconut is the most extensively grown and used nut in the world, playing a significant role in the economic, cultural, and social life of over 80 tropical countries. Young coconut is defined as the fruit at the stage of 6-months. Apart from coconut water and meat of a young coconut, the rest of the coconut is discarded as a waste. It is assumed that young coconut mesocarp contains high phenolic compounds which are vitally important due to their potential in performing as antioxidants and antimicrobial compounds. Various components of coconut drupe are used for numerous purposes in human health such as treatment for diarrhea, arthritis, etc. The present study sought to analyze the proximate composition in young coconut mesocarp of 15 coconut forms grown in Sri Lanka, namely; *Sri Lankan tall*, *navasi*, *gon-thembili*, *ran-thembili*, *pola pol*, *bodiri*, *kamandala*, *dikiri*, green dwarf (*pumila*), yellow dwarf (*eburnea*), red dwarf (*regia*), brown dwarf (*braune*), king coconut (*thembili*), *rathran thembili* and *navasi thembili*. The moisture and ash contents were determined using the methods described by AOAC (1990). The crude fat content was determined using the Soxhlet extraction method and the crude protein content was determined using the Kjeldahl method. Significantly the highest moisture (87.05 ± 0.07 %), crude ash (28.15 ± 0.07 %) and crude fat (18.30 ± 0.03 %) percentages were observed in mesocarp of brown dwarf coconut whereas king coconut had a significantly high crude protein (79.76 ± 1.55 %) percentage. Significantly the lowest moisture, crude fat and crude protein percentages were recorded in mesocarp of *bodiri* form whereas *ran thembili* mesocarp had significantly the lowest crude ash percentage. As suggested by the results of the study, it can be concluded that in general, the young mesocarp of almost all selected coconut forms are rich in nutrients which can be employed to develop any value added products instead of disposing it as a waste.

Keywords: Proximate composition, young coconut mesocarp

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907/B

Extraction of essential oil content from peels of citrus varieties available in Sri Lanka by hydro-distillation

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Citrus fruits are consumed as fresh fruits or juices and peel is discarded as waste. However, citrus peels are rich in essential oils. Although citrus essential oils can be extracted from peels, leaves, roots, flowers and seeds, the higher amount of essential oil can be obtained by peels. Distillation is the widely used extraction method to recover oil. During distillation, the citrus peels are exposed to boiling water or steam, and release their essential oil through evaporation. Therefore, the present study was undertaken to evaluate the essential oil content in peels of twenty-five local citrus varieties namely, seven sweet orange varieties, four mandarin varieties, two pomelo varieties and twelve other citrus varieties. Essential oil content was determined by hydro-distillation. Results revealed that all tested citrus varieties contained appreciable amounts of essential oil contents. A significantly high essential oil content (2.58 ± 0.12 ml/100g DW) was observed in “*Calamansi*” followed by lime (2.25 ± 0.12 ml/100 g DW). The lowest essential oil content was recorded in “*pomelo red*” (0.58 ± 0.12 ml/100 g DW). Among seven sweet orange varieties the highest essential oil content was observed in variety “*Sisila*” (1.92 ± 0.12 ml/100 g DW) followed by “*Maliga thenna*” (1.75 ± 0.12 ml/100 g DW), whereas the lowest essential oil content was noted in variety “*Arogya*” (1.00 ± 0.00 ml/100 g DW). Furthermore, non-significant differences were observed in variety *Bibila sweet* (1.58 ± 0.12 ml/100 g DW) and “*Maduruketiya dodam*” (1.58 ± 0.12 ml/100 g DW). Furthermore, among four mandarin varieties, the highest essential oil content was observed in variety “*Indu*” (1.75 ± 0.12 ml/100 g DW) followed by “*Kondanaran*” (1.25 ± 0.12 ml/100 g DW). Moreover, the lowest essential oil content was noted in variety “*Rahangala*” (0.92 ± 0.12 ml/100 g DW). There is a high potential for the development of newer value-added products using citrus peel essential oils.

Keywords: Citrus, essential oil, hydro-distillation, peels, value added products

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908/B

Assess the efficiency of Amirthakaraisal on germination and growth of Okra (*Abelmoschus esculentus* L.) seedlings

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The present study was carried out at the crop farm of Eastern University, Batticaloa at a mean temperature of 27.4 °C and an annual rainfall of 1600 mm in 2018, in order to assess the efficiency of Amirthakaraisal solution on the germination and growth of okra (*Abelmoschus esculentus*) seedlings. A pot experiment was carried out using okra variety Haritha and it was laid out in a Completely Randomized Design (CRD) in the field. The treatments were direct sowing of Okra seeds (T1), soaking in water (T2) and soaking in 1% (T3), 3% (T4), 5% (T5), and 7% (T6) Amirthakaraisal solutions with five replicates per each treatment. The mean comparison was conducted using Dunnett's Multiple Range Test (DMRT) to compare the means of the treatments. The results of the experiment showed that germination percentage of okra seeds was higher in the seeds treated with 3% Amirthakaraisal solution giving the highest value of 95% at the end of 9 days. Leaf greenness (measured as SPAD value (measured using SPAD meter) which is proportionate to chlorophyll content), plant height, root length, dry weight of the total plant were comparatively higher in plants when they were treated with 3% Amirthakaraisal solution in weekly intervals up to three weeks. According to the results of the present study, it was concluded that soaking okra seeds in 3% Amirthakaraisal comparatively enhances the germination and subsequent higher growth rates in okra.

Keywords: Amirthakaraisal, germination, growth

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Extraction and characterization of alginate from brown seaweed variety *Sargassum cervicone*

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Alginate is one of most important structural components in marine brown seaweeds which is highly used in both food and non-food applications. This study was carried out to analyze the effect of extraction methods on alginate yield and physico-chemical characteristics of extracted alginate. Alginate was extracted under acid and alkaline conditions at different temperatures (acid hot, acid room, alkaline hot, alkaline room temperature) from the brown seaweed variety *Sargassum cervicone* which was collected from Down South Coast, Hikkaduwa, Sri Lanka. Moisture content, ash content, carbohydrate content, viscosity, DPPH radical scavenging activity, and total phenolic content of extracted alginate were analyzed according to standard procedures. Analysis results of the yield of alginate revealed that acid hot temperature extraction method exhibited the highest yield of $31.94 \pm 0.22\%$, while alkaline room temperature method exhibited the lowest yield of $17.9 \pm 0.20\%$. Further, the alginate yield from all four extraction methods were significantly different ($P < 0.05$) from each other and the decreasing order of yield from the extraction method were found to be acid hot > acid room > alkaline hot > alkaline room temperature. Alginate extracted from alkaline room temperature extraction and alkaline hot temperature extraction showed a significant difference ($P < 0.05$) in moisture content. However, there were no significant differences ($P > 0.05$) in ash content and carbohydrate content of the alginates extracted from all four extraction methods. The viscosity values of alginates extracted from both acid and alkaline hot temperature extraction methods were significantly different ($P < 0.05$) from the viscosity values obtained from acid and alkaline room temperature extraction methods. According to DPPH inhibition percentage results, alginates which were extracted by both alkaline and acid room temperature methods were significantly different ($P < 0.05$) in DPPH inhibition percentage to the alginates which were extracted by both alkaline and acid hot temperature methods. Also total phenolic content of alginates extracted by both alkaline and acid room temperature methods were significantly different ($P < 0.05$) to total phenolic content of alginates which were extracted by both alkaline and acid hot temperature methods.

Keywords: Alginate, *Sargassum cervicone*, extraction, physico-chemical characteristics

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910/B

Production of single cell protein using pineapple, sour orange and sour mango peel

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Protein deficiency has become a major challenge worldwide with the fast-growing world population, thus it is important to explore novel alternative methodologies to produce proteins to meet the nutritional demand. In this backdrop, locally available pineapple, sour orange and sour mango peel wastes were studied for their suitability to produce single cell proteins using natural palmyrah (*Borassus flabellifer*) toddy yeast under liquid state fermentation system. Pineapple, sour orange and sour mango peel collected from the local market in Jaffna were cleaned, washed and blended separately and their physico-chemical properties such as total soluble solids (TSS), pH, reducing sugar, moisture content, protein, fat and ash content were determined in triplicates. The extract of fruit peels was filtered and diluted to 10% and autoclaved separately. The sterilized peel extracts were inoculated with 5 ml natural palmyrah toddy yeast ($1.625 \pm 0.15 \times 10^6$ cells/ml) and allowed for fermentation at 100 rpm for 48 h in triplicates. The sediments were collected by centrifugation, oven dried and the dry weight was measured to determine the protein content on the basis of total nitrogen content. The pH of the fruit peels ranged from 3.7-4.1 and TSS of the three peels were recorded within a range of 10.8-12.3%. The results of the physico-chemical composition of fruit peels established that pineapple, sour orange and sour mango peel are a good nutrient source for yeast cell mass formation with the significant amount of reducing sugar (12.3-27.8 g/L), protein (6.2-7.2%), fat (0.9-2.5%) and ash content (4.2-6.1%). The biomass yield ranged from 8.61-9.40 g/l with the least biomass yield observed from sour mango while the maximum yield was observed from pineapple. Pineapple peel generated a significantly higher amount of protein ($49.7 \pm 1.3\%$) followed by the sour orange and sour mango peel ($29.5 \pm 1.2\%$ and $24.6 \pm 0.2\%$, respectively). It is concluded that natural and locally available pineapple peel waste are good substrates among the pineapple, sour orange and sour mango peel for the production of protein-rich cell biomass using fermentation by natural toddy yeast of palmyrah.

Keywords: Liquid state fermentation, palmyrah toddy yeast, pineapple peel, single cell protein, sour mango peel, sour orange peel

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911/B

Development of an energy beverage with nutraceutical properties using *Moringa oleifera* leaf and green tea extracts

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The objective of this study was to develop a nutritious energy beverage rich in electrolytes and antioxidants. The extracts of dried *Moringa oleifera* and green tea leaves were used as the two main ingredients of the beverage. Sugar syrup and fresh juices from ginger and lime were the other ingredients used in the nine product formulations. Three product formulations were selected using a Balanced Incomplete Block Design and sensory evaluations were conducted using a semi trained panel. Out of three, the most acceptable beverage formula was selected based on the highest mean rank value as there was no significant difference ($p > 0.05$) among the sensory characteristics of the three formulations. Comparison of the new beverage with the leading product in the market revealed that the overall acceptability of the market leader was significantly ($p < 0.05$) higher than the new beverage. However, between two products, there was no significant difference in taste, after taste and flavor. Three samples from selected formulation were subjected to the physicochemical, chemical and antioxidant analysis. New beverage contained 146.78 kJ of energy per 100 mL and the same volume would fulfill 8.5%, 7.3%, 7.1%, 0.5% and 0.2% of the daily Ca, Fe, Mg, K and P requirements, respectively. Carbohydrate, protein, fat and caffeine contents of the new beverage were 8.5%, 0.04%, 0.01% and 20 mg/100 mL, respectively. Total phenolic content (17.25 ± 0.0 mg gallic acid equivalents/1 g), total flavonoid content (3.0 ± 0.47 mg quercetin equivalents/1 g), DPPH radical scavenging activity (5713.2 ± 442.37 μ g ascorbic acid equivalents/1 g), ABTS radical scavenging activity (2232.8 ± 1752 μ mol trolox equivalents/1 g) and ferric reducing antioxidant power (12720.21 ± 207.25 μ mol trolox equivalents/1 g) of the beverage indicated that the new product has a high antioxidant potential. This study revealed that the new beverage developed with the incorporation of the extracts of dried *M. oleifera* and green tea leaves could provide adequate energy to consumers with higher nutritional content compared with the leading energy drink available in the market. However, this product needs to be further developed in the future studies.

Keywords: Electrolytes, nutraceutical beverage, antioxidants

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912/B

Performance evaluation of co-compost powder and pellets applied at different soil depths on *Eleusine coracana* L. (finger millet) under poly-house conditions

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At present, Sri Lanka faces severe issues in liquid and solid waste management. Co-composting of fecal sludge and the organic fractions of Municipal Solid Waste (MSW) is considered as an appropriate low-cost technology that can enhance sanitation and waste management in low-income countries. Further, form and placement depth are two important factors of fertilizer application, which affect the efficiency of nutrient uptake by plants. It consequently encourages maximum yields of intensively managed agronomic crops by improving soil fertility and quality. The objective of this study was to compare the performance of co-compost pellets and powder and to evaluate the effect of different application depths of them on the growth and yield of finger millet under poly-house conditions. Finger millet plants were established in poly bags and were setup in Latin square design with nine treatments in a greenhouse at the Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka. Co-compost powder and pellets made using Dewatered Fecal Sludge (DFS) and MSW were used at four different soil depths: surface application, 10 cm shallow incorporation, bottom layer application and complete soil mixture over inorganic fertilizer. Plant height, number of leaves, leaf area, shoots and roots dry weight, number of days for flowering and yield data were recorded. Soil pH and Electrical Conductivity (EC) were recorded as soil parameters. The results revealed that depth of co-compost application did not have any effect on growth and yield of finger millet, soil pH and EC. Application of DFS-MSW co-compost recorded significantly ($p < 0.05$) higher growth and yield performance (63% higher) compared to inorganic fertilizer. Further, a significantly ($p < 0.05$) higher yield could be obtained in the DFS-MSW co-compost powdered form compared to pellet form. It is recorded that, 49 % of grain increment was recorded in powder form over the pellet form. Further, co-compost resulted a significant improvement of soil pH over inorganic fertilizer (from 6.35 to 6.99). According to these results application of co-compost powder at 10 cm depth can be recommended for finger millet considering the convenience and cost of application.

Keywords: Application depth, co-compost, finger millet, pellets, powder

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913/B

Impacts of *Elaeis guineensis* (oil palm) cultivation on soil abiotic and biotic properties in Nakiyadeniya, Sri Lanka

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Since impacts of *Elaeis guineensis* (oil palm) plantations on soil and groundwater table have not been thoroughly studied in Sri Lanka, some myths have arisen about negative impacts of this cultivation with lack of scientific details. Wet zone, Sri Lanka where oil palm cultivation is prominent has started showing up severe groundwater decline and soil quality degradation problems since in the recent past. The contribution of oil palm to these problems is highly controversial. Therefore, the main objective of this study was to assess the impacts of oil palm cultivation on soil abiotic and biotic properties. Soil samples from 1-year, 7-year and 19-year-old oil palm cultivations in Nakiyadeniya estate, Sri Lanka were studied comparative to the Kanneliya natural forest, 14-year rubber cultivation in Nakiyadeniya and an abandoned site in Nakiyadeniya. Samples were taken in triplicates in 10 cm, 30 cm and 50 cm soil depths from each site, monthly from May to October. Bulk density, moisture content, pH, temperature, conductivity, particle density, organic matter, water holding capacity, porosity, cation exchange capacity and total Nitrogen in soil were analyzed as the abiotic properties of soil using standard methods. Bacterial and fungal colony forming units per gram of soil, were counted by (Mean number of colonies in triplicate* Dilution factor)/ Volume of the inoculum, as the biotic properties of soil. The data were analyzed using Minitab software (version 14.0). The results revealed that oil palm does not cause significant impact on any soil parameter such as soil temperature, soil bulk density, soil particle density, soil porosity, soil organic matter content, soil conductivity, soil moisture content, soil water holding capacity, soil pH, soil cation exchange capacity, soil total Nitrogen content and the biotic properties (ANOVA pairwise comparisons, $P > 0.05$). However, the impacts of oil palm cultivation on few parameters such as soil pH, soil moisture content, soil particle density, soil water holding capacity, soil cation exchange capacity, soil total Nitrogen content, bacterial and fungal colony counts slightly vary with the age of the oil palm cultivation. Based on these results, it can be concluded that, the impacts of oil palm cultivation on soil biotic and abiotic parameters, does not significantly vary with the soil depth. Further it can be concluded that, the impacts of oil palm cultivation on soil biotic and abiotic properties are not significantly different from the impacts of 14-year rubber cultivation and the Kanneliya natural forest.

Key words: Impact of oil palm, abiotic properties of soil, biotic properties of soil

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914/B

Assessment of the bio-insecticidal properties of three tropical plants using aphids and thrips

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The extensive and injudicious use of conventional agrochemicals have interfered the delicate balance in natural ecosystems by causing development of insecticide resistance in insects, bioaccumulation and biomagnification of pesticide residues. At present, a growing attention is placed on the development of more ecofriendly and sustainable pest management approaches, with special emphasis on bio-pesticides. Therefore, the present study was conducted to evaluate the bio-insecticidal potential of three selected local plants species, namely *Strychnos nux-vomica*, *Euphorbia acruensis* and *Zamioculcus zamiifolia* under laboratory conditions using aphids (*Aphis gossypii*) and thrips (*Thrips tabaci*) as the target pests. Stock plant extractions were prepared using both fresh and dry forms of the selected plant species using petroleum ether as the solvent of extraction. Subsequently, three concentrations (75%, 50% and 25%) of each plant type in both fresh and dry forms were prepared through appropriate dilution of stock extracts. Randomly selected laboratory-adopted aphids were exposed to each treatment (10 insects/treatment) in petri dishes with filter papers treated with 0.5 ml of each treatment. Meanwhile, 0.5 ml of distilled water treated petri dish was used as the control. Experiment was repeated for 30 times and the 12-hour percentage mortality rates (MR) were calculated. The entire experiment was replicated for thrips also. General Linear Model (in the form of ANOVA) was used for the statistical comparison of mortality rates (response) of aphids and thrips, while considering the plant type, dry and fresh forms as the predictors. The mortality rates of aphids and thrips denoted significant variations among dry and fresh extracts of the three plants ($P < 0.05$). The highest mortality rates were observed from the fresh form extracts in all the three plants. *E. acruensis* denoted the significantly highest pesticidal potential with mean mortality rates of 77.0+8.7% and 73+7.3% for aphids and thrips, respectively, while *S. nux-vomica* denoted the lowest {12.0+2.5% and 9.0+2.3% for aphids and thrips, respectively} at 75% concentration under the fresh form. In case of the dry form extracts, *E. acruensis* reported the highest mortality rate for aphids as 42.0+4.9%. Meanwhile, *Z. zamiifolia* indicated the highest mortality rate for thrips (46.0+5.6%). The control treatment reported no mortality of either aphids or thrips. Based on the overall performance, fresh form extracts of *E. acruensis* could be recommended to be applied as a bio-pesticide for aphids and thrips, while suggesting further studies using different solvents and field trials.

Keywords: Aphids, bio-pesticides, thrips

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915/B

A study on interspecific interactions of plants in natural ecosystems and prospecting for allelopathic agents

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Allelopathy is a common biological phenomenon in which one organism produces biochemicals that influence the growth, survival, development, and reproduction of other organisms. Phytochemicals that mediate allelopathy is called allelochemicals which are important sources of alternatives for synthetic herbicides. Prolong use of synthetic herbicides lead to develop herbicide-resistant weeds which pose considerable threat for agriculture and thereby to the food security. The objective of this study was to study allelopathic interactions between selected plants and weeds in the natural ecosystems to identify potential donor plants for allelopathic chemicals. This study comprised of 40 plants that possess negative inter-specific interactions with weeds, based on the literature records and observations carried out in the field. Floristic diversity and population abundance of weeds around the selected plants were recorded at the radius of 1 m, 2 m and 3 m from the plant base using a 1 m² quadrat in the paddy based eco-systems and mixed dry eco-systems. The study was replicated at least three times and data were analyzed using descriptive statistics. Common plants with similar growth habits and anatomical characters in the same eco-systems were considered as the control for this study. The effects of factors such as low light under the canopy were excluded in this study. An interesting pattern of weed exclusion by 17 plant species including *Cerbera manghas* L. (Wel Kaduru), *Pinus caribaea* (Pinus) and *Filicium decipiens* (Pihibiya) were observed across the circular periphery of plants. Weed density were significantly suppressed towards the base of the plant from the 3 m peripheral circumference. It is an indication for the presence of some active allelopathic interactions. These plants are being studied further to discover prospective allelopathic interactions and agents therein. The outcomes of this study provide a strong basis to develop eco-friendly weedicide.

Keywords: Allelopathy, allelochemicals, weed, weedicide, eco-system

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916/B

Identification of the adaptable *Capsicum annuum* L. varieties for low water availability under *in vitro* conditions

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Capsicum annuum L. (chilli) is a dominant crop cultivated in Kalpitiya peninsula where soil water availability is a major constraint. Introduction of commercial vegetable varieties adaptable to low water availability is a solution. Thus, 11 commercial chilli varieties including five exotic and six local varieties were screened using Polyethylene Glycol (PEG) 6000 supplemented Murashige and Skoog (MS) media to induce drought under *in vitro* conditions. Three PEG levels 20, 40 and 60 g/L were tested against the control medium without PEG. Experiment was repeated two times with 60 seeds per treatment. Seed germination and the early growth parameters of root and shoot length, root, and shoot dry weight and number of leaves after 30 days of culturing were assessed using ANOVA. Over 80% seed germination was recorded in five varieties namely Kodian Hot, Lanka Hot, Deluxe, Vijaya and MICHY1, where a significant drop was observed only at 60 g/l PEG. In all varieties the growth parameters showed a decreasing trend with increased PEG levels. Even though variety Deluxe showed the best performance in control, a significant decrease was observed with increased PEG levels in all the parameters. However, some varieties including Vijaya in shoot length, root dry weight and number of leaves, MI3 in root dry weight and number of leaves, Sera234 in root dry weight, MICHHY1 in shoot length and MICHHY2 and MI2 in shoot dry weight did not show a significant difference among all the PEG levels over the control. Vijaya in shoot dry weight and root length, Sera234 in shoot length, shoot dry weight and root length, MI3 in shoot length and root length and Lanka Hot in number of leaves showed a comparable growth in 0-40 g/l PEG levels. In Kodian Hot for four parameters and Galkiriyagama, Lanka Hot and MICHHY1 for three parameters showed a comparable performance in 0-20 g/l PEG supplemented media. Based on the results Vijaya, Sera234 and MI3 were selected as the adaptable varieties for low water availability.

Keywords: *Capsicum annuum* L., polyethylene glycol, early growth parameters

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917/C

Review on labour safety in new road construction projects in Sri Lanka

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The construction industry in Sri Lanka is one of the main industries which contributes to the growth of the country's economy by providing building and infrastructure facilities to other industries and also by providing employment opportunities. Construction projects are categorized as building, industrial and infrastructure. Road and highway projects are established under infrastructure projects. Presently many new road construction projects are being introduced in Sri Lanka. Most of the road construction projects are not aware of labour safety and the number of accidents which take place is only second to the number of building construction projects. Therefore, this paper discusses the types and causes for new road construction accidents in Sri Lanka. Available literature was critically analyzed and listed under the topic, "types and causes of road accidents". Then a link was developed between the types and causes. Types of accidents in road construction projects are collapse of concrete parts, masses on earth falling from heights, accidents during transportation of loads, working on machines, loading, unloading and passing motorists in vicinity being blasted with explosives. The causes for those accidents were identified as lack of proper inspection, human factors, lack of personal protective equipment and lack of communication. Therefore, it is important to give awareness for the construction industry professionals and labourers on the type and causes of road construction and to see the migratory measures. Giving proper training to carry out construction work in a safe manner, arranging awareness programmes on construction hazards, providing suitable personal protective equipment and rewarding labourers will help to mitigate new road construction accidents.

Keywords: Road construction, labour accidents, safety

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918/C

Automatic system to separate male and female of ornamental goldfish

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Ornamental goldfish farmers in Sri Lanka are very interested about exporting male fish because of their brighter colour, shapes, size and beauty. The purpose of this system is to design and implement a fully automated system for separating male and female goldfish using image processing methods. There are three glass tanks connected by a glass tube. One glass tank is used to collect goldfish and the other two are used to receive separated male and female fish. Image processing methods are used to detect incoming goldfish and machine learning algorithms are used to identify separation of male and female goldfish. There are three gates to stop incoming fish, and to direct male and female fish to respective tanks. After detecting the incoming fish, the first gate is opened, and the fish is identified as either male or female. According to the identification, the second gate and diverter gate are opened. Contour methods in image processing and K-Nearest Neighbour (K-NN) popular machine learning language are used and male and female goldfish are separated from their background which is mostly water. K-NN is an algorithm that stores all available cases and classifies new cases based on a similarity measure (e.g. distance functions). A case is classified by a majority vote of its neighbors, with the case being assigned to the class most common amongst its K nearest neighbors measured by a distance function. If $K = 1$, then the case is simply assigned to the class of its nearest neighbor. Using K-NN, 71% accuracy of identifying male and female could be achieved. Gender of goldfish can be classified by using K-NN by training and testing 100 images.

Keywords: Goldfish, image processing, canny edge detection, machine learning, K-Nearest Neighbour (K-NN)

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919/C

Voltage indicator and automated notification system for RSU sites

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All telecommunication equipment generally require -48V DC input power. Such power systems consist of multiple parallel-redundant rectifiers that convert AC power to -48VDC power, charge lead-acid storage batteries, and supply power to critical-load equipment. Network elements and other systems (Power, Security, MSANs) are monitored from Network Operation Center (NOC) staff. MSANs (Multi-Service Access Node) and RSUs (Remote Switching Units) are powered by commercial power. When such commercial power failures occur, such situations should be notified to the NOC staff and Regional Staff. Currently this information is provided when a customer complaints and rigorous fault diagnosis is carried out. Challenges in monitoring such power failures include the inability to immediately notify the support staff of the fault and thereby increase the restoration time. The solution to these problems was provided through this project to create a system which can detect, notify and record the voltage of the output of the rectifier in real time. If the value is below the threshold value it will send a text message to relevant parties. The project consists of hardware and software implementation. The total system will consist of following modules, voltage level measuring module, local data storage, and a communication module to send the notification. The system was tested in the real network with the consent of the Kotte Regional Telecom Office, Sri Lanka Telecom. The main advantages of this solution include, ability for the NOC engineers to understand the draining of the backup battery bank in real-time, to facilitate uninterrupted service by planning the resources in an optimum way and to achieve the Node Up-time, Key performance Indicator (KPI), at 99.999%.

Keywords: Remote Switching Units, telecommunication

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Cricket batting posture analyser

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Cricket is one of the most popular sports in the world. Many Sri Lankan youngsters join cricket to realize their dream of becoming a professional cricketer in future. The making of a professional cricketer relies on guidance and training at a beginner level, especially for the batsman, which more guidance and specific supervision needed. Coaches are obliged to pay attention to each one of the team members. Hence limited time and attention remain for individuals. Under this study, a machine vision system to analyze cricket batting posture is developed, which identifies the technical issue of the posture and batting timing when batsmen played shot and inform batsman the necessary adjustments needed to be corrected for perfection. The 3D image of the batsman is analyzed and compared with the corresponding benchmarks of batting posture. Mathematical models used to calculate the joint angles of the skeleton of the batsman and an artificial neural network is used to obtain results of the proposed system. Stroke was classified into four levels; perfect, good, bad and very bad relevant to the output value of the neural network. Experimental overall results of the proposed system show an accuracy of over 86%. The experimental results show the proposed system is effective and could be trained to assess the required strokes of the batsman.

Keywords: Cricket, batting posture, image processing, 3D image, artificial neural network

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921/D

Evaluation of anti-microbial activity of a combined extract formulated from *Azadirachta Indica*, *Cassia fistula* and *Nelumbo nucifera*

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Azadirachta Indica, *Cassia fistula* and *Nelumbo nucifera* are frequently found medicinal plants in Sri Lanka. Although the antimicrobial activity of these plants has been investigated individually, the effectiveness of combined extract has not been determined in previous studies. The aim of this study was to formulate a combined extract using *A.indica*, *C.fistula* and *N.nucifera* and evaluate its anti-microbial activity. Powdered leaves of *A.Indica*, *C.fistula* and flowers of *N.nucifera* were refluxed with ethanol and distilled water separately. Aqueous and ethanol extracts of each plant at different concentrations were tested against *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Candida albicans* using agar well diffusion method. Gentamycin and Clotrimazole were used as positive controls for bacteria and fungi respectively. As negative control, 1% DMSO was used. From aqueous and ethanol extracts of each plant, the extracts which showed highest antimicrobial activity was used to prepare the combined extract. Effective concentrations of selected extracts were determined against tested microorganisms. Combined extract was formulated with respective concentrations and the antimicrobial activity was determined. Ethanol and aqueous extracts of all three plants, concentrations ranging from 62.5–1000 mg/ml exhibited maximum antimicrobial activity against *S.aureus*. According to the half-maximal inhibitory concentration (IC₅₀) values of each extract against *S.aureus*, ethanol extract of *C.fistula* and the aqueous extracts of *A.indica* and *N.nucifera* were selected as the suitable extracts. According to the dose response curves final effective concentrations of ethanol extract of *C.fistula* and the aqueous extracts of *A.indica* and *N.nucifera* were 250 mg/ml, 1000 mg/ml and 250 mg/ml respectively and incorporated into the combined extract at a ratio of 1:4:1. Compared to the results of individual extracts, combined extract has shown enhanced antimicrobial activity against all tested organisms with a highest activity against *S aureus*. The diameter of zone of inhibition (mm) of combined extract against *S. aureus*, *P.aeruginosa* and *C.albicans* were 30±1 mm, 26±1 mm and 16±1 mm, respectively and the activity was comparable with the positive control. In conclusion, the synergism between the constituents or total sum of effects of the combination may cause enhanced growth inhibition of tested microorganisms. Further studies are pursued to formulate a herbal soap from combined extract.

Keywords: *Azadirachta Indica*, *Cassia fistula*, *Nelumbo nucifera*, combined extract, antimicrobial activity

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922/D

Phylogenetic reconstruction of Pacific Swallow clade of Genus *Hirundo*

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Swallows belong to the family Hirundinidae of the genus *Hirundo* which comprises of 14 recognized species. Pacific clade of Genus *Hirundo* consists of two group; *Hirundo neoxena* distributed in New Zealand and Australia and *H. tahitica* distributed in Tahiti islands. In addition, there is another group called *H. javanica* considered to be closely related to the Pacific clade. It is also assumed that *H. javanica* consists of seven subspecies; *H. j. domicola* (Sri Lanka and Western Ghats of India), *H. j. javanica* (Andaman, Myanmar, Thailand, Cambodia, Philippines), *H. j. namiyei* (Ryukyu Island and Taiwan), *H. j. frontalis* (New Guinea), *H. j. albescens* (New Guinea), *H. j. ambies* (New Britain) and *H. j. subfusca* (Solomon, Fiji and Tonga). Genetic studies of these birds are yet to be performed. Therefore, we carried out a detailed phylogenetic analysis using samples of previously assumed sub species of *H. javanica* to determine the phylogenetic status and evolutionary history. Maximum likelihood and Bayesian analysis using two mitochondrial gene regions, Cytochrome b (1,006 bp) and ND2 (1,023 bp) was performed. Resulted phylogenetic trees from both analyses have similar topologies with higher nodal support (higher bootstrap value and Higher Posterior probability value). *H. j. domicola* separates from other groups about 1.08 million years ago (MYA) and *H. j. subfusca* splits from its congeners about 2 MYA. Therefore, our study revealed that previously considered two subspecies, *H. j. domicola* (South India and Sri Lanka) and *H. j. subfusca* (Fiji) can be elevated to species level.

Keywords: Phylogeny, evolutionary history, pacific swallow, *Hirundo javanica domicola*, *Hirundo javanica subfusca*

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923/D

A comparative study on protease inhibitory activity of different varieties of *Vigna* species growing in Sri Lanka

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Proteases are important cellular components which are involved in the regulation of vital cellular mechanisms. However, their over expression or presence in higher concentrations leads to different human diseases. Therefore, protease inhibitors from natural sources have gained attention as potential therapeutic agents. The present study was designed to evaluate the trypsin inhibitory activity of the fresh mature seeds of different varieties of *Vigna unguiculate* and *Vigna radiata* which were collected from field crop research and development institute Mahailuppallama, Sri Lanka. Concentration gradient of (20%, 10%, 5% and 2.5%) crude protein extract of each variety was evaluated for trypsin inhibitory activity using 1% Hammerstein casein as the substrate. The maximum trypsin inhibitory activity showed by all tested varieties of *V. unguiculate* was greater than 75%, while it was less than 30% for all tested varieties of *V. radiata*. Among varieties of *V. unguiculate*, the highest trypsin inhibitory activity ($90.82 \pm 2.66\%$) was exerted by 20% extract of the variety called *MICP 01*. The other varieties named *Waruni*, *Dhawala* and *Bombay* indicated the maximum trypsin inhibitory activity of $85.70 \pm 1.48\%$, $77.19 \pm 2.69\%$ and $74.72 \pm 1.08\%$ respectively. Partial purification of *MICP 01*, indicated that the fraction precipitated by 60% ammonium sulphate contained the highest concentration of trypsin inhibitors and they are larger than 8kDa. Heat stability studies revealed that the Trypsin inhibitors present in *MICP 01* are unstable under high temperatures. The results of the present study revealed that different varieties of *V. unguiculate* possess a promising trypsin inhibitory activity which reflect their therapeutic potential.

Keywords: Proteases, trypsin, inhibition, *Vigna*

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924/D

Inconspicuous vocal repertoire of endemic Sri Lanka Bush Warbler (*Elaphrornis Palliseri*): A quantitative description of within-species variation in vocalization

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Many passerines possess extravagant vocalizations which often provide evolutionary advantages. Birds have evolved many variations in vocalization in order to withstand the associated costs. The current study focused on investigating intraspecific vocal variations in Sri Lanka Bush Warbler (*Elaphrornis palliseri*) which is a range restricted montane endemic to Sri Lanka. The vocal recordings were made in three locations in the central highlands; Galwaysland National Park, Horton Plains National Park and Hakgala Strict Nature Reserve using Telinga parabolic reflector containing a MKH 20-P48 omni directional RF condenser microphone and a PMD 661 MK solid state recorder. The sonogram analysis and statistical inferences were performed using Raven Pro 1.5.0 bioacoustics software program of the Cornell Lab of Ornithology, Friedman test and paired sample t-test, respectively. Key acoustic measurements reflecting temporal and frequency attributes in vocalization including the length of notes (in seconds), length of inter-note intervals (s) maximum frequency (Hz), minimum frequency (Hz) and Peak frequency (Hz) were analyzed. The vocal repertoire of Sri Lanka Bush Warbler consists of a single prominent call giving a metallic “*chwrip...chwrip...*” sound which is brief but sharp and high pitched. The vocal episodes exhibited a less complex structural organization which contains several brief consecutive notes separated by distinct pauses of varying lengths. The mean highest frequency behaves within a range of 15,000 Hz – 16,000 Hz while the range of mean lowest frequency is 1,900 Hz – 2,300 Hz. The mean peak frequency of each successive note lies between 6,000 Hz and 8,000 Hz. The mean duration of each note lasts for 0.1 s – 0.2 s and the mean durations of first two consecutive inter-note intervals are 3.4 s and 3.0 s, respectively. The peak frequency is significantly different ($P = 0.04$) among individuals while other frequency attributes including highest frequency ($P = 0.529$) and the lowest frequency ($P = 0.266$) are conserved. The temporal attributes including the length of notes ($P = 0.139$) and the lengths of the first two inter-note intervals ($P = 0.478$) also not varied among individuals. These results provide a deep descriptive analysis to describe inconspicuous vocalization of *E. palliseri*.

Keywords: Sri Lanka Bush Warbler, variations in vocalization, vocal repertoire

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925/D

Carbon sequestration of trees in urban green spaces of a metropolitan university: A case study from the University of Colombo, Sri Lanka

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Urban areas are responsible for majority of the global anthropogenic Carbon Dioxide (CO₂) emissions. Thus, the impacts of climate change are aggravated in urban landscapes. Urban green spaces mitigate the negative consequences of climate change by reducing CO₂ emissions. This study was conducted to estimate the species specific aboveground, belowground and total carbon stocks of trees within the green spaces of University of Colombo (Colombo 03) with the aim of estimating its carbon sequestration potential. Trees with a diameter at breast height (DBH) > 3 were recorded and identified. The DBH and height was measured. Aboveground biomass (AGB) was estimated as a product of stem volume and basic wood density by using an allometric equation. Basic wood density values were calculated for species with previously published wood densities at 12% moisture content, using a conversion factor of 0.828. For rest of the species, AGB was estimated following a generic allometric equation. The AGB of open grown urban trees were estimated as 80% of the calculated AGB values projected by forest derived allometric equations. Aboveground carbon stock was determined as 49% of the AGB, while belowground biomass was estimated using 0.2 root: shoot ratio for tropical regions. A total number of 1380 trees belonging to 141 of species and 48 families were recorded. Basic wood densities were calculated for 101 species. The species that showed the highest carbon sequestration was *Pithecellobium dulce* (125.41 t). The highest amount of carbon stocks was found in trees belong to family Fabaceae (245.73 t). Trees in 0-25 cm diameter range showed the lowest biomass storage whereas the highest biomass storage was showed by trees in >250 cm diameter range. The total carbon, aboveground and belowground carbon stocks were estimated to be 32.56 t/ha, 27.13 t/ha, and 5.43 t/ha, respectively. Large healthy trees estimated with greater carbon sequestration than small trees. The generic equation overestimated the carbon stock values compared to the estimations from wood density incorporated equation. Basic wood density is an important variable for predicting AGB in the absence of species-specific allometric equations.

Keywords: Urban green spaces, University of Colombo, aboveground and belowground carbon stocks, allometric equations

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Assessing intraspecific diversity in three *Syzygium* R.Br ex Gaertn. (Myrtaceae) species in Sri Lanka using morphological characters

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Genus *Syzygium* R.Br ex Gaertn. is one of the largest genera with the highest number of species in Sri Lanka. Two major local taxonomic treatments present contradictory views on present nomenclature; thirty-two species with twenty-five endemics by Kostermans and twenty-five species with thirteen endemics by Ashton in 1981, suggesting the necessity of revising current taxonomic status of the genus. The present study attended to assess the phenotypic variation of three selected *Syzygium* species in Sri Lanka. Two study groups were formed based on major morphological variations. The first study group consists of two-point endemic species *Syzygium fergusonii* collected from Knuckles, *Syzygium montisadam* from Adam's Peak and an unidentified *Syzygium* species collected from Morningside. The second study group comprised of *Syzygium turbinatum* collected from three populations Knuckles, Adam's Peak and Gongala. Five individuals were collected from each species per population. A total of twenty three quantitative and qualitative vegetative characters were measured. Characters were coded and Maximum Parsimony tree was constructed using Mesquite version 3.6.1 separately for two study groups. The species of study group 1 separated into two clades in the Maximum Parsimony tree. The most parsimonious tree has a tree length of 33 steps with consistency index of 0.968 and a retention index of 0.9749. The unknown *Syzygium* species and *Syzygium montisadam* formed one clade while individuals of *Syzygium fergusonii* formed the other clade. In the second study group, three populations of *Syzygium turbinatum* were separated into two main clades. The most parsimonious tree has a tree length of 42 steps with consistency index of 0.761 and a retention index of 0.814. Individuals of *Syzygium turbinatum* collected from Knuckles formed one clade whereas individuals from Morningside and Adam's Peak formed the other clade. The study revealed that the unknown *Syzygium* species is more closely related to *Syzygium montisadam* than to *Syzygium fergusonii*. Reproductive isolation arises from the biogeographical separation of the habitats could lead to the formation of new species or discrete lineages of existing species. *Syzygium turbinatum* populations collected from Knuckles may represent potential new species. The study recommends understanding true genetic diversity of selected species and taxa, considering molecular species delimitation and phylogenetic studies, a vital aspect of germplasm conservation of native and endemic taxa.

Keywords: *Syzygium*, species limits, vegetative morphological characters, Maximum Parsimony tree

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927/D

Managing the Cultural Landscape in Regional Development: A Case Study from Kegalle District, Sri Lanka

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The richness of cultural assets in Kegalle urges us to think of their preservation and longevity. However, with globalization, people are automatically moving to new technology and facilities for a comfortable life. Accordingly, various development activities are carried out to fulfil the needs of man. Physical planning activities will increase with the growing population; therefore, more and more land will be allocated for construction projects, road networks, and other physical planning purposes. Although humans need this development, the cultural landscape will also be impacted in various ways. The present study used GIS tools to identify the impact of current and proposed development projects on the tangible cultural landscape of Kegalle. Primary and secondary data of the study mainly focused on the geographical distribution of archaeological sites and current and future development projects of the Kegalle district. These data were gathered mainly through field observations and by consulting experts. In addition to cultural heritage sites, distribution data pertaining to land use, streams, roads, land reclamation, building structure and development projects were also gathered. These data were then processed using GIS tools to evaluate the impact of regional scape physical development on the cultural landscape in Kegalle. First, a Sensitive Area Map was developed based on the locations of the archaeological sites. In this map, 3 buffer zones were designed for each site based on current legal frameworks regarding cultural heritage preservation, and possible dormant cultural value of the sites. This map was compared with the distribution of selected physical development sites using GIS tools in order to generate vital information on risk prone areas based on intersects. The present study was able to generate a fully descriptive database of archaeological sites of Kegalle district, and 4 original maps containing information crucial for tangible cultural heritage preservation in the district; 1) Distribution map of archaeological sites, 2) Density map of archaeological sites, 3) Map of the impact of current development projects, 4) Map of the impact of future development projects. The study indicated that the cultural landscape as well as the monuments identified have a tendency to be affected by this development in Kegalle district. It is expected that the results of the study will help overcome identified possible problems and mitigate them, since the study also proposes several mitigatory measures to prevent further damage. The study further identified the crucial need to create and analyse a full-scale map covering culturally vulnerable locations in the whole of Sri Lanka in order to protect our cultural identity.

Keywords: Cultural landscape, regional development, preservation and mitigation, Kegalle, GIS

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928/D

Development of best fit models based on allometric equations to predict the clear bole height stem carbon content of *Lumnitzera racemosa* in Kadolkele and Rekawa mangrove forests

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Mangroves are highly productive intertidal ecosystems in tropical and subtropical regions and are very significant in carbon sequestration compared tropical forest ecosystems. The objective of the present study was to develop allometric equations to estimate the stem carbon content of *Lumnitzera racemosa* in Kadolkele and Rekawa mangrove forests. Kadolkele mangrove forest is a planted mangrove forest in the wet zone and Rekawa mangrove forest is a natural mangrove forest in the intermediate zone of Sri Lanka. Forty five trees of *Lumnitzera racemosa* were sampled from each mangrove forest. Stem core samples were obtained from each tree and their dry weights were measured. The organic carbon content of stem core samples was determined using loss on ignition method. This study used stem diameter at breast height (DBH), clear bole height of the stem (CBH), crown height (CH), total height (TH), leaf area (LA) of *Lumnitzera racemosa* to develop allometric equations to estimate clear bole height stem carbon content. For each site, 75% of data were used for model construction and 25% were used in model validation. Stepwise regression model with backward elimination was used to develop the best fit model to predict the clear bole height stem carbon content. MINITAB 14 statistical software was used in statistical analysis. Results showed that clear bole height stem carbon content of *Lumnitzera racemosa* can be determined using DBH and CBH. The best fit allometric equation of stem carbon content for *Lumnitzera racemosa* in Rekawa was $\text{Ln C} = -3.240 + 1.8877 \text{ Ln DBH} + 1.0334 \text{ Ln CBH}$ with a reliability of 96.3%. In Kadolkele, the best fit model was $\text{Ln C} = -2.207 + 1.326 \text{ Ln DBH} + 1.077 \text{ Ln CBH}$ with a reliability of 73.5%. The proposed method provides valuable insight to predict the stem carbon content of *Lumnitzera racemosa* using non-destructive method with sustainable approach. Furthermore, this method can be applied for other common mangrove species to estimate stem carbon content and those information will provide valuable insights to mangrove restoration programmes.

Keywords: Allometric equations, mangroves, stem carbon, Sri Lanka

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929/D

Development and optimization of a low-cost media for the mass cultivation of Actinomycetes species

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Actinomycetes species (spp) is a group of bacteria which offer an array of life saving antimicrobials in biopharmaceutical industry. Actinomycetes are informally categorized into the genera *Streptomyces*, *Frankia*, *Actinomyces* and *Nocardia*. Nutrient requisites for the growth and reproduction of Actinomycetes spp. are supplied by the culture media which maximize growth of the desired strains. Actinomycetes Isolation Agar (AIA) is the conventional selective media for the cultivation of a broad range of Actinomycetes. The aim of the present study is to develop an alternative media for the cultivation for Actinomycetes. This study is focused on the development of a novel culture medium containing readily available inexpensive nitrogen and carbon sources. Chicken feathers and waste bread were replaced as the nitrogen and carbon source respectively. Actinomycetes were isolated from the soil and cultured on the conventional media to compare the microbial growth. Macro and micronutrient contents were similar to the conventional media. Carbon and Nitrogen parameters were assessed in variable formulations to optimize the low-cost media (LCM). Biochemical tests were performed using the optimized compositions to confirm the growth of Actinomycetes. Growth rate was similar to that of the conventional media. The colony forming units (CFU) were obtained from the LCM and AIA. On average CFU of 2.67×10^8 was obtained on AIA while a CFU of 1.88×10^8 was obtained when grown on the LCM. The final pH of the low-cost media was 7 ± 0.2 before sterilisation. The outcome of this study was evident that the new medium facilitated a positive growth of Actinomycetes species in vitro conditions. Optimization of this medium was targeted to maximize microbial biomass yield and reduce the cost. However, further research is required in validating the media for Actinomycetes growth with molecular level confirmation.

Keywords: Actinomycetes species, Low cost media, Chicken feathers, Waste bread

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930/D

Seasonal, Spatial and Epidemic Characteristics of Dengue Vectors in a rapidly urbanizing hill country locale and its relationships with dengue cases and climate

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In Sri Lanka, dengue has emerged as the dominant infectious disease and its spread to cities such as Kandy city and its peripheral urban areas has driven its transmission. Akurana is one such suburb situated north of Kandy city with rapid urbanization. Characterizing the role of the dengue vectors and its seasonal, spatial and extreme variation is needed to model dengue risk. Our objectives were to investigate the relationship between the prevalence of the *Aedes aegypti* and *Aedes albopictus* mosquito species and the prevalence of dengue cases in the Akurana Medical Officer of Health (MOH) sub-district. We obtained entomological surveys and weekly case records from the Regional Malaria Office in Kandy and Central Provincial health offices for 2014-2019. The presence of dengue larvae of either *Ae. albopictus* or *Ae. aegypti* mosquitoes in water receptacles in various sites was recorded. Monthly averages of vector prevalence indices - Breteau Index (BI), Container Index (CI) and Premises index (PI) - showed a bimodal seasonality with peaks in March to May and November to December. *Ae. aegypti* was thrice as prevalent as *Ae. albopictus*. The *Ae. aegypti* mosquitoes showed lower prevalence than *Ae. albopictus* during March to May. Dengue cases in Akurana showed peaks in 2003, 2006, 2009, 2012 and 2017. The 2017 epidemic showed the highest peak with a total number of 356 dengue cases in the MOH area of Akurana as well as the rest of the country. The dengue cases correlated with *Ae. aegypti* with a time lag of around 1 to 20-days. During the epidemic of 2017, the averages of the vector indices were higher by 40 % than in the remaining year. *Ae. albopictus* was enhanced relative to *Ae. Aegypti* in the epidemic year 2017. The indices of PI, CI, BI showed a moderate but significant negative correlation between species (PI: -0.405, CI: -0.406, BI: -0.37, $p=0.05$). Correlation analysis was carried out with the dengue cases and weather the entomological data with a lag of a range of few months and significant relationships were established with the chi-squared test. This work has provided spatial and seasonal and epidemic characteristics of dengue species and its relationships with dengue incidence.

Keywords: Dengue, dengue vectors, climate, seasonality, epidemics

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931/D

Microplastics in commercial sea salts in Sri Lankan market

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Plastic is a ubiquitous pollutant, which mainly originates inland and mostly ends up in the ocean. They break up into micro-size particles (< 5mm) by ultraviolet light and mechanical wave forces and are referred to as Microplastic (MP), which have been detected in products such as seafood and sea salts. This study determined the presence of MPs in commercial sea salt in the Sri Lankan market for household consumption. Salt samples were dissolved in distilled water and the suspension was filtered through a 0.1 mm mesh. The residues were collected into a beaker and were subjected to wet peroxide oxidation using aqueous Fe (II) (0.05 M) and hydrogen peroxide (30%), below 75 °C. Density separation was performed using NaCl and MPs were extracted onto a membrane filter (0.45 µm) and enumerated using a dissecting microscope. Fourier transform infrared (FTIR) spectroscopy was used to identify polymer types. A generalised linear model (GLM) with a negative binomial distribution was used to determine whether the concentration of MP/kg varied by site of the saltern and type of salt. Of the 21 brands analysed; 11 and 8 were table and crystal salts, respectively. One rock-salt and one lab-grade NaCl sample were also examined. Eight and seven brands were derived from salterns in Puttalam and Hambantota respectively, and four imported brands. All the samples had MPs ranging from 20-193 MP/kg (average values; table salt = 58± 27 MP/kg; crystals = 47 ± 17 MP/kg; Puttalam = 55 ± 25 and Hambantota = 48 ± 21 MP/kg). MPs were predominantly present in the form of microfibrils (66%), followed by microparticles (21%) and microfilms (10%). Of the 23 types of polymers identified; polyethylene (18%), HDPE (14%) and resin dispersion (12%) were notable. The possibility of containing the above polymers in a salt brand was 71%, 53% and 47%, respectively. There was no significant difference in the concentration of MPs by site or type of salt (GLM; p>0.05). Results show that all the salt samples analysed had a high level of MPs and an understanding of health risks associated with salt consumption needs to be addressed.

Keywords: Microplastics, sea-salt, polymer type, plastic pollution

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932/D

Bycatch analysis associated with Sri Lankan Blue Swimming Crab (*Portunus pelagicus*) fishery using bottom set gillnet in Negombo Coastal Waters

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There is an increasing demand for Sri Lankan Blue Swimming Crab meat in international markets and it is one of the lucrative income sources in the fisheries sector. Negombo is one of the areas that is involved in the commercial Blue Swimming Crab Fishery (BSCF) in the Western part of Sri Lanka. Ecological impacts on the environment due to various fishing activities are a great concern today. Therefore, the present study focused on bycatch species associated with bottom set gill net fishery in Negombo coastal waters from April to November 2019. Carapace width (CW) of males and females of the landed crabs ranged from 7.28 cm-15.7 cm and 3.06 cm-15.8 cm, respectively. Range of weight of male and female crabs were from 22.45 g- 334.6 g and 23.0 g-275.35 g, respectively. There were thirty five (35) species recorded as bycatch species, comprising of bony fishes (31), cartilage fishes (2) and crustaceans (2), belonging to 7 orders and 22 families. Of the recorded species, *Dasyatis zugei*, *Dasyatis kuhlii* and *Lutjanus malabaricus* were prominent in the bycatch. Most of the species recorded as bycatch (77%) were immature. The observed mesh sizes were, 1.5, 2, 2.25, 3.25, 3.5, 4, 4.5, 6, 7 inches. Out of these. 3.5, 4.5 and 6 inches mesh sizes were most commonly used. Fishers set the gill net width different number, of net pieces (3-38) and the recorded fishing distance ranged from 1-10 km from the shore Fishers mostly used Outboard Fiber Reinforced Plastic (OFRP) boats (86.37%) and 14% of Theppam. Interviews conducted with fishermen indicate that 95% of fishermen were owners of the fishing crafts, while 5% of fishermen used fishing crafts of others. The common engine horse power used was 25 hp (59%) and other engine horse power used were 9 hp (5%), 15 hp (5%) 30 hp (5%) and 40 hp (14%) However, present study pointed out that it is necessary to take steps to reduce the catch of immature bycatch species using suitable fisheries management actions.

Keywords: Blue Swimming Crab, fishery, bycatch, coastal

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933/D

Fisheries and biological aspects of Devil Rays landed in Negombo Fishery Harbor

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Mobula rays are commonly known as devil rays. They belong to Family Mobulidae under Class Chondrichthyes. Though there are 9 members recorded around the world, only 5 members can be seen in the Indian Ocean. While some countries land them as target fishery, some other countries unload them as a by-catch. Mobula gill plates have well established market demand in the world for Traditional Chinese Medicine. Mobuia rays are numerically low due to high age at maturity, slow growth, low fecundity, and long gestation period. These devil rays were categorized under CITES appendix 11 in 2016. A study on abundance of mobula species in the Indian Ocean was conducted from April to November 2019, landed in one of the major fishery harbors in Sri Lanka; Negombo. Biological and fisheries data were collected from landed mobulids by examining the species and also 147 boat skippers. The life stages of each species were categorized using disc width of the mobulid. Of the recorded species *Mobula japonica* (43%) were the most abundant species, *Mobula kuhlii* and *Mobula tarapacana* recorded 38% 19% respectively. Those 3 mobula species were landed from both Inboard Multi-day and Outboard fiber reinforced plastic boats, using gillnet as a major fishing gear. The most common gill net mesh size ranged from 13.6-16 cm. Of the landed devil rays, the highest juvenile percentage was shown by *M. japonica* (48%), he highest sub- adult percentage was shown by *M. tarapacana* (52%), and the highest adult percentage was shown by *M. kuhlii* (52%). The recorded maximum disc width for all Mobula species had declined compared to the previous studies. The interview conducted with boat skippers indicated that mobula rays were landed more than the manta rays. Therefore, this study might be helpful for policymakers to implement appropriate conservation measures to protect the devil rays around the Indian Ocean.

Keywords: Devil rays, mobula, conservation, fishery, Indian Ocean

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934/D

Spatial and temporal variation of ambient SO₂, NO₂ and dust fall in the vicinity of Lakvijaya coal power plant in Sri Lanka

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The studies on environmental monitoring near coal power plants are necessary to monitor the changes in environmental parameters. The present study was carried out to assess the spatial and temporal variation of ambient SO₂, NO₂ and dust fall in an area between 500 m and 3 km from Lakvijaya coal fired power plant in Kalpitiya Divisional Secretariat Division from April to September 2019. Sampling sites included eight (08) sampling locations in the study area and a reference site in a less polluted area in Mathurankuli. Ambient SO₂ and NO₂ levels at each site were determined using “Ogawa” passive air samplers whereas dust fall was determined as described by Kornelius and Kwata (2010). The meteorological parameters were collected from the Department of meteorology. Data were analyzed using MINITAB 17. The mapping of spatial and temporal variation of air pollutants were done using Inverse Distance Weighing (IDW) surface interpolation of geographical information system (GIS). The highest SO₂ ($7.09 \pm 1.80 \mu\text{g m}^{-3}$) was shown from S1 while the highest NO₂ ($5.41 \pm 1.00 \mu\text{g m}^{-3}$) and dust falls ($477.00 \pm 249.00 \text{ mg m}^{-2} \text{ day}^{-1}$) were shown from S5. The highest concentration of SO₂ on temporal scale ($8.83 \pm 1.50 \mu\text{g m}^{-3}$) was observed from the month of July while the lowest concentration of SO₂ ($1.43 \pm 0.49 \mu\text{g m}^{-3}$) was observed from the month of September. The highest concentration of NO₂ ($4.68 \pm 0.74 \mu\text{g m}^{-3}$) was observed from the month of September while the lowest concentration of NO₂ ($1.52 \pm 0.22 \mu\text{g m}^{-3}$) was observed from the month of June. The results further revealed that the ambient NO₂ and SO₂ levels were within the permissible levels. During south west monsoon period, S5 and S4, the closest sites to the power plant showed the highest dust fall rate which were 477.00 ± 249.00 and $340.00 \pm 157.00 \text{ mgm}^{-2} \text{ day}^{-1}$ respectively. The Lakvijaya coal fired power plant found to be a source of studied atmospheric pollutants in the study area and it is recommended to carry out future research to find out the relative contribution of the power plant on SO₂ and NO₂.

Keywords: SO₂, NO₂, dust fall, coal power plant, “Ogawa” passive air samplers

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935/E1

Temperature effect on Al-ZnO/n-In₂S₃/p-CIGS thin-film solar cells using 1D-SCAPS simulator

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In this study, we report the influence of temperature on the CIGS-based (Cu(In, Ga)Se₂) thin-film solar cells in the temperature range 298 K to 400 K. We propose the Al-ZnO/n-In₂S₃/p-CIGS structure as an alternative to the conventional CIGS-based solar cells. The main objective of this study was to analyze the influence of temperature on the newly proposed device structure. The solar cell performance was investigated by its solar cell parameters, viz. short circuit current density (J_{sc}), open-circuit voltage (V_{oc}), fill factor (FF), and efficiency ($\eta\%$) using 1D-SCAPS software. As the temperature increased, the cell's performance showed a downward trend, especially efficiency dropped from 22% to 14% as temperature rise from 298 K to 400 K.

Keywords: p-CIGS, In₂S₃, Al-ZnO

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936/E1

Self-cleaning, hydrophobic, antifogging, TiO₂ coating for photovoltaics solar panels

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Electricity is the most essential energy form in the modern world because electrical energy can be easily converted into any other form as desired. There are several energy sources of electricity, among which renewable energy sources are foremost and used to fulfill energy requirements. Solar energy is an abundant resource that can be used for the above task with simple conversion devices with little attention on maintenance. The easiest way to use energy from the Sun is to convert light energy into electrical energy using photovoltaic (PV) cells. Many efforts have been committed to the development of novel technologies associated with photovoltaic cells with the aim of increasing the energetic yields of such green energy devices. The efficiency of solar devices can be greatly reduced by dust and bird faeces collecting on top of the panels. Furthermore, solar panels do not operate at full capacity in the morning due to water droplet deposition (fogging) on top of panels during the night. This study is mainly aimed to find a sustainable solution for these unveiled problems. Addressing the above problems at the manufacturing stage of the devices to minimize them with optimized conditions is the main goal of this study. Hydrophobic surfaces help to remove dust particles from the top of the solar panel. Titanium dioxide (TiO₂) particles can be deposited on top of the solar panels as they can act as a protecting layer toward mechanical aggressions and assures high anti fogging features. Since titanium dioxide (TiO₂) is a semiconductor material, it has photo catalytic (self-cleaning) ability. The TiO₂ film applied on glass plates exhibits enhanced non-adhesion capacity of a dust particle accompanied with its hydrophobic characteristics. Under the optimized condition of the film, the water droplets make a contact angle greater than 90° with the glass plate. The hydrophobic characteristic of the film repels water away from the glass surface. Furthermore, the coating can be used to protect panels from bird fouling and other heavy soiling sticking onto the glass surface due to its own non-adhesive characteristics.

Keywords: Hydrophobic, self-cleaning, antifogging, PV efficiency

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937/E1

Did the COVID-19 curfews or seasonal wind changes drive the drop in fine air-borne particulate matter in Colombo after 20 March 2020?

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Due to the COVID-19 pandemic, a curfew was imposed in Colombo from March 20 to late May. The associated shutdown of traffic, many industries and other activities gives a controlled experiment for an analysis of the characteristics of sources of air pollution. There have been claims that the air pollution dropped solely due to the curfew; however, the drop off can also be attributed to the seasonal reversal in wind directions. Our objective is to seek to assess the relative roles of the curfews and the wind reversals by analyzing observations of the air quality index PM_{2.5} (particulate matter sized less than 2.5 μm). We obtained the air quality measurements from the monitoring stations maintained by the Central Environment Authority (CEA in Battaramulla), US Embassy (USEM in Colombo-7) and also that of our organizations in Colombo 7. The USEM has an EPA certified instrument and its hourly data were characterized from September 2017 to May 2020. If the average for the week before and after March 20 is considered, the drop observed ranges up to 20-30%. However, this drop around March 20, 2020 was similar to that in 2018 and 2019. As there was no curfew in previous years, the drop in air pollution in Colombo is attributable largely to the seasonal change in wind directions in early April with a secondary contribution from the curfew. Even if 2,3 or 4 weeks before and after March 20 were considered, the drop in 2020 is proportionately similar to that in 2018 and 2019. The drop in air quality between March and May occurs because, the wind directions change coming from North-East to South-West and therefore there is a prospect of polluted air reaching Sri Lanka from the Indian sub-continent rather than the relative pristine air over the Indian Ocean.

Keywords: Particulate matter, COVID-19 impacts, seasonality of air pollution, PM_{2.5}

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Design and implementation of Low Drop Diode Equivalent (LDDE) circuits for piezoelectric energy harvesting

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Piezoelectric energy harvesting is a way of harvesting energy from ambient vibrations. One of the major limitations of existing energy harvesters is their interface circuitry. Interface circuitry is the one that connects piezoelectric generator output to a load by converting available AC input to usable DC form. Traditional diode rectifiers are not feasible due to the use of micro volt level energy harvesters. Even though it is an efficient circuit in higher energy levels, forward conduction drop makes it less efficient. Making an efficient rectifier is a challenging task in these conditions. To address the above problem, MOSFETs (Metal Oxide Semiconductor Field Effect Transistor) are used instead of silicon diodes since MOSFETs have a very low resistance in triode region. This property of MOSFETs are used in this study. By allowing MOSFET to operate in triode region, four diodes in the bridge of conventional rectifier is replaced by four MOSFETs in passive MOSFET rectifier. In active MOSFET rectifier, a comparator is used to enhance the efficiency. This research work presents the methodology of designing and implementation of low drop diode equivalent (LDDE) circuits for piezoelectric energy harvesting. In this work, three different rectifiers are investigated by simulations and experiments. They are, silicon diode bridge rectifier, passive MOSFET bridge rectifier and active MOSFET bridge rectifier. The efficiency of the standard conventional bridge rectifier is compared with the passive full wave MOSFET rectifier and the active full wave MOSFET rectifier. Efficiency of the conventional bridge rectifier is 42.04%, full wave passive MOSFET rectifier is 54.49% and full wave active MOSFET rectifier is 66.09%. Through simulation results and the measured data, it was able to verify the efficiency of MOSFET based rectifiers are better than diode based rectifiers.

Keywords: Full wave bridge rectifiers (FBRs), low drop diode equivalent (LDDE), piezoelectric devices (PZDs), synchronous rectifiers, vibration energy harvesting

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939/E2

Study of the structure and morphology of “bagasse” fibre produce from Sri Lankan sugarcane

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Sugarcane is used worldwide as a feedstock for ethanol and sugar production. Bagasse is the dry fibrous residue that remains after sugarcane stalks are crushed to extract their juice, which corresponds to about 25% of the total weight and contains 60% to 80% of carbohydrates. The sugarcane bagasse is also mainly formed by two carbohydrate fractions, cellulose and hemicellulose, embedded in a lignin matrix similar to other plant cell walls. The structure and the morphology of bagasse fibre produced from Sri Lankan sugarcane have been investigated using FTIR spectroscopy, XRD and SEM. Morphological studies on fibre surface using SEM analysis revealed that it has a rough surface with parallel filaments on the surface of the fibre. FTIR spectroscopic data revealed the presence of functional groups at 3336 cm^{-1} (O-H stretching), 2916 cm^{-1} (C-H stretching), 1033 cm^{-1} (C-O stretching), 1728 cm^{-1} (C=O stretching), 1159 cm^{-1} (C-O-C and C-O stretching) and $1500\text{--}1600\text{ cm}^{-1}$ (C-C aromatic skeletal vibrations) which can be attributed to cellulose, hemicellulose and lignin. The XRD pattern clearly indicated the presence of both crystalline and amorphous regions and a crystallinity index of 54 in the crystalline region. They exhibited mainly the cellulose structure with the intensity peak at $2\theta = 22^\circ$ and a shoulder in the region of $2\theta = 14^\circ\text{--}17^\circ$. Furthermore, FTIR, XRD and SEM data revealed the similarity of Sri Lankan sugarcane bagasse fibre as in other lignocellulosic fibres reported elsewhere and with bagasse fibre produced in other countries. These similarities confirm the possibility of using Sri Lankan sugarcane bagasse fibre for value added applications such as manufacturing of building materials, nano cellulose, bio charcoal, etc which would result in increased revenue and job opportunities like in other countries.

Keywords: Bagasse, Fibre, FTIR, SEM, XRD

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940/E2

Optimization of a western blot-based extracellular signal-regulated kinase 1/2 (ERK1/2) activation assay to detect sphingosine 1-phosphate receptor 1 activation in mammalian cells

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G protein-coupled receptors (GPCR) are the target of more than 30% of the approved drugs in use. Precise understanding of ligand-GPCR interactions and the subsequent signal transduction pathways is pivotal in drug discovery and development. Sphingosine 1-phosphate receptor 1 (S1PR1) is a class A GPCR that mediates vital physiological functions such as early vascular, nervous and immune system development and pathophysiological processes such as carcinogenesis. Hence, an assay to determine potential drug candidates for S1PR1-modulated diseases would be of immense biomedical value. Extracellular signal-regulated kinase 1/2 (ERK1/2) are ubiquitously expressed serine/threonine kinases that have shown significant involvement in mediating S1PR1-regulated processes mentioned above. Furthermore, activated/phosphorylated ERK1/2 (phospho-ERK1/2) have depicted a direct correlation to the activation of S1PR1 independent of the activated G α subunit, making it a reliable endpoint readout. In contrast, the previously established assays for cAMP activation, IP3 and Ca²⁺ mobilization, are dependent on the type of G α subunit, and are upstream in the signaling cascade to use in endpoint assays. Hence, this research is focused on the optimization of a western blot-based ERK1/2 activation assay, to detect the activation of human S1PR1 with its physiological ligand sphingosine 1-phosphate using C6 rat glioma cells that overexpress S1PR1 tagged with green fluorescent protein (GFP) (C6-S1PR1 cells). This assay will then be used to delineate novel S1PR1-specific intra-cellular signal transduction pathways leading to ERK1/2 activation. The activation of S1PR1 is assessed by detecting the level of phospho-ERK by Western blotting with monoclonal antibodies that are specific for phospho-ERK. First, overexpression of S1PR1 in C6-S1PR1 cells was confirmed by fluorescence detection of the GFP tag at 509 nm. Next, RT-PCR with S1PR1-specific primers was carried out to detect the over-expression of the receptor at mRNA level which will require further optimization. ERK1/2 activation was induced by FBS in C6-S1PR1 cells and the cell lysates from the above experiment were used in the optimization of SDS-PAGE using Coomassie staining. A resolving gel composition of 12% was finalized to be used in the assay.

Keywords: ERK1/2, mammalian cell culture, GPCR, S1P, signaling assays

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941/E2

Assessing the levels of Cr, Cd and Pb in biotic and abiotic components of Kolonnawa marsh, Sri Lanka

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Heavy metal pollution has become an issue of global concern. Aquatic ecosystems have a high potential to accumulate heavy metals due to the discharge of industrial and domestic effluents. This situation is undesirable and a threat to aquatic animals and plants. This study assessed the Cr, Cd and Pb levels in selected abiotic and biotic components of the Kolonnawa marsh, Sri Lanka. Samples of water, sediment, leaves (*Annona glabra*), snails (*Planorbella trivolvis*) and fish (*Oreochromis niloticus* and fingerlings) were collected from five locations. At each location five random samples were collected. Fish caught from the area for consumption were used. Sampling was done during March to November 2019. The collected samples were subjected to wet digestion and analyzed using microwave plasma atomic emission spectroscopy. Cr, Cd and Pb were detected in several abiotic and biotic components of the marsh. The highest level of Cr and Pb were found in sediment (58.47 ± 2.83 mg/kg and 6.17 ± 0.94 mg/kg, respectively) whereas highest Cd level was found in snails (7.38 ± 0.97 mg/kg). The results showed a trend in accumulation of heavy metals as; water < leaf < snail < fish < sediment. This findings show that Cr level in water, leaves and fish are a potential risk according to permissive levels declared by the Central Environmental Authority, Sri Lanka for water (0.002 mg/l) and WHO levels for consumption for leaves and fish (leaves: 1.30 mg/kg, fish: 12.00 mg/kg). The positive and significant correlation between Cr and Pb levels highlight the similarity with respect to the sources of the two metals. Findings of this study indicate that immediate steps are necessary to control discharge of contaminated effluents into the Kolonnawa marsh.

Keywords: Heavy metals, Kolonnawa marsh, biotic, abiotic

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Fatty acid profiles of selected widely consuming traditional rice varieties (*Oryza sativa* L.) in Sri Lanka

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Rice contains many monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs) which are beneficial to human health. Sri Lanka has a long history of rice cultivation and it is reported to have more than 1000 traditional rice varieties (TRVs). However, at present only few TRVs are popular. This study evaluates fatty acid (FA) profiles of ten selected, widely consumed, pigmented and non-pigmented TRVs (Hearth Banda, Pachchaperumal, Kurulu thuda, Rathel, Kahawanu, Kalu Heenati, Suwadel, Murungakayan, Madathawalu and Pokkali) in Sri Lanka. Fat was extracted from whole grain rice flour by Soxhlet fat extraction, derivatized to fatty acid methyl esters and analyzed by gas chromatography-flame ionization detector (GC-FID) method. Results showed statistically significant ($p < 0.05$) differences in FA profiles among the tested rice varieties. The major FAs, palmitic (C16:0), oleic (C18:1), and linoleic (C18:2) acids ranged from 3.80 ± 0.06 – 6.30 ± 0.11 , 8.07 ± 0.01 – 11.85 ± 0.03 and 6.39 ± 0.08 – 9.80 ± 0.10 mg/g of rice on dry basis, respectively. Total MUFA, PUFA and saturated FA (SFA) contents varied from 8.35 ± 0.01 – 12.18 ± 0.03 , 6.65 ± 0.07 – 10.13 ± 0.10 and 4.40 ± 0.07 – 7.09 ± 0.13 mg/g on dry basis, respectively. The highest quantities of MUFAs, PUFAs and essential FA, linoleic were found in white rice variety, Rathel. On the other hand SFA, which is considered as unhealthy was also highest in Rathel and lowest in the red rice variety, Murungakayan. All the tested varieties have shown a PUFA/SFA ratio higher than 0.4 the minimum value recommended for a healthy diet and was highest (1.63 ± 0.10) in the white rice variety, Kahawanu. Generally whole grains of studied TRVs can be considered as a nutritious and healthy diet. Rice varieties with healthy and nutritionally important FA profiles could be used as raw materials for developing functional food products and as genetic sources for breeding new varieties with high nutritional qualities. Additionally, data generated may contribute to the development of national food composition database in Sri Lanka.

Keywords: Fatty acid profiles, traditional rice, pigmented rice, non-pigmented rice, whole grain rice

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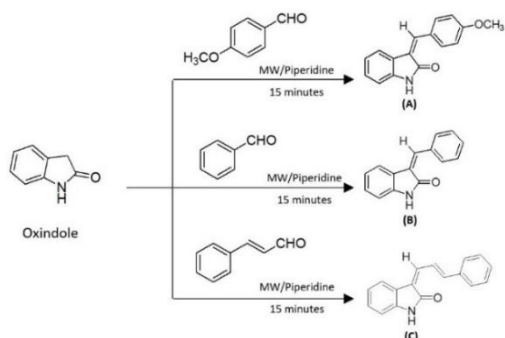
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Microwave assisted synthesis and investigation of antifungal activity of 3-substituted indolin-2-ones

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Microwave Assisted Drug Synthesis (MADS) is considered as promising green synthesis method of drug discovery which can use to complete an organic reaction within short period of time. The dielectric heating procedure found in microwave radiation has improved the atom-economy, E-factor and product purity. Oxindole scaffold is a ubiquitous pharmacophore found in variety of pharmaceutical and biological active compounds. 3-substituted indolin-2-ones containing oxindole nucleus are credited to have extensive range of biological applications. Here we report microwave-assisted green synthesis of 3-substituted indolin-2-ones from oxindole and naturally occurring aldehydes in the presence of piperidine as a catalyst. A mixture of oxindole (0.1 mmol), aldehyde (0.1 mmol) and piperidine in 5 ml ethanol was irradiated inside the microwave oven at high power (900 W) for 15 minutes to obtain targeted 3-substituted indolin-2-ones (A, B, C) in scheme 1. The products were obtained in high yield and the completion of the reaction was confirmed by thin layer chromatography (TLC). It is reported that conventional method takes 3-16 hours to complete the same reaction with sufficient yield. Nuclear Magnetic Resonance (¹H NMR) and Fourier-Transform Infrared (FTIR) spectroscopic data confirmed the formation of products A, B and C. The compounds were tested for *in vitro* antifungal activity against *Candida albicans* (ATCC 10231) and *Candida glabrata* (ATCC 90030) using well diffusion assay. The mean zone of inhibition (ZOI) of compounds A, B and C (250 µg/ml concentration) against *Candida albicans* and *Candida glabrata* were 20.0 mm, 20.0 mm, 19.3 mm and 14.6 mm, 14.6 mm, 11.6 mm respectively. The mean (ZOI) of positive control miconazole against *Candida albicans* and *Candida aglabrata* was 11.3 mm and 24.6 mm respectively. The results suggest that all synthesized 3-substituted indolin-2-ones possess significant antifungal effect against *Candida albicans* and *Candida glabrata*. Microwave assisted synthesis is a rapid efficient and environmentally safe green synthetic method in the synthesis of biomedical significant oxindole derivatives.



Scheme 1: Synthetic pathway for 3-substituted indolin-2-ones

Keywords: Microwave assisted, oxindole, 3-substituted indolin-2-ones, anti-fungal

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944/E2

Development of a new slow release fertilizer system using ammonium nitrate incorporated *Excoecaria cochinchinensis* 'Variegated' plant bark particles

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Fertilization improves efficiency and enhances the quality of product recovery in agricultural activities. Nitrogen (N), phosphorus (P), and potassium (K) containing fertilizers are often seen as boosters of modern agriculture. Among these, nitrogen containing fertilizers are considered to be more important. However, the pollution that happens by excessive or improper fertilization can lead to environmental and health risks. Slow release fertilizers are used to reduce the overall amount of plant nutrients introduced into the environment and energy consumption for fertilization. The aim of this study is to develop a new slow release fertilizer system using the *Excoecaria cochinchinensis* 'Variegated' (Chinese Croton or Firestorm) plant bark particles. Experimental results showed that the level of nitrogen content in different parts of the plant varied from 3990 mg kg⁻¹ to 8250 mg kg⁻¹. It was found that phosphorous content in the plant varied from 64 mg kg⁻¹ to 531 mg kg⁻¹ and potassium content varied from 1830 mg kg⁻¹ to 7290 mg kg⁻¹. The fertilizer system was developed from Chinese Croton bark particles (<5 mm) after treating with saturated ammonium nitrate (NH₄NO₃) solution. Nitrogen content of the plant bark particles was increased by 241% after saturation with ammonium nitrate. The release patterns of nitrogen from ammonium nitrate incorporated bark particles (10 g) in a sandy loam type soil matrix (200 g) were studied using columns with deionized water (pH 6.5). Parallel studies were carried out to evaluate the leaching patters of a commercially available nitrogen fertilizer sold in Sri Lanka using soil leaching columns. Control reactions were carried out with ammonium nitrate in a soil matrix and soil matrix alone. Each analysis was carried in triplicate. According to the results, within 24 hours more than 20% of nitrogen from ammonium nitrate and more than 45% of nitrogen from the commercially available fertilizer were eluted in the soil matrix given. However, after 15 days, the eluted amount of nitrogen was recorded as only 12% from that NH₄NO₃ incorporated Chinese Croton bark particles. Therefore, Chinese Croton bark particles can be considered as a potential nitrogen fertilizer carrier for the development of a new slow release fertilizer system.

Keywords: Ammonium nitrate, Chinese Croton, nitrogen, slow release fertilizer

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945/E2

Chemical composition and anti-diabetic properties in leaves of accession of cinnamon (*Cinnamomum zeylanicum*) Sri Wijaya and Sri Gemunu

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Cinnamomum zeylanicum is an evergreen tropical tree which is proven to have hypoglycaemic properties. Proanthocyanidins, which are phenolic compounds belonging to the class of flavonoids present in cinnamon are considered as the main bioactive component which imparts a hypoglycaemic effect. Although oral hypoglycemic synthetic drugs can achieve this, synthetic drugs cause several side effects on human health. Hence, the purpose of this study was to investigate natural herbs that have fewer side effects for managing diabetes. Phytochemicals that are responsible for the anti-diabetic properties in two accessions of *Cinnamomum zeylanicum* leaf, known as Sri Gemunu and Sri Wijaya, were tested for the hypoglycemic effect. Out of the three extraction methods; ethanolic extraction, hot water extraction and pressurized hot water extraction, ethanolic extraction showed the highest extraction yield. The yield of Sri Gemunu ethanolic extract was 6.20 % w/w and yield of Sri Wijaya ethanolic extract was 9.9% w/w. Ethanolic extracts of the two accessions were tested for total phenolic content (20.60 ± 0.01 mg gallic acid eq.g⁻¹ of Sri Gemunu, 6.07 ± 0.01 mg gallic acid eq.g⁻¹ of Sri Wijaya), total flavanoid content (72.02 ± 0.02 mg quercetin eq.g⁻¹ of Sri Gemunu, 23.59 ± 0.02 mg quercetin eq.g⁻¹ of Sri Wijaya), total proanthocyanidin content (0.60 ± 0.05 g catechin eq.g⁻¹ of Sri Gemunu, 0.15 ± 0.05 g catechin eq.g⁻¹ of Sri Wijaya) and DPPH radical scavenging activity (IC_{50} 58.18 \pm 2.53 μ g/mL of Sri Wijaya, 69.60 \pm 5.48 μ g/mL of Sri Gemunu). GC-MS analysis and HPLC analysis indicated that both accessions were rich in eugenol and cinnamaldehyde. According to the results of the study, ethanolic extract of leaves of Sri Gemunu *Cinnamomum zeylanicum* accession displayed significant amounts of phytochemicals that are related to the anti-diabetic properties compared to the leaves of Sri Wijaya.

Keywords: *Cinnamomum zeylanicum*, ethanolic extraction, hypoglycaemic, Sri Gemunu accession, Sri Wijaya accession

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946/E2

Synthesis of a bifunctional chitosan derivative and its applications in removal of metal ions in aqueous solutions

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Chitosan, one of the most well studied biomaterials, has been widely employed for several environmental applications as an efficient natural polymer ligand. Owing to its unique properties, chitosan shows good metal binding properties towards various metal ions. In order to increase the selectivity and adsorption capacity towards metal ions, chemical modifications with the introduction of functional groups have been carried out much extensively thereby producing various chitosan derivatives. The present work focuses on two such monofunctional derivatives, namely carboxymethyl chitosan (CMC) and ethylenediaminetetraacetic acid chitosan (EDTA-CS), which have been studied as excellent adsorbents for various metal removal purposes. The main objective of this research study was to synthesize a new bifunctional chitosan derivative, namely ethylenediaminetetraacetic acid carboxymethyl chitosan (EDTA-CMC), by attaching both carboxymethyl and EDTA functional groups on to the polymer backbone and thereby enhancing the metal binding properties furthermore. Bifunctional derivative synthesis was carried out by combining the procedures of CMC and EDTA-CS synthesis. Both CMC and EDTA-CS were synthesized according to previous work for the comparison purpose. Newly synthesized EDTA-CMC derivative was characterized qualitatively by Fourier Transform Infra-Red (FT-IR) Spectroscopy and Thermo Gravimetric Analysis (TGA). According to TGA, thermal stability of derivatives was in the order of EDTA-CMC > EDTA-CS > CMC. Adsorption properties of EDTA-CMC were investigated with Cu^{2+} , Co^{2+} , Mg^{2+} and the results revealed that EDTA-CMC is a more suitable candidate than CMC and EDTA-CS for the removal of Cu^{2+} . Metal uptake by EDTA-CMC was almost 100% in 100 ppm, 200 ppm and 300 ppm Cu^{2+} solutions with an adsorbent dose of 5 mg and for a contact time of 4 hours.

Keywords: Polymer ligand, chitosan derivatives, metal adsorption

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947/E2

Analysis of major carotenoid pigments present in leaf extract of Sri Lankan variety of *Clausena indica*

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Clausena indica, or “mee-gon karapincha” which belongs to the family Rutaceae is a valuable plant grown in Sri Lanka, India and other Asian countries. It grows as a shrub or a small tree depending on the different environmental conditions. Due to its great medicinal properties, *C. indica* is used in Ayurvedic medicine practices not only in Sri Lanka but also in other Asian countries as well. Secondary metabolites such as phenols, flavonoids, alkaloids and carotenoids that are found in many medicinal plants are reported to be potent free radical scavengers and possess antioxidant properties. Therefore, the major carotenes, xanthophylls and chlorophylls present in the acetone extract (partitioned into petroleum ether) of the leaves of *C. indica* were evaluated in this study by using the High-performance Liquid Chromatography (HPLC) on a reversed phase column with a UV-visible photodiode array detector (PDA). The detection of carotenoid peaks was confirmed by their retention times, the position of the absorption maxima (λ_{max}) and their spectral fine structures. Xanthophylls (oxygenated derivatives of carotenoids), carotenes (hydrocarbon carotenoids) and chlorophylls are the three different pigments identified in the Sri Lankan curry leaves species, *C. indica*. The major xanthophyll identified by the *C. indica* leaf extract was lutein which consists of more than 22% of the total carotenoids and chlorophyll content. Neoxanthin, another xanthophyll was detected in minor quantities. Chlorophyll a and b were identified with an area percentage of nearly 55% and being the most abundant pigment out of the three pigments identified in this study. The major carotene identified in leaf extract of *C. Indica* is β -carotene. Appearance of a peak in the UV-vis absorption spectra for carotenoid eluted at 14.817 min indicates that the *cis*-lutein is also present in minor quantities in the leaf extract of *C. indica*. This study provides an identification of important plant pigments present in leaf extracts of *C. Indica* which could be the contributory factor for the pharmacological activities present in *C. indica*.

Keywords: Carotenoid, chlorophyll, HPLC chromatogram

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Determination of Losartan level in human blood by HPLC

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Hypertension is a serious medical condition that significantly increases the risk of heart, brain, kidney and other diseases. Hypertension is one of the major causes of premature death worldwide. Losartan, the potassium salt of 2-n-butyl-4-chloro-hydroxymethyl-1-[(2-(1H-tetrazol-5-yl) biphenyl-4-yl) methyl] is a potent, orally active and highly selective anti-hypertensive agent widely used in Sri Lanka for treatment of hypertension. Losartan is widely prescribed by the physicians due to simple dosing regimens and their synergistic antihypertensive action, improved hypertension control and fewer dose-dependent side effects. Overdose with Losartan is rare but, in some cases, it may result in serious consequences. Thus, in forensic applications it is important to quantify the Losartan level in human blood to verify a person suffering from an over-dose. Therefore, a simple method is described here which uses liquid-liquid extraction combined with a simple HPLC method for the identification and quantification of Losartan in blood. A simple high-performance liquid chromatography method has been developed for the determination of Losartan in human blood. The method was validated by a 250 mm x 4mm ID packed with LiChorspher® 100 RP - 18e, 5 µ (particle size) column. Using a UV detection. The mobile phase consisted of Methanol: 0.05% O-Phosphoric acid in Type A water (65:35). UV detection was performed at 225 nm. The calibration curve of Losartan was linear between the concentration range 200-1000 (ng/ml) and analytes were extracted from blood samples by Liquid-Liquid Extraction (LLE). The limits of detection (LOD) and quantification (LOQ) of Losartan were 100 and 200 (ng/ml), respectively. The method was successfully applied for the determination of Losartan in human blood for some reported cases.

Keywords: Hypertension, forensic, Losartan, Angiotensin – II receptor, percentage recovery

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Analysis of crude extracts of *Crateva adansonii* (Lunuwarana) bark on renal calculi

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Plants and plant-derived products play a major role worldwide as traditional remedies for various diseases as those are known to be with lesser side effects when compared to western medicines. There are wide varieties of herbal drugs that are used as prophylactic and curative agents which can be administered as adjunct therapies accompanied with modern medicines but the mechanism of action of these drugs are unclear. Stone formation of urinary tract is a very common disease. Renal calculi mainly consist of $\text{Ca}_2\text{C}_2\text{O}_4$. Dried bark of *Crateva adansonii* has been used as a powder or decoction in traditional medicine. It was found that this plant contains alkaloids, tannins, saponins, anthraquinones, etc. The objective of this study was to evaluate the effect of crude extracts of *Crateva adansonii* stem bark on renal calculi. *Crateva adansonii* bark extracts were prepared using three different solvent systems (methanol, ethyl acetate and 50% methanol). Activities of crude extracts dissolved in distilled water were tested with pure calcium oxalate and renal calculi under *in-vitro* conditions. Calcium oxalate concentration was determined by titration with standardized KMnO_4 solution. Calcium oxalate solubilities in aqueous solutions of methanol, ethyl acetate, 50% methanol crude extracts and distilled water were $9.18 \times 10^{-5} \text{ mol dm}^{-3}$, $9.52 \times 10^{-5} \text{ mol dm}^{-3}$, $2.29 \times 10^{-4} \text{ mol dm}^{-3}$, $1.26 \times 10^{-4} \text{ mol dm}^{-3}$, respectively. Solubility of renal calculi in aqueous solutions of methanol, ethyl acetate, 50% methanol crude extracts and distilled water were $1.50 \times 10^{-4} \text{ mol dm}^{-3}$, $1.58 \times 10^{-4} \text{ mol dm}^{-3}$, $2.45 \times 10^{-4} \text{ mol dm}^{-3}$ and $1.53 \times 10^{-4} \text{ mol dm}^{-3}$, respectively. An increase in solubility of CaC_2O_4 and renal calculi in 50% methanol extract could be seen compared to other extracts and distilled water which was used as the control. Hence, it can be said that there is/are water soluble compound/compounds that can influence the solubility of CaC_2O_4 and renal calculi in the crude extracts of *Crateva adansonii*.

Keywords: Renal calculi, CaC_2O_4 , *Crateva adansonii*

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950/E2

Fabrication and characterization of an environmentally friendly packing material using banana fiber composite

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The use of polythene and plastic has increased rapidly because of their special properties such as low density, low electrical conductivity, transparency, and stiffness. These properties let plastics to be predominant among packing materials. However, from the aspect of environment, accumulation of plastics caused a huge problem since it is a non-biodegradable product. Loss of soil fertility, killing of soil micro-organisms and marine life are some of the negative impacts cause by plastics. The main objective of this project is to find out an alternate packaging material, which is biodegradable and made by a waste material. Characterization of the product using tensile properties of the packing material is the second objective. Banana pseudo stem becomes a waste material after harvesting. Since it is an environmental friendly material, banana pseudo stem was selected for fabricating environmental friendly packing material. Already there are industries which make paper materials from banana fibers. In this research, we tried to give more tensile strength to the packing material than the paper materials that have been fabricated from banana fibers. Therefore, a composite material was prepared using banana fibers together with wheat starch. Wheat starch was used as a fiber bonding material. Banana pseudo stem pieces were boiled, chopped and blended to obtain the maximum amount of fibers. Fixed amount of fibers were boiled with fixed amount of water varying the amount of starch. Tensile strength of each composite specimen was measured using Universal testing machine. Out of the specimens, for the ratio of 100×10^{-3} kg of banana fibers to the 25×10^{-3} kg of starch showed the maximum tensile stress of 1.81×10^6 Pa, maximum load of 115.11 N and 1.067×10^{-3} m extension at the maximum load. The tensile results obtained show this composite can be used as a packing material. By further improving the properties such as thermal properties, moisture content and pH variations, a better packing material can be designed which have high tensile strength. Furthermore, this investigation of the use of banana waste would help to establish a new approach for the country's socio-economic growth.

Keywords: Banana fiber, pseudo stem, tensile strength

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951/E2

Comparison of structural properties and energetics of model amino acids containing unsaturated side chains using all-atom and united-atom force fields in MD simulations

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There are two main types of molecular mechanics force fields; all-atom force field and united atom force field. United atom representation does not explicitly treat non-polar hydrogen atoms and those hydrogen atoms were grouped with the connecting carbon atoms. United atom force fields significantly reduce the number of atoms in the system and decrease the computational expense by up to an order of magnitude. Therefore, the use of united atom force fields is beneficial when the simulation systems are large. The main purpose of this research is to investigate the structural similarities and/or differences of unsaturated aliphatic carbon chains with the use of those two types of force fields in molecular dynamics simulation. For this purpose, four model amino acids were built and then subjected to 10 ns long molecular dynamics simulation in aqueous medium using Kirkwood-Buff Derived Force Field (KBFF) as the united atom force field, and AMBER99SBILDN as the all-atom force field with GROMACS molecular dynamics simulation package. The total energy of the simulation systems, non-bonded interaction energies, dihedral angle distribution, Root Mean Square Deviation (RMSD), the radius of gyration, Solvent Accessible Surface Area (SASA) and the end-to-end distance of amino acids were analyzed. According to the total energy variation, non-bonded interactions, dihedral angle distribution, radius of gyration, and RMSD values indicate that both the all-atom and united atom force fields simulate structural properties giving similar variations. Only SASA exhibit a detectable increase for all-atom model amino acids. This observation is obvious as all-atom model amino acids are simply having more atoms than their counterparts of united-atom amino acids and hence, more surface area. Therefore, it can be concluded that in longer molecular dynamics simulations, using united atom force field one can get structural and dynamical properties of molecular systems with a relatively shorter simulation time compared to that with all atom force field.

Keywords: Force fields, United-atom ff, All-atom ff, molecular dynamics

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Hate speech corpus generation using crowdsourcing

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With the rapid growth of social media use, the number of user-generated posts keep growing exponentially. Social media platforms find it challenging to moderate all these posts before reaching a wider range of audience as the posts are written using multiple languages and using different forms of multimedia. One such content that social media platforms find it difficult to detect is hate speech written in local languages such as Sinhala or Singlish. The contextual, linguistic expertise, social and cultural insights should be considered when identifying hate speech accurately and the social media platforms lack moderators with this knowledge. Research is being carried out in detecting hate speech on social media in English using machine learning algorithms, etc. with the help of crowdsourcing platforms to label and annotate data. However, a problem still exists, and further research is needed as common crowdsourcing platforms such as Amazon Mechanical Turk do not recruit workers from Sri Lanka who have Sinhala literacy to get the data labelled. Following this necessity, in this research, we propose a suitable crowdsourcing approach to label and annotate social media content and to generate corpora with words and phrases so that the algorithms can use the annotated dataset and corpus to identify hate speech using machine learning algorithms. Therefore, this research paper focuses on only a sub-area of ongoing research with mechanisms used to identify hate speech for data annotation, corpus generation and ensure trustworthiness of the participants. With the use of a well-implemented crowdsourcing platform, it will be possible to find more nuanced patterns with the use of human judgment and filtering and to take preventive measures to create a better cyberspace.

Keywords: Hate speech, Sinhala literacy, crowdsourcing

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A smart pen for online teaching

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Chalk and marker pens are the main tools for teaching in a conventional learning environment but use of these tools consumes money and creates health issues. When considering a pandemic situation like Covid-19, most of the academic and professional presentations are done using online platforms. Since people are very remote to each other, constant eye contact with the listener is important for the presenter or teacher to gain the desired results. In a social distancing situation, it is difficult to get chalk, markers or normal ballpoint pens. This paper investigates the development of an algorithm using image processing for a smart pen as a replacement for chalk, markers and normal ballpoint pens in online communication. Using a black board or a white board to assist online conversations has a disadvantage of breaching the eye contact, since the presenter is setting very remotely to the spectator. Furthermore, using conventional digital pens and pads consumes money even more. To address these problems, a smart pen and this algorithm were developed to write on the screen directly without having to look away but looking at the screen directly. The Algorithm is capable of detecting and tracking a particular point on the pen directed to the web cam constantly and integrate that path directly to the pixel coordinate space of the live image. Once the pre-defined color sequence is identified by the proposed algorithm, only then the writing can be done on the screen which would appear as writing on empty space but pointing to the web cam. To identify the color surfaces many color models like gray-scale, RGB, HSV can be used. In this project HSV color model is used for color segmentation. This interface and the proposed pen are user-friendly. The proposed application is acquired by Python and Opencv libraries. Using this application user can draw on the screen by moving the smart pen, for which the tracking is done using web camera. Once the defined colors in the smart pen are found, the reading from the webcam feed is started. There are a variety of algorithms, but in this project, the novelty lies in the fact that three colors are used in the smart pen and there is an ability in the proposed smart pen to rotate the color surface to hide one color in order to stop drawing. When one color is not showing then drawing is stopped.

Key words: Drawing, image processing, online teaching, smart pen

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