Sri Lanka Association for the Advancement of Science

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06 – 11 December, 2021

Part I: Abstracts

Sri Lanka Association for the Advancement of Science – 2021

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Oral Presentations

In vitro study to identify effects of fetal haemoglobin inducing agents on primary human erythroid cells

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Beta-thalassemia is an autosomal, recessively inherited monogenic disorder characterized by defective beta-globin synthesis. Deposition of excess alpha-globin in erythrocytes and their precursors due to unbalanced globin synthesis is the main underlying pathophysiology. Clinical data show that induction of fetal haemoglobin (HbF) in erythroid cells ameliorates the disease severity and associated complications. Hence, improving HbF via up-regulating gamma-globin gene expression has been identified as a novel treatment. The aim of our *in vitro* study was to identify the effects of fetal haemoglobin inducing agents in human erythroid cells. Haematopoietic stem cells (HSC) from umbilical cord blood samples collected from three healthy human placentas were isolated. Firstly, mononuclear cells were separated from the interface after fractionation on Histopaque®-1077 Hybri-Max and CD34+ HSCs were isolated using positive selection by magnetic activated cell sorting. HSCs were then expanded and differentiated into mature erythroid cells using a three-phase liquid culture protocol. Primary human erythroid cells at day 7 of the culture were incubated with hydroxyurea (20 μM), butyric acid (10 μM), 5-azacystidine (10 μM), decitabine (5 μM), busulfan (30 μM), vorinostat (2.5 μM) and valproic acid (1000 μM) for 72 hours. Effects of these compounds on cell expansion, viability, morphology, as well as α-, β- and γ-globin mRNA levels were measured using standard laboratory methods. Negative controls were tested in parallel. Compared to other compounds, hydroxyurea and butyrate treated erythroid cells displayed a significantly high mean fold expansion and viability. Significantly higher gamma-globin mRNA levels were observed in hydroxyurea treated cells (Mean relative expression: $186 \pm SEM16$) compared to negative control cells (Mean relative expression: $137 \pm SEM14$). Highest γ/β globin mRNA ratios were observed in busulfan ($12.6 \pm SEM2.9$) and decitabine ($12.1 \pm SEM3.3$) treated erythroid cells. In conclusion, hydroxyurea induces gamma-globin expression and decitabine and busulfan favourably alter the γ/β-globin mRNA ratios *in vitro* in human erythroid cells.

Keywords: Fetal haemoglobin induction, primary erythroid cells

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Efficacy and safety of three Ayurveda decoctions for polycystic ovary syndrome: A randomized, single-blind, three-arm, clinical trial - Study protocol

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Polycystic Ovary Syndrome (PCOS) is one of the most common endocrine abnormalities in women of reproductive age. Due to fear of side effects of allopathic medicines some patients prefer to take Ayurveda treatment for PCOS. Ayurveda treatment for this condition is widely practiced in Sri Lanka. However, most drugs are not clinically tested for efficacy and safety. Therefore, the aim of this research is to detect the efficacy and safety of three Ayurveda decoctions (decoction of *Nigella sativa*, decoction of *Sesamum indicum* and decoction of *Nigella sativa* and *Sesamum indicum*) used for PCOS. The study would be conducted as a randomized, single blind, three arm, comparative clinical trial. This study will be conducted in the National Ayurveda Teaching Hospital, Borella and the Rotterdam (2003) diagnostic criteria will be used to diagnose PCOS. Selection of participants will be done according to the inclusion and exclusion criteria and allocated randomly into three arms. Participants of Arm I, Arm II and Arm III will receive an oral drug for twelve weeks and will be followed up for 3 months after the administration of the drug. Each patient will undergo hematological and biochemical investigations before and after the interventions. Transabdominal sonography or transvaginal sonography will be carried out before and after the treatment and during the follow up period as a primary outcome measure. Symptom severity and their impact on quality of life will be assessed at the beginning and at end of the treatment by PCOS symptoms and Health Related Quality of Life Questionnaire. Body constituent (Prakriti) is identified by screening with the help of a validated questionnaire at the beginning and end of the study. Association between constituents and PCOS will be evaluated at the beginning and end of therapy. Data will be analyzed using Wilcoxon sign rank test and Mann-Whitney U test. At the end of this clinical research, the effectivity of Ayurveda treatment for PCOS could be presented. Furthermore, it would result in evidence-based scientific data on classical Ayurveda treatment.

Eating behaviours and its association with BMI among undergraduates in a tertiary education institute

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Eating behaviour and lack of physical activity contribute to poor health and academic performance. The present study investigated eating behaviour and its association with Body Mass Index (BMI) among undergraduate students in a tertiary educational institute. A descriptive study was conducted among 354 undergraduates using stratified random sampling. The pre-tested self-administered questionnaire was used to collect information on fast food, sugar added beverage, fruits and vegetable consumption and physical activity. BMI was measured according to the NAHANES guidelines. The data were analyzed using SPSS version 25. The majority of the students were female (76.6%), and the mean age of the sample was 22.41 ± 2.39 years. Among the students, 19.5% were underweight, 13.6% were overweight and 24.6% were obese. The majority of the undergraduates consumed fast food less than 3 times per week (54.2%), beverages with sugar less than 3 times per week (77.7%) and 89.2% of the undergraduates consumed fruits and vegetables more than 3 times per week. The majority exercised less than 3 times per week (63.0%) for at least a 30-minute duration. There was a significant gender difference in the frequency of consumption of sugar added beverages per week ($P < 0.001$), with females having a higher frequency of consumption more than 3 times per week. The frequency of beverages with sugar consumption in the obese category (33%) was higher than the normal BMI (19.7%) and overweight (8.3%) categories. In conclusion, the frequencies of consumption of fast food and beverages with sugar among undergraduates were less than 3 times per week. Fruits and vegetable consumption was more than 3 times per week. Consumption of beverages with sugar was significantly associated with high BMI among the study group. Our findings emphasize the need for interventional strategies to discourage the consumption of beverages with added sugar among the undergraduate population.

Keywords: Food habits, physical activity, undergraduates, BMI

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Dengue epidemic identification and its seasonal and spatial variability in the Administrative/Health sub-districts of Matale district from 2005 to 2020

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Dengue has been an important public health problem in Sri Lanka since early 2000s. The disease is endemic in the country and epidemic at 3-5 year intervals. Initially, dengue was prevalent in Colombo and then spread to other large, urbanized centers. During the past two decades, it has spread to towns in Matale district. Identification of seasonal, spatial and epidemic patterns in dengue transmission at fine scale can help understand contributing factors and transmission patterns and dynamics. Our objectives were the identification of dengue epidemics, seasonality of dengue transmission and their spatial variability at a sub-district spatial resolution for 2005-2020. Data on weekly aggregated dengue cases were obtained from the office of the Regional Director of Health Services in Matale from 2005-2020 for the 13 health sub-districts. These are identical to the Administrative Divisions except for the division of Matale and Dambulla between the Municipal Council and remaining areas.   Epidemics were identified based on exceeding a threshold of the running average of the weekly average of dengue cases and the standard deviation for the preceding 5 years. Epidemics were detected in 2006, 2009, 2014, 2016, 2017 and 2019. The monthly averages of dengue cases from 2005 - 2020 shows a bimodal distribution with peaks in May to July and October to February. Incidence is twice as likely as during the mid-year as during the end year. This seasonal peak follows in the months after the start of the Yala and Maha seasonal rains in April/May and September/October. In the district, the mid-year averages exceed that of the end-year averages except Dambulla, Galewela, Pallepola, Naula, Ambanganga, Yatawatta and Matale. More detailed analysis is warranted, inclusive of climatic variables to bring out the spatial relationships. This work has provided spatial and seasonal and epidemic characteristics of dengue incidence at finer scale and points the way to including climate, demographic analysis at scales finer than the sub-district.

Keywords: Dengue, epidemics, seasonal variation, spatial variation, Matale district

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Efficacy of hydroxyurea in reducing the erythropoietic stress of ineffective erythropoiesis in transfusion dependent beta thalassaemia: A randomised, double-blind placebo-controlled clinical trial

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The unbalanced synthesis and accumulation of α-globin chains due to impaired synthesis of β-globin results in the destruction of red blood cells (RBC) and erythroid precursors of patients with β-thalassaemia. This leads to an increased erythropoietic activity and ineffective erythropoiesis in the bone marrow of these patients. Hydroxyurea is a licenced medication that decreases the RBC destruction of patients with β-thalassaemia. However, its effect on erythropoietic stress is unclear. In this study, our objective was to evaluate the effect of hydroxyurea on erythropoietic stress of ineffective erythropoiesis in transfusion-dependent (TD) β-thalassaemia. This experimental study was carried out at the Thalassaemia Unit of Colombo North Teaching Hospital as part of a randomised, double-blind placebo-controlled clinical trial that evaluates the efficacy of hydroxyurea. We recruited 24 patients with TD β-thalassaemia who were taking hydroxyurea 10-20 mg/kg/day and 16 patients who were receiving a placebo. The erythropoietic stress of ineffective erythropoiesis was assessed by measuring serum soluble transferrin receptor (sTfR) levels before and six months after taking either hydroxyurea or placebo. Levels of sTfR were measured using a validated enzyme-linked immunosorbent assay. Paired t-test was used in the statistical analysis. Nineteen (79%) out of 24 patients who received hydroxyurea showed a reduction in sTfR level, of which 8 (33%) and 6 (25%) showed >25% and 10-25% reductions, respectively. A significant reduction in mean sTfR level was observed after hydroxyurea treatment (72.3$\pm$SD25.9) compared to pre-treatment levels (89.6$\pm$SD22.9), ($p<0.01$). Conversely, no difference in sTfR levels was seen in patients who received the placebo pre-(91.9$\pm$SD24.7) and post-treatment (96.4$\pm$SD19.4), ($p=0.17$). In conclusion, oral hydroxyurea significantly reduced the erythropoietic stress of ineffective erythropoiesis in patients with TD β-thalassaemia showing a promise as a treatment modality.

Keywords: β-thalassaemia, hydroxyurea, serum soluble transferrin receptors, ineffective erythropoiesis

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Dynamics of microscopy, rapid diagnostic tests and nPCR positivity during follow- up of malaria patients

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Sri Lanka, after eliminating indigenous malaria in 2012 is in the prevention of re-establishment (POR) phase. Integrated drug efficacy surveillance (iDES), using either microscopy or Rapid Diagnostic Tests (RDTs) to follow-up malaria patients, is recommended for monitoring drug efficiency for countries with low malaria cases. The objective of this study was to determine the dynamics of microscopy and RDT positivity during follow-up of patients, after initiation of treatment. The positivity of microscopy, RDT and nPCR, were monitored for 76 *Plasmodium falciparum* and 76 *P. vivax* nPCR confirmed patients followed up during the period April 2014 - December 2017. Tests were performed on D0 (day of diagnosis), D1, D2, D3 and thereafter weekly on D7, D14, D21 and D28. Microscopy detected 74 *P. falciparum* patients while all 76 were positive for the HRP2 band of the RDTs, but only 55 were positive for the pLDH band. Kaplan Meier analysis showed similar estimated survival probabilities for microscopy, pan pLDH test line and nPCR. The estimated mean survival times by microscopy, nPCR and pan pLDH test line of RDT being 12.7 days (95%CI =11.7-13.7), 12.5 days (95%CI=11.6-13.5) and 12.8 days (95%CI=11.7-13.9), respectively. HRP2 positivity differed significanlty due to persisitant antigenimia in most of the patients. The estimated mean and median survival times for HRP2 were 23.7 days (95% CI=22.8-24.6) and 28 days (95%CI=26.7-29.3), respectively. Microscopy and RDT detected 75 out of 76 nPCR confirmed *P. vivax* patients. For all three diagnostic tests, the median survival time was 7 days. This study shows that PCR positivity correlated with patent parasitaemia proving accuracy of microscopy. This makes them useful tools for follow-up of malaria patients in a POR setting. Use of RDTs (pan pLDH test line) is acceptable for *P. vivax.* Due to false negativity of pan pLDH test line and persistent HRP2 antigeneamia, it is a less valuable tool to follow-up *P. falciparum* patients.

Keywords: Malaria, microscopy, RDT, nPCR, patient follow-up

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Determination of the extractability of *Tamarindus indica* (Tamarind) seed gum using different extraction methods

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Tamarindus indica L. (Tamarind) is an evergreen fruit tree that is extensively grown in Sri Lanka. Tamarind pulp is widely consumed as a spice and flavouring agent in which the seed is a byproduct and wasted without further production. As the seed contains 65% of gum, which can be used as gelling, stabilizing, thickening and binding agent, it is important to study the properties of tamarind seed gum along with its extractability and potential applications. Thus, this study was conducted to determine the extractability of tamarind seed gum using selected water and solvent-based extraction methods to apply it in the food industry. For the gum extraction from seeds, three extraction methods as water extraction, hot water extraction and acidic extraction (pH 3.5) were conducted for tamarind kernel powder which accounts for 70-75% of the seed, followed by ethanolic precipitation. The extractability of tamarind seed gum from each of these methods was calculated in terms of the gum yield and analyzed by ANOVA in Minitab 16 software at a significance of 0.05. According to the results of the study, the lowest yield and extractability (17.60 ± 0.11 and $27.08 \pm 0.16\%$, respectively) were obtained from the gum extracted by the water extraction method. Moreover, the extractions conducted using hot water and acidic medium resulted in the yield of 40.04 ± 0.17, $46.12 \pm 0.32\%$ and the extractability of 61.60 ± 0.25, $70.95 \pm 0.50\%$, respectively. The findings reveal that acidic extraction is an appropriate method to extract tamarind seed gum with the highest extractability. Further scientific studies should be conducted to identify the properties of tamarind seed gum beneficial in food-based applications such as binding, thickening and gelling properties to bring it to the Sri Lankan food industry without wasting another valuable resource in Sri Lanka.

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Formulation and characterization of Elephant Foot Yam (*Amorphophallus paeoniifolius*) flour incorporated bread

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The Elephant Foot Yam (EFY) is an underutilized yam variety with high yield potential that is known in Sri Lanka as "Kidaram". The goal of this study was to formulate loaves of bread incorporating EFY flour that were blanched at 85 °C for 30 s, before being sun-dried at 40±3 °C for 36 h and to assess the physicochemical attributes and consumer preferences. The control loaves of bread were developed without incorporating EFY flour and the EFY flour incorporated loaves of bread were developed using Two-Factor Three-Level Factorial Design. According to the results, the volume and the specific volume have decreased and the density has increased with increasing the EFY ratio. The sensory evaluation data revealed that the bread formulated with 30% EFY and 70% wheat flour (c_2d_2) was in the acceptable range. Soluble proteins, crude fiber, ash content, DPPH radical scavenging activity and the total phenolic content (as Gallic acid equivalent GAE/g) were higher in c_2d_2 than in control breads and the values were 0.5080±0.0057 mg/ml, 2.5695±0.0623 g/100 g, 3.714±0.318 g/100 g, 1.8148±0.0396 mg/ml and 14.298±0.228 mg GAE/g, for c_2d_2, and 0.442±0.019 mg/ml, 0.295±0.019 g/100 g, 1.019±0.157 g/100 g, 12.872±0.237 mg/ml and 6.468±0.347 mg GAE/g for control bread, respectively. Furthermore, the total plate count and the yeast and mold count for c_2d_2 were 18×10^2 CFU/g and 18×10^2 CFU/g, respectively on the 6th day under ambient conditions and the values were within the safe level for consumption. The control bread made with 100% wheat flour expressed to be unacceptable for consumption after 4 days of production. Collectively, this study shows the potential application of underutilized EFY flour as an ingredient in the formulation of value-added loaves of bread.

Keywords: Bakery food, elephant foot yam, traditional yams, value-addition

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Effect of coconut variety (*Cocos nucifera* L.) on quality of virgin coconut oil extracted from the dry processing method

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Coconut (*Cocos nucifera* L.) kernel is the base for products such as coconut oil, desiccated coconut and coconut milk. Different types of coconut oil are produced from coconut kernels by changing processing conditions and the status of raw materials. Virgin coconut oil (VCO) is obtained from fresh, mature coconut kernel by mechanical or natural means and is a superior natural edible oil extracted from mixed coconut varieties. The variety of coconut shows diverse characteristics. Therefore, this research focuses on the quality evaluation of VCO extracted from four types of coconut varieties, namely Tall×Tall (TT), Gon Thambili (GT), Ran Thambili (RT), and San Ramon (SR). Mature coconuts from each variety (50 nuts) were collected from Bandirippuwa Estate of Coconut Research Institute, Sri Lanka to extract VCO by cold press oil extraction method. Extractability of VCO, moisture (SLSI 2012), free fatty acid (FFA) (SLSI 2012), fatty acid profile (gas chromatography) (AOCS, 1998) peroxide value (PV) (SLSI 2012), colour (Lovibond scale) (SLSI 2012), total phenolic substances (Galic acid equivalent) (Folin-Ciocalteau reagent method), antioxidant capacity (α, α-diphenyl-β-picrylhydrazyl, 0.1 mM) and sun protection factor (SPF) of VCO extracted from each variety were determined. The experiment was arranged as a complete randomized design with three replicates. Data were analyzed using ANOVA and Tukey's test with pairwise comparision by MINITAB 17 software. Oil extractability (58% - 59%), FFA (0.04% - 0.12%), colour (0.43 -0.93), and fatty acid profile of VCO did not show variation among varieties. A characteristic fatty acid profile was observed from virgin coconut oil from all varieties. A higher concentration of total phenolic substances was observed in GT (0.24 ± 0.03 mg GAE/100 g) while antioxidant capacity (857.19 ±14.99 mg/ml) and SPF (8.99 ± 1.26) were rich in RT. The varietal difference did not affect significantly the physicochemical properties of VCO whereas the antioxidant capacity and SPF of RT are significant from others.

Keywords: Coconut varieties, dry processing, physicochemical properties, virgin coconut oil

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Development of a functional tea (*Camellia sinensis* L.) blend rich in phenolics and antioxidants

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Functional tea blends are recently popularized because of their wellness properties for better functioning of the body. During the COVID 19 pandemic, demand for black tea and green tea has been grown up due to their health benefits; especially, antiviral and immunity-boosting properties. Therefore, the present study was undertaken to find out the best blending ratio of black and green teas in order to make a functional tea blend rich in phenolics and antioxidants. The studied blends were prepared with black tea: green tea; 1:1, 1:2, 2:1, 1:3, 3:1 and 2:2 ratios. Among the six different blends, the premier functional tea blend was determined based on its phenolic content and antioxidant capacity. Total phenolic content (TPC) and total antioxidant capacity (TAC) in both methanolic and aqueous extracts of the functional tea blends were determined by using the Folin-Ciocalteu method and ferric ion reducing antioxidant power (FRAP) assay, respectively. Among aqueous extracts of tested tea blends, the highest TPC was recorded in the blend made up with a 1:2 ratio of black and green tea (111.06 ± 4.83 mg GAE/ g DW), whereas the lowest TPC was recorded in the blend having a 3:1 ratio of black and green tea (7.82 ± 0.98 mg GAE/ g DW). The total phenolic content of functional tea blends in methanolic extracts was not statistically ($P>0.05$) significant. Similarly, aqueous extracts of the 1:2 (black tea: green tea) blend recorded the significantly highest TAC (637.15 ± 29.75 mg TE/ g DW), and the same blend also showed significantly the highest TAC in methanolic extracts (273.07 ± 2.60 mg TE/ g DW) as well. The lowest TAC in the methanolic extract was observed in the 3 black tea: 1 green tea (225.16 ± 4.39 mg TE/ g DW) blend. The lowest TAC in the aqueous extract was recorded in 2 black tea: 1 green tea (310.87 ± 21.84 mg TE/ g DW) blend. The findings of this study conclude that the blend with 1 black tea: 2 green tea is rich in TPC and TAC. Therefore, it would be ideal to develop as the premier functional tea blend rich in phenolics and antioxidants.

Comparative evaluation of five unpopular cooking type banana accessions for their proximate composition

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Banana (*Musa* spp.) is one of the most widely grown and consumed fruits in Sri Lanka. Cooking-type bananas are starchy and are mostly consumed after cooking. Although Sri Lanka has a diverse range of cooking-type bananas, the information is scattered. Many cooking type bananas are not so popular among people. Therefore, the present study was conducted to evaluate and compare the approximate composition of five unpopular cooking type banana accessions in Sri Lanka, namely; *"Alumondan" (ABB), "Kannannoru" (AAB), "Diyamondan" (ABB), "Kithala" (ABB)* and *"Kadili" (ABB).* The proximate composition (moisture, dry matter, crude protein, crude fat and crude ash contents) of the samples were determined according to the official AOAC methods. Results were generated from mean comparison using SAS statistical software (SAS Institute, 1999). All tested banana pulps possessed considerable amounts of moisture, dry matter, crude protein, crude fat and crude ash. The moisture content of the tested pulps was decreased as *"Kithala" > "Kannannoru" > "Alumondan" > "Diyamondan" > "Kadili"* and ranged between 59.83 ± 0.6 % and 72.22 ± 2.2 %. The dry matter content ranged between 27.78 ± 2.2 % and 40.17 ± 0.6 % and highest dry matter content was recorded in the pulp of "*Kadili*". The highest crude ash content was reported in *"Kithala"* (4.50 ± 0.2 %) whereas the lowest crude ash content was recorded in *"Alumondan"* (3.25 ± 0.1%). There was no significant difference (P<0.05) between the ash contents of *"Alumondan", "Kadili"* and *"Kannannoru"*. The crude fat contents of tested samples were ranged from 0.26 ± 0.13 % to 1.45 ± 0.17 %, while the crude protein contents varied from 3.03 ± 0.1 % to 5.71 ± 0.1%. The highest crude fat and protein contents were reported in the pulp of *"Kannannoru"*. The fat contents of *"Kannannoru", "Diyamondan"* and *"Kadili"* were not significantly different. In conclusion, the results imply that the pulp of *"Kannannoru"* and "*Kithala*" are rich in nutrients compared to the other three unpopular cooking banana accessions. Hence, they could be popularized as a vegetable among people. Also, it could be suggested that all five accessions can be incorporated into the formulation of banana-based value-added products.

Keywords: Cooking type bananas, proximate composition

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Evaluating the crude protein contents of some selected seaweeds of Sri Lanka

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Seaweeds have become an emerging source of proteins in the world. The objective of this study was to evaluate the crude protein content of selected seaweeds from Jaffna (Northern coast), Trincomalee (East coast), Hikkaduwa (West coast), Kalpitiya (North Western coast) and Matara (Southern coast) of Sri Lanka. The crude protein contents of cultivated and wild grown seaweeds were determined using the Kjeldahl method. The crude protein content of brown seaweeds such as *Padina* sp. (12.58 ± 1.05%), *Sargassum filipendula* (10.43 ±0.14%) and *Turbinaria ornata* (8.15 ± 0.00%) were determined. Moreover, the crude protein content of green seaweeds such as *Caulerpa racemosa* (13.75 ± 1.08%)*, Ulva lactuca* (6.95 ± 0.22%), *Ulva fasciata* (16.38 ± 0.38%) and *Caulerpa lentilifera* (14.51 ± 0.01%) as well as red seaweeds including *Gracilaria edulis* (10.64 ± 0.10%), *Gracilaria corticata* (16.21 ± 2.22%), *Eucheuma denticulatum* (6.62 ± 0.22%), *Gracilaria verrucosa* (16.77 ± 0.20%), *Gracilaria salicornia* (9.61 ± 0.01%) and *Kappaphycus alvarezii* (10.53 ± 0.06%) was evaluated. Data were statistically analysed by ANOVA method in Minitab software. There was a significant difference between the crude protein contents of different seaweed species ($p \leq 0.05$ at 95% confidence interval). Generally, the crude protein content of seaweeds varies with the species, geographical location and harvesting period. Although Sri Lankan seaweeds contain considerable amounts of crude proteins, further studies on how these factors affect the protein content of seaweeds of Sri Lanka are essential before producing seaweed incorporated food products.

Keywords: Chlorophyta, crude proteins, Kjeldahl method, phaeophyta, rhodophyta, seaweeds

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Fatty acid composition and physicochemical properties of oil extracted from head and viscera of Indian Mackerel (*Rastrelliger kanagurta*)

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The aim of this study is to investigate and compare the total lipid content, fatty acid composition and physicochemical properties (iodine value, acid value, and refractive index) of oil obtained from the head and viscera of Indian Mackerel. Fish with equal length were collected from fish markets and the research was run in triplicates for each sample. Oil was extracted using the modified Bligh and Dyer method. Iodine value, acid value and refractive index were determined according to American Oil Chemists' Society (AOCS) Cd 1b-87 and Cd 3d-63 methods and ISO 6320:2017(E) standard method, respectively. The fatty acid composition was determined by gas chromatography-mass spectrometry. The total mean oil content of the head and viscera of the Indian mackerel were (7.47 ± 0.84 w/w%), (4.66 ± 0.57 w/w%), respectively. In fatty acid analysis, it was observed that oil extracted from viscera of Indian mackerel contains a higher proportion of fatty acids including SFAs (44.75%), PUFAs (37.99%) and MUFAs (15.34%) than the oil obtained from the head of Indian mackerel which contains 39.12% of SFAs, 28.52% of PUFAs and 11.66% of MUFAs. Palmitic acid was the prominent SFAs and oleic acid was the dominant MUFAs discovered in both the head and viscera of Indian mackerel. Omega-3 fatty acid was the major type of PUFAs presented in oil extracted from head and viscera, while Eicosapentaenoic acid (C20:5n-3, EPA) and Docosahexaenoic acid (C22:6n-3, DHA) were the most abundant. The greatest amount of DHA (23.91%) was obtained from the viscera oil. A higher level of EPA and ω-6 was recorded for head oil compared to viscera oil. There were significant differences ($p < 0.05$) in the iodine value (141.59 I_2 /100 g, 143.62 I_2 /100 g), acid value (20.47 mg KOH/g, 22.41 mg KOH/g) and refractive index (1.4720, 1.4784 at 40 °C) of oil obtained from head and viscera of Indian mackerel. This study concludes that the head and viscera of Indian mackerel can be considered as a potential source of Omega-3 long-chain polyunsaturated fatty acids.

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A study on consumer perception and purchasing behaviour towards ready-to-eat food among students and parents in Colombo district, Sri Lanka

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The demand for food across the world has changed drastically with consumers moving away from traditional food in favour of convenience foods such as ready-to-eat (RTE) food. This study aimed at performing a comprehensive analysis on the consumer purchasing behaviour and perception towards RTE food products available in Sri Lanka. The present study was carried out with randomly selected school-adolescents aged between 11 and 19 years (n=93) and parents of school-children aged between 6 and 10 years (n=72) using a structured, self-administered questionnaire. The data were analysed using descriptive and nonparametric inferential statistics. The respondents had purchased RTE food less often than expected. There was no statistically significant relationship between the mother's employment status and the frequency of purchasing RTE food (p>0.05). Expecting a variation in foods was the main motive for the respondents to purchase RTE food (>50%) while convenience was the second (>18%). Major factors that determined the respondents' choice of RTE food were taste, brand, nutritional value and quality. Students frequently showed concern about taste (52%) while parents sought nutritional value (61%) and quality (60%). The majority (51%) of parents never or rarely allowed their children to involve in decision-making process when purchasing RTE. Conversely, school-adolescents tend to make their own decisions (78.4%) while male students had a higher frequency than the females (p<0.05). However, most students (48%) and parents (72%) were not satisfied with the existing RTE food due to many health-related concerns. The majority liked to spend Rs.100-200 per healthy meal and Rs.50-100 per healthy snack, which represent the usual prices of meals and snacks in the market. However, there was no significant relationship between the price that parents are willing to pay for a healthy meal and their monthly family income (P>0.05). In conclusion, future RTE food manufactures need to emphasize nutritional value, healthiness, price and the taste of their products.

Keywords: Purchasing behaviour, ready-to-eat food, consumer perception, decision making

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Nutritional and sensory properties of traditional rice-based string hoppers incorporated edible green seaweed *Ulva fasciata*

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Seaweeds are comprised of several nutrients that make them beneficial to human health and nutrition. In Sri Lanka, seaweeds can be identified as underutilized marine plants. The purpose of this study was to assess the nutritional composition of locally available edible green seaweed *Ulva fasciata* and its potential to be used as a functional food ingredient to improve the nutritional and sensory properties of traditional rice (*Oryza sativa* L.) based string hoppers. String hoppers were prepared using white rice ("Suwandel") flour and red rice ("Weda Heenati") flour, which was substituted at 0% as control, 2.5% and 5% (w/w) with *U. fasciata* powder. Sensory evaluation was carried out to identify the best combination. A 5-point hedonic scale from "neither like nor dislike" to "like extremely" was used in sensory evaluation. Proximate analysis was performed for the accepted product. According to the proximate analysis, dried seaweed powder *U. fasciata* (moisture $11.81 \pm 0.14\%$) contains, $17.12 \pm 0.19\%$ of total ash, $14.91 \pm 0.26\%$ of crude protein, $6.01 \pm 0.64\%$ of soluble protein, $0.41 \pm 0.03\%$ of crude lipid, $30.10 \pm 1.30\%$ of crude fiber and $26.89 \pm 0.09\%$ of total carbohydrate in dry weight basis. 2.5% (w/w) *U. fasciata* powder incorporated "Suwandel" rice string hoppers were scored as the best according to the sensory analysis. That sample was very well-liked for appearance, texture, smell, taste and overall acceptability when compared to other samples. Hence, the proximate and phytochemical studies were performed for the cooked 2.5% (w/w) *U. fasciata* added "Suwandel" string hoppers and control sample ("Suwandel" string hoppers). The proximate analysis revealed that the 2.5% (w/w) *U. fasciata* powder incorporated "Suwandel" rice string hoppers had a high percentage of total ash $(1.73 \pm 0.11\%)$, crude protein $(9.85 \pm 0.17\%)$, soluble protein $(2.62 \pm 0.24\%)$ and crude fiber $(21.46 \pm 0.97\%)$ as well as a lower amount of total carbohydrate $(46.37 \pm 0.31\%)$ and crude lipid content $(0.49 \pm 0.06\%)$ when compared to the control sample. The moisture content of cooked 2.5% (w/w) *U. fasciata* powder incorporated "Suwandel" string hoppers sample and control samples were $55.59 \pm 0.49\%$ and $54.07 \pm 0.09\%$, respectively. The addition of that 2.5% (w/w) *U. fasciata* powder to "Suwandel" string hoppers significantly increased total phenolic and total flavonoid content. The results were expressed as 0.68 ± 0.10 µg GAE/mgml^{-1} and 0.12 ± 0.02 µg QE/mgml^{-1}, respectively. The study shows that the underutilized Sri Lankan *U. fasciata* has a high potential to be a functional food ingredient in rice-based string hoppers made with traditional rice variety "Suwandel".

Keywords: Seaweeds, string hoppers, traditional rice

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Effect of addition of glucose syrup on biochemical properties during the processing of black tea

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The illegal adulteration of tea (*Camellia* species) with sucrose, glucose syrup and carbohydrate derivatives is a serious problem occurring in Sri Lanka and may lead to quality deterioration of tea. The present study aimed to investigate the effect of glucose syrup concentration (3, 6 and 10%) on biochemical properties such as total polyphenol content (TPC), antioxidant activity, moisture content and colour (L*, a*, b*) of black tea. Tea leaves in the fermented stage from low, mid and upcountry were purposely adulterated with glucose syrup at a ratio of 3, 6 and 10% and non-adulterated samples were used as a control. Adulterated samples were dried at inlet temperature 120 °C and outlet temperature 80 °C using the dehydrator for 20 minutes and the hot water extractions were analyzed. The total polyphenol content and the antioxidant activity of black tea were significantly affected ($p<0.05$) by the glucose syrup concentrations. The highest polyphenol content was obtained from up grown control sample and it was 48.40 ± 0.15 mg GAE/ 100 ml and lowest was obtained from 10% glucose syrup added mid-grown tea sample and it was 25.75 ± 0.15 mg GAE/ 100 ml. The antioxidant concentration of glucose syrup added low, mid and upcountry tea samples that wanted to scavenge 50% of DPPH were varied in the range of 2.26-3.00 mg/ml, 2.26-2.96 mg/ml and 0.50-1.92 mg/ml, respectively. The highest antioxidant activity was given by the control tea samples and the lowest was given by the 10% glucose syrup added tea samples. When increasing the glucose syrup concentration, both total polyphenol content and antioxidant activity were significantly ($p<0.05$) decreased. The moisture contents of dried tea samples were in the range of 4.8-6.6%. The moisture content of dried tea samples was not significantly affected ($p>0.05$) by the glucose syrup concentration. The increase of glucose syrup concentration significantly decreases the L* value indicating the increment of the darkness of tea infusion. Glucose syrup content did not significantly affect ($p>0.05$) the a* and b* values which are responsible for the redness and yellowness of tea infusion. Adulteration of black tea with glucose syrup affected the total polyphenol content, antioxidant activity and brightness of the black tea but did not affect the moisture content.

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Development of alginate-based antimicrobial edible coating to improve the physicochemical, microbiological and sensory attributes of cheese

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Cheese is an extremely perishable food product that needs proper packaging to minimize the contamination with spoilage microbes, and the development of the unpleasant appearance, off-odors, which leads to deterioration. In this research, a seaweed-based edible antimicrobial coating was developed using alginate extracted at the laboratory from *Sargassum* sp. as the main ingredient, glycerol as the plasticizer, cinnamon (*Cinnamomum zeylanicum*) essential oil (CEO) as the antimicrobial agent, distilled water as the solvent, and calcium chloride (5% w/v) as the cross-linking agent to enhance the physicochemical, microbiological, sensory attributes of processed cheese. The effectiveness of edible coatings on cheese was evaluated throughout 40 days of storage. Four types of alginate-based coatings were developed as solution 1; 1% (w/v) alginate and 0.25% (w/v) glycerol, solution 2; 1% (w/v) alginate, 0.2% (w/v) CEO, and 0.25% (w/v) glycerol, solution 3; 2% (w/v) alginate and 0.5% (w/v) glycerol, and solution 4; 2% (w/v) alginate, 0.2% (w/v) CEO, and 0.5% (w/v) glycerol. Subsequently, microbiological (counts of total mesophilic aerobic bacteria, yeasts, molds, and coliforms), sensory, and physicochemical properties (moisture, weight loss, pH, hardness, colour change, fat content) of alginate solution-coated cheese obtained at 0, 10, 20, and 40 days of storage at 10 °C and 85% relative humidity were compared with those of CEO-coated and uncoated cheese. Cheeses coated with antimicrobial solution-4 exhibited a decreased loss of moisture, weight, change in pH, hardness, colour, and fat content compared to other coated and uncoated cheeses. Solution 4-coated cheeses obtained the highest acceptability score for all attributes (odor, colour, surface shininess, hardness, taste, and overall acceptability) in sensory analysis, and it was the most successful in preventing the growth of coliforms while maintaining the yeasts, molds, and total mesophilic aerobic bacteria counts in accepted safe levels throughout the storage. Based on physicochemical, microbiological, and sensory attributes, solution-4 (2% (w/v) alginate, 0.2% (w/v) CEO, and 0.5% (w/v) glycerol), which exceeded the performance of uncoated cheese was selected as the best formulation for antimicrobial coating preparation.

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Improvement of post-harvest storage potential of pre-cut jackfruit (*Artocarpus heterophyllus* Lam) by application of an edible coating developed with agar extracted from *Gracilaria edulis*

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Pre-cut jackfruit is highly perishable. The aim of the study was to investigate the effect of the application of an agar-based edible coating on quality parameters of pre-cut jackfruit within a storage period of 5 days under refrigerated conditions (6±1 °C). Gel-forming ability of agar extracted by boiling *Gracilaria edulis* in water was used to develop 1% agar-based coating by dissolving agar and glycerol in distilled water to coat pre-cut jackfruit. Jackfruit of initial brix 6.23 ± 0.39° was selected. Total soluble solids (TSS), titratable acidity, weight loss, ascorbic acid content, pH and colour are basic quality parameters that will change during fruit ripening. Those parameters of coated and uncoated jackfruits were measured daily and compared for 5 days. Data analysis was done with ANOVA at a 95% confidence interval. Initial TSS, hue, titratable acidity, and ascorbic acid content of jackfruit before applying the coating were, 6.33 ± 0.58°, 86.40 ± 1.45°, 0.07 ± 0.00 (% of citric acid) and 7.14 ± 0.24 (mg/100 g), respectively. On the fifth day, TSS° of coated and uncoated samples were, 11.00 ± 0.87° and 14.17 ± 0.76°, respectively. Thus, a significantly higher TSS was observed in the uncoated sample. Hue of coated and uncoated samples on the fifth day was, 80.30 ± 0.20° and 77.80 ± 0.50°, respectively. Thus, a significantly higher decrement in hue was observed in the uncoated sample compared to the coated. Titratable acidity (% of citric acid) of coated and uncoated samples on the fifth day were 0.06± 0.00 and 0.06 ± 0.00, respectively. The ascorbic acid content (mg/100 g) of coated and uncoated jackfruit on the fifth day were, 9.04 ± 0.32 and 6.50 ± 0.24, respectively marking a slight increment in the coated sample than the initial value. The weight loss percentage of coated and uncoated samples on the fifth day were 0.69 ± 0.14 and 1.12 ± 0.24, respectively. Thus, a higher weight loss was observed in the uncoated sample than the coated sample. In conclusion, the application of 1% agar-based coating was successful in delaying ripening by maintaining better quality values for TSS, hue and ascorbic acid content while reducing weight loss in ready-to-cook jack-fruit.

Keywords: Agar-based edible coating, jackfruit, post-harvest storage

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Evaluation of habitat selectivity and species abundance of freshwater fish of the upper and lower reaches of the Kelani River Basin

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Kelani river is an important ecosystem complex for the freshwater fish biota of Sri Lanka and one of the most polluted rivers in the country. However, for Kelani River, the distribution of fish and their responses to fluctuations or stresses to water quality have not been investigated. Therefore, the study intends to analyze and compare the species composition, diversity and diversity indices of the fish fauna in the upper and lower reaches of the Kelani River. The study was conducted over one year period at upper and lower catchments of the Kelani river basin. Data were collected on species richness, abundance and diversity along with the most important diversity indices such as Shannon Wiener index (H'), Pielou's evenness and Simpson's index (Ds). Twenty-six predetermined sampling sites for both upper and lower catchments representing the main river with tributaries depending on the pollution status and fish availability were selected for the study. Fish diversity data were collected once in three months for all locations and all freshwater fish samples were collected using the cast net and after being identified they were released back to the site of capture. A total of 37 freshwater fish species belonging to 12 families were recorded and out of these, 22 species belonged to family Cyprinidae and 17 species were endemic to Sri Lanka. Furthermore, family Cyprinidae had the highest number of species in both catchments as 79.64% in the lower catchment and 94.45% in the upper catchment. Among the cyprinids species in both lower and upper basins, *Rabora daniconius* recorded the highest frequencies as 34.07% and 32.89%, respectively. Within the lower catchment, *Dawkinsia srilankensis* and *Garra ceylonensis* were present mostly in polluted locations and *Pethiya reval* was also evenly distributed forming these three species as a major component and the best-adapted species of the fish population. In the upper catchment *G. ceylonensis* and *Tor khudree* are present mostly in fast-flowing cold waters indicating their low tolerance for variation in temperature and dissolved oxygen. Within the lower and upper catchment, the highest H' index was recorded in Kaduwela (2.47) and Lahupana Ella (2.08) with comparatively high species richness with other locations respectively. Furthermore, the lowest value (0.69) recorded in Wellampitiya in lower reach relatively received low species richness as well. Within the upper catchment, the lowest H' index (1.09) was recorded for Bagawanthalawa located in the hilly area. Due to the proper conditions of the riverine habitats, fish species like *T. khudree* inhabit upstream whereas downstream has a higher species richness due to various available habitat properties in the river.

Keywords: Kelani river, water quality, freshwater fish, diversity

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Determining the causes of failing pre-auction tea samples at the qualitative analysis by an expert panel of tea tasters within the last five years in Sri Lanka

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Sri Lankan tea known for generations as "Ceylon Tea" is reputed for its taste and aroma the world over. In the global export front, the country holds the position of the third-largest exporter of tea. The tea processing factories for exports continually improve and upgrade to meet required technical and hygienic standards to conform to the international food safety requirements. However, it was revealed that more than 2000 pre-auction tea samples get rejected per annum. Therefore, the objective of the current study is to disclose the main factors that lead to failing pre-auction samples (FPAS) at the qualitative analysis by an expert panel of tea tasters within the last five years. Total population sampling was used as the sampling technique (n=1500). Data were analyzed with the use of SPSS. The dependent variable of the research is failing pre-auction samples (FPAS) while six independent variables have been recognized: water extract (WE), alkalinity (A), acid insoluble ash (AIA), crude fibre (CF), the microbiological requirement (MR) and not true to grade (NTG). Correlation tests were performed in order to test the hypothesis. The regression results of measuring relationships between AIA and FPAS, CF and FPAS, MR and FPAS, and NTG and FPAS signify valid regression models ($p<0.005$) which explains 47.9%, 59.4%, 51.5% and 55.7% variance of the outcome variables, respectively. It was revealed that AIA, CF, MR and NTG are significant predictors ($p<0.005$) of FPAS since beta coefficient values are greater than 0.7. The investigation intends to give helpful bits of alertness to all the stakeholders of the tea industry so that to put efforts into the reduction of failing pre-auction samples. As per the results, the highest cause of failing pre-auction samples is high levels of crude fiber which cannot be completely controlled during tea processing. Therefore, taking sufficient preventive measures at the factory level to reduce the amount of crude fiber in processed tea is vital. It was revealed that there are significant relationships between acid insoluble ash and failing pre-auction samples, crude fiber and failing pre-auction samples, microbiological requirement and failing pre-auction samples, and not true to grade and failing pre-auction samples.

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Phenolic and flavonoid contents and antioxidant activity of different edible parts of *Artocarpus heterophyllus* Lam. (Moraceae)

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Artocarpus heterophyllus (Jackfruit) is a widely grown perennial fruit tree which belongs to the family Moraceae. The majority of all parts of the plant are being used for medicinal purpose because of having numerous pharmacological properties such as antioxidant, anti-inflammatory, antibacterial, anti-cariogenic, anti-fungal, antineoplastic, hypoglycemic and wound healing effects. The present study was undertaken to determine total antioxidant capacity (TAC), total phenolic content (TPC) and total flavonoid content (TFC) of different edible parts (seeds, bulbs, seed-shells and rags) of fruits of two varieties of jackfruit *viz. Fartherlong* and *Hirosa* in two maturity stages (mature and ripen). The TAC, TPC and TFC were determined using ferric iron-reducing antioxidant power (FRAP) assay, modified Folin-Ciocalteu method and colorimetric method, respectively. Among the results of the tested parts, significantly highest TAC (14.13 ± 0.17 mg TE/ g DW), TPC (9.36 ± 1.41 mg GAE/ g DW) and TFC (18.63 ± 1.07 mg RE/ g DW) were recorded in rags of ripen fruits of *Fatherlong* variety. The lowest TAC, TPC and TFC values were observed in bulbs of ripen fruits in both varieties. Rags and seed-shells had higher TAC, TPC and TFC values than seeds and bulbs. The TAC, TPC and TFC of rags and seed-shells in both varieties have been increased with maturity. However, with maturity slight reduction of TAC, TPC and TFC in seeds and bulbs of both varieties were observed. Furthermore, the results revealed that the TAC showed a significantly strong positive correlation with the TFC ($R^2 = 0.9001$) and with the TPC ($R^2 = 0.822$) and it expresses that the phenolic components contribute significantly to the antioxidant capacity of different edible parts of fruits of *A. heterophyllus*. The present study revealed that rags and seed shells which are normally removed when processing, contain higher bioactive compounds and antioxidant capacity. Therefore, rags and seed-shells of fruits of *Artocarpus heterophyllus* can be used to develop value-added products such as pickles, chutneys, sweets, snacks, jams, etc. instead of disposing of them as waste.

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Development of rice bran oil incorporated table margarine and determination of its oxidative stability

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Rice bran is a by-product of the milling process, which is rich in protein, vitamins, enzymes, and containing 18-22% oil. Rice bran oil (RBO) is a rich source of bioactive compounds such as tocopherols tocotrienols, γ-oryzanol, phytosterols, polyphenols and squalene which are responsible for antioxidant capacity. Rice bran oil is a versatile oil with a balanced fatty acid profile and the functional properties of γ-oryzanol. It has an ideal ratio (1:2.2:1.5) of saturated fatty acids, monounsaturated fatty acids and polyunsaturated fatty acids that is close to the recommendation of the world health organization. Even though margarine is an easy option to improve the overall quality of dietary fat, most kinds of margarine consumed in Sri Lanka are made from oils rich in saturated fatty acids. Therefore, rice bran oil is a good option to replace saturated fatty acids in oils. The objective of this work was to develop rice bran oil incorporated table margarine and to determine the oxidative stability of the novel margarine. Blends were developed by adding RBO amounts of 5%, 10%, 15% and 20% into the standard margarine blend. The use of synthetic antioxidants in lipid-rich foods has been discouraged due to safety issues. As a result, the use of natural antioxidants is on the rise. Further, assuming RBO as a natural antioxidant, another 4 types of blends were developed by adding ascorbyl palmitate (0.015%), TBHQ (tertiary butylhydroquinone) (0.015%), rosemary extract (0.2%) and RBO (20%), and Ascorbyl palmitate (0.0075%). Then, the oxidative stability of treatments was determined by the accelerated shelf-life method. TBHQ added to blend, showed the highest induction time (2.070 ± 0.010) hours, being the most oxidative stable sample. There was no significant difference ($p > 0.05$) in stability among RBO blends of 5%, 10%, and 15%. Finally, the margarine was developed with 20% RBO and (0.0075%) ascorbyl palmitate, which showed similar oxidative stability as TBHQ. Further, the physical, chemical and sensory properties of novel margarine were determined. Even if our staple diet is rice, still rice bran oil remains uncharted.

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Co-benefit assessment of a coastal railway embankment for tsunami risk reduction: A case study in Panadura, Sri Lanka

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The tsunami risk in populated coastal areas is escalating due to unprecedented population growth. Tsunami risk management in Sri Lanka primarily depends on Early Warning Systems but, they can only save human lives. Expensive, hard, defensive structures such as seawalls and tsunami breakwaters are needed to protect property against a tsunami. Developing countries like Sri Lanka do not have sufficient budgetary allocations for such measures. However, some coastal infrastructure such as coastal railway embankments could be upgraded to function as defensive structures as a co-benefit. This abstract presents a case study that has identified the viability of upgrading the coastal railway embankment between Panadura and Pinwatta considering a probable tsunami risk. A set of upgrades was proposed to the existing railway to achieve this co-benefit and the cost of upgrading was estimated. The tsunami inundation, propagation, and generation were modelled using the Community Model Interface for Tsunami (ComMIT model). The tsunami induced damage on the housing sector in the selected case study area was estimated in monetary terms with and without the proposed upgrades to the railway embankment. The tsunami damage mitigation co-benefit was interpreted in monetary terms. Results emphasized a massive reduction in the property damage worth Rs 0.36 billion due to the upgraded embankment with an estimated co-benefit of Rs 0.17 billion. The inundation extent of the study area was reduced by 2.68 km^2. It was economical to upgrade the selected railway embankment as a co-beneficial structure for tsunami damage mitigation. The upgraded coastal railway embankment not only reduced the property damage but also increased the possible evacuation time of the occupants of the area. Coastal railway designs should be done considering both economic development and tsunami risk reduction perspectives to make those public fund investments more fruitful.

Keywords: Tsunami, Sri Lanka, co-benefit, economical

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Assessment of wave climate change and its impact on littoral drift along the coastline of Sri Lanka

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Climate change became a major research topic due to the consequent impact on the environment. Coastal erosion is one of its major environmental impacts in Sri Lanka and it is considered as a major socio-economic issue as well. However, the scientific evidence is limited on wave climate change and its impact on littoral drift. The purpose of this study was to identify the patterns of the change in wave climate and find its relation to beach erosion in different coastlines of Sri Lanka. Firstly, we analyzed the long-term wave climate (peak wave periods, significant wave heights and mean wave direction); secondly, we identified the patterns of the change in wave climate; and thirdly we estimated the sediment transport rates using the CERC equation. Re-analyzed wave data was obtained from a recent study. Sediment transport rates were estimated by defining 73 coastal cells covering the entire coastline of Sri Lanka. Open-source analytical tools such as Panoply, Python Pandas, OriginPro, and Oriana were used to extract and analyze wave data at each cell from the re-analyzed data. This study showed that the coastline of Sri Lanka has a tendency towards erosion due to changes in significant wave heights and mean wave directions. In general, the mean wave direction and the peak wave period were not significantly affected during last 3 decades and the wave direction ranged between 135° and 275°. Moreover, the significant wave height has slightly increasing trend according to time series analysis. The littoral drift and its direction are mainly governed by Southwest monsoon and Northeast monsoon, and the highest sediment transport rate takes place during the Southwest monsoon season. As a result, some locations such as Panadura, Dondara, Vankalai, Mullaitivu in the southwest, northeast, and northwest respectively could pose severe long-term erosion. The annual net sediment transport rate is ranged between 0.8 and 4.5 × 10^5 m³/year along the western coast and is the highest. This study identified an erosion trend due to change in pattern of littoral drift and showed the vulnerable coasts for erosion of Sri Lanka.

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Comparison of pollution scenarios of East (including Floating market), West, South-West Beira Lakes and Galle Face Lakes

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Beira Lake is a crucial landmark situated in the center of Colombo. Due to its spread through different parts within the city, the Beira Lake is categorized into four major basins; East Lake (including floating market), West Lake, South-West Lake and the Galle Face Lake. This study was conducted to quantitatively analyze, understand and compare the water quality status and dynamics of the different basins of Beira Lake. One-time water sampling from chosen sample stations within the Beira Lake was carried out, followed by laboratory experiments to assess the water quality. The samples were tested for temperature, pH, total dissolved solids, electrical conductivity, salinity, dissolved oxygen, Secchi depth, nitrate, nitrite, reactive phosphorous (orthophosphate), ammoniacal nitrogen, biochemical oxygen demand, chemical oxygen demand and Chlorophyll-a. Results indicated the Floating Market area to be highly polluted and nutrient enriched with reactive phosphorous (1.116 mg/l) and ammoniacal nitrogen (0.66 mg/l), giving the highest mean values of all four sites studied. Rapid urbanization, rainwater runoff and anthropogenic activities such as untreated wastewater influx into the lake on a daily basis can be identified as the reasons for these obtained values. For successful restoration of Beira Lake, careful targeting of the root causes of pollution and their mitigation is needed. This can be done by obtaining detailed understanding of the Beira Lake catchment land use and their contribution to the pollution of the lake.

Keywords: Chlorophyll-a, eutrophication, wastewater inflows, water quality

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Assessing the impact of the X-Press Pearl Ship Fire on air pollution in Western Sri Lanka

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The container cargo vessel X-Press Pearl caught fire on May 20, 2021 while anchored 9.5 km northwest of the Colombo Port. It carried 1,486 containers with toxic content including 25 tons of nitric acid, other chemicals, cosmetics, and lubricants, along with 78 metric tons of plastic nurdles. After burning for five days, the cargo exploded on 25th May and sank partially on 2nd June. After the explosion and fire, plumes of thick dark smoke were seen from miles away. We seek to see whether the air pollution from this disaster was detected on our ongoing instrumental measurements on the Western Coast and the Hills. We pose the questions: (i) were the wind conditions likely to lead to pollution over the locales in which our instruments were situated? and (ii) were particulate matter and other gases detected?   The weather, wind and air-pollution data (fine particulate matter and Carbon Dioxide) reported here were recorded every few minutes. Pollution roses are a quick way to summarize the likely arrival of pollution at any place using the data from the period of the fires and the wind speed and directions. The pollution roses analyzed to 16 quadrants of the compass show that the arrival directions on average were preferentially from the ship's general locale to the Colombo, Puttalam and Nawalapitiya regions. However, the concentrations of fine particulate matter and Carbon Dioxide in these locations during the duration of the fire does not show significant peaks at the hourly time-step when compared with the readings for the last few years. While no significant anomalies have been detected at the hourly time step, work is ongoing with data collected every 5 minutes. As the instrument in Colombo, Puttalam and Nawalapitiya were 20 km,106 km, and 84 km from the ship, there could have dilution and intermittent periods of the plume reaching each locale and the pollution could also be transported above these locales. As trace toxins and particulates could affect the cloud microphysics and chemistry, further analysis is warranted. Work on estimating the potential emissions and the modelled trajectories is being reported separately.

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Identification of historical changes and management of the Kalu river estuary (Calido beach)

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An estuary is a semi enclosed body of water, where a river meets the ocean. Fisheries, aquaculture, ecotourism, and port facilities rely on estuaries to contribute revenue to national, regional, and local economies. Estuarine shorelines are continuously dynamic and shaped by climate change induced by oceanic conditions, coastal erosion and river floods. Kalu river estuary is a beach, recently affected by estuarine dynamics in Sri Lanka. It was affected by floods in the short-term and coastal erosion in the long-term. The goal of this study was to identify the chronological causes and effects to manage the estuarine shoreline with the specific objectives of identifying the existing conditions of the site, estimating the accretion and erosion rates and areas, investigating the chronological causes and effects of management measures in river estuaries. The accretion rates and areas in Calido beach were estimated and aided in identifying the estuarine shoreline dynamic from 2004 to 2021. Reasons for the dynamic was identified as changes in the wave patterns, existing management structures, high discharge in the river in the main monsoons and unplanned widening of the estuary for the floods. The study was helpful to identify the underline issues with the estuarine dynamics. The fishing and the tourism sector of the residents will benefit through the identification of the most effective management measure. The study can be extended with bathymetric data and field surveys to estimate the sand volume in the future.

Keywords: Kalu River, estuary, management measures, historical changes, coastal erosion

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Valuation of eco-system services of green roofs as a sustainable rooftop technology: A case study for Colombo, Sri Lanka

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Rapid urbanization has led to alarming repercussions on the environment and human health. Therefore, global emphasis is directed towards switching into building sustainability, especially in urban areas. However, the lack of area availability is a major drawback towards introducing urban greening concepts. Integration of green roofs is a commonly used greening concept as it utilizes the highly spacious roof surface areas in a sustainable manner. Green roofs also provide a multitude of additional benefits to the building and surroundings, which are known as ecosystem services. Some of these services include cooling energy savings, run-off reduction thereby reducing urban flash floods, urban heat island mitigation, air quality improvement, carbon sequestration, and improving the building aesthetics while providing habitat and recreational opportunities. Even though research has been conducted throughout the world regarding green roofs, no studies have been conducted to valuate the eco-system services provided by green roofs in terms of their environmental and economic benefits in the Sri Lankan context, considering local climatic and financial scenarios. Therefore, the major objective of this research is to perform a comprehensive analysis on the effectiveness of green roofs, considering their environmental and economic feasibility for Sri Lanka, by using Colombo as a case study. The present study investigates the ecosystem services of green roof technology by retrofitting 10 rooftops with hypothetical semi-intensive green roof scenarios. Studied green roofs achieved an energy saving potential of 22.29 KWh/yr/m^2 with an annual saving of LKR 481.46 per m^2. Furthermore, green roofs provided a benefit of LKR 125 per m^2 in terms of air pollutant removal and CO_2 sequestration. In financial terms, green roofs exemplified 17-18 years to recover its total investment with a NPV of -8857.71 (LKR/ m^2) for the selected case studies in Colombo district.

Keywords : Eco-system services, green roofs, Sri Lanka

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Groundwater susceptibility assessment of Kala Oya Basin, Sri Lanka

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Among Sri Lanka's River basins, Kala Oya basin is the third largest, and it is one of the most widely used sources of water for irrigation, water supply, and other diversions. North Central and North Western provinces are known to be having bi- seasonal climates: dry season and rainy season. In the dry season, people tend to rely on groundwater resources as surface water fails to fulfill their needs. In the dry season, the most important water source of the Kala Oya basin is the groundwater for both domestic and agricultural purposes. Natural and anthropogenic activities can adversely affect the quality of groundwater. Using the DRASTIC model in a GIS platform, the current study assisted in evaluating the vulnerability of groundwater. DRASTIC is an index method that considers the main hydrological and geological factors with a potential impact on groundwater pollution, in which each of the hydrogeological factors was assigned a rating from 1 to 10 based on a pre-set range of values. Its acronym stands for Depth to groundwater, Recharge rate, Aquifer, Soil, Topography, Impact of Vadose zone, and Conductivity of Aquifer. To map the groundwater vulnerability of the study area, the DRASTIC indices were calculated in the GIS environment by overlaying seven layers for dry and wet seasons in ArcGIS. The study shows that most of the watershed area comes under moderate groundwater vulnerable zone ($121 < DI \leq 135$) because of the high use of fertilizers for agricultural purposes, which led to the pollution of the groundwater in this watershed. This is a major cause of concern as the Kala Oya area is prone to drought and groundwater pollution. The study produced a valuable map for management personnel because it gives a very comprehensive indication of vulnerability to groundwater contamination. The high vulnerability of groundwater contamination makes it necessary for local authorities to manage groundwater resources, monitor this problem closely and to act accordingly. Vulnerability maps are good tools to make local and regional assessment of groundwater vulnerability potential to identify areas susceptible to contamination, to design a monitoring network, and to evaluate groundwater contamination, particularly nonpoint contamination.

Groundwater modeling to investigate the oil spill contamination of Chunnakam aquifer in Jaffna peninsula

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In Jaffna peninsula groundwater is the only water source for sustaining life and the environment. Four groundwater aquifers are available for water consumption based on the capacity and quality of water; namely, Vadamarachchi-East aquifer, Chavakachcheri aquifer, Chunnakam aquifer and Kayts aquifer. Among these aquifers, Chunnakam aquifer has the largest capacity and acceptable quality of water for drinking and other usage. Overextraction of groundwater and anthropogenic activities affect the quality of ground water in different ways. Similarly, the Chunnakam aquifer is affected by the fossil fuel power station in Chunnakam, and this was identified in 2013. An analysis showed that the intake well and the adjacent wells are contaminated with oil. Modflow 6 - MT3DMS software was used to identify contaminant transport and the change of their concentration with time. ArcGIS was used to create the groundwater level contour map and spatial distribution of oil and grease concentration. Based on the groundwater contour map, groundwater level is varying from 4.0 msl to - 1.5 msl and the flow is towards the lagoon from NE to SW direction. According to the spatially distributed contamination map, the high oil and grease concentration layers were observed in the surroundings of the Chunnakam power station. Around 375 m surrounding area of the Chunnakam power station having a high risk of contamination. The results revealed that there are high concentrations of oil and grease in the water samples fluctuating around 7 mg/l. This finding suggests that oil and grease contamination affects the groundwater quality even today (2021). However, the groundwater modeling shows that oil and grease concentrations in the Chunnakam aquifer decreases with the time. These results could help to recognize and prioritize areas for future sustainable groundwater development plans.

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Study on tidal rise and salinity intrusion in Benthara River lowland corridor

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Eighty four percent of the Gross Domestic Production (GDP) of Sri Lanka is based on the agricultural sector. The degradation of productive agricultural lands due to various reasons is a major critical problem for the economy of a developing country like Sri Lanka. Saltwater intrusion is one of the major causes of land degradation along the coastal belt. Benthara lowland corridor is affected by high levels of salinity intrusion and about 80 percent (2279 ha) of productive agricultural lands have been abandoned due to this issue. It is important to predict future land inundation areas due to tidal rise and future salinity transportation along the river to develop future salinity management strategies. Therefore, this study sought to assess and forecast future saltwater intrusion along the Benthara River and propose suitable engineering solutions to mitigate future salinity intrusion in Benthara lowland area. The future land inundation area due to tidal level rise was mapped considering the future tidal level projections according to the analysis results of 20 years tidal data. Light Detection and Ranging (LiDAR) was used to obtain high-resolution land surface elevation. To prepare the digital elevation model for the study area, LiDAR data, contour lines and spot heights were used. DEM and the land inundation forecasting maps were developed in the Arc GIS environment. Salinity intrusion data up to 30 km along the Benthara River and precipitation data were analyzed using SPSS software. Two hypothesis tests were done for this analysis. The results of the analysis were demonstrated graphically and mathematically as an equation.

Keywords: Benthara river, tidal rise, salinity intrusion, LiDAR Data, DEM

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Validation of high resolution GGMs over Sri Lanka using ground gravity & GPS-levelling data

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With the advent of new gravity dedicated satellite missions (CHAMP, GRACE and GOCE), the long wavelength gravity field modeling of the Earth is possible with remarkable accuracy. Numerous global geopotential models (GGMs) have been developed to date with the improved satellite gravity information, enhanced land gravity and satellite altimeter data. Since recent past, high resolution GGMs (HR-GGM) have been developed with significant accuracy. They can be useful for local and regional geodetic and geophysical applications; especially, in areas with lack of ground gravity data coverage. An accuracy analysis of GGMs is vital before using them in geodetic or geophysical applications. In this study, five HR-GGMs are evaluated against the absolute gravity, Bouguer anomaly and GPS-levelling data. Two regions with flat and rugged terrain; Jaffna and Bandarawela, were utilized to investigate their variations appropriately. Analysis of gravity and Bouguer anomaly revealed that the even high resolution global models are not capable of representing features in rugged mountainous areas because of the omission errors resulted due to the truncation of the model's gravity field at its maximum degree and order, but fitted quite well with flat terrain. A clear bias around 1.6 m of Sri Lankan GPS-levelling datum can be seen through the results of geoid height analysis of high mean values and comparatively low standard deviations. Overall, recently released SGGUGM-2 model shows a better agreement with ground gravity and GPS-levelling data in Sri Lanka.

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Pavement thermal behavior with reference to the physical attributes: An experimental and field comparison

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Pavements represent a high fraction of the urban land use and contribute to the Urban-Heat-Island (UHI) in cities by absorbing radiation and converting it to heat, which is released back to the surroundings. This contributes to the microclimatic variations in urban areas, which exhibit higher ambient temperatures in comparison with their outskirts. Different types of pavers are available for pavement construction with vast variations of colour, material, surface smoothness, and mixed designs. These variations may account for varied absorption of radiation and heating and contribute to the UHI in different intensities. Several studies have been carried out to identify how various physical attributes of pavements effect towards urban microclimates using experimental setups. However, these results may vary from the actual thermal performance, and limited studies have been conducted comparing between them. Therefore, the objective of this study is to compare and contrast the trends and quantities of thermal performance between the outside actual pavers and the experimental set ups. Experimental pavers placed at the University of Sri Jayewardenepura, Sri Lanka were classified using their surface textures and colours as Grey-Rough (GR), Grey-Jagged (GJ), Grey-Smooth (GS), Red-Rough (RR), and Black-Rough (BR). The study of actual pavement setups was conducted at two outdoor locations at Jaltara and Kahathuduwa. The experimental paver comparisons with the outdoor pavers in the real-world scenario show that even though the quantifications for the surface temperatures vary based on the size, location and local climate condition of the location, the proportionate variations of the temperature between the experimental pavers and the real-world pavers are similar. The results showed that, at the peak hour the surface temperature of outside actual pavers was higher than that of experimental paver setups by 7.62, 10.32, 9.25, 13.28, 14.94 ºC for GS, GJ, GR, RR, BR, respectively. However, both experimental and outdoor pavers showed similar trends in their temperature profiles. Therefore, it can be concluded that the heat absorption depends on the physical attributes of the pavement in similar trends disregarding the scale, although actual pavers show higher surface temperature. Thus, the outdoor data collection performed in this study validates the experimental results.

Keywords: Urban heat island, pavements, thermal performance, experimental study

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A GIS-based decision support tool for the renewable energy resource planning in Sri Lanka

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With the global shortage of fossil fuels and significant environmental damage through its extraction, the need of switching to renewable energy sources has been identified as a timely endeavour. A careful screening is essential when selecting potential locations for wind and solar farms, keeping in mind the significant land use limitations for harnessing these energy sources optimally. The present research has made an attempt to develop a GIS based Weighted Overlay Model to identify potential locations for the development of Wind and Solar power plants, which are rapidly advancing renewable energy resources in Sri Lanka. Among the different land use types available, four types of land use patterns which are barren lands, sand areas, open forests and scrub lands were identified as sites with least productivity and were considered as potential lands for solar and wind power plant establishment. Forest reservations, wildlife reservations, archaeological sites, water bodies, coastal conservation areas, distance to roads and railway lines, urban centers, building extent including houses and distance from airports and seaport were identified as constraints for the power plant development and were subtracted the land use map to obtain the total restricted area map. Based on the criteria identification process, wind speed, distance to road, distance to urban centers, distance to houses, distance to transmission line, land use pattern, elevation, slope and bird fly path were selected as major parameters that influence the installation wind farms in Sri Lanka. The parameters considered in the solar model were solar irradiance, distance from the roads, distance from the urban centers, distance from the houses, transmission line, elevation and slope. Weightages for each of the parameters were obtained through consulting experts in Sustainable Energy Authority. The suitability map for the areas of potential wind plants was represented with 3 main suitability criteria. Accordingly, 5 major suitability criteria were identified in site suitability map of solar energy. The model validation performed by overlaying the developed site suitability map with the existing solar and wind power plants showed a significant accuracy with the current Sri Lankan renewable energy resource distribution.

Keywords - Land suitability analysis, Wind energy, Solar energy, GIS, Weighted Overlay

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Causes of disputes in Sri Lankan construction industry based on the procurement system used

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The Sri Lankan construction industry is one of the main industries which contributes 7.7–8.0% Gross Domestic Product (GDP) towards the country's economy and a considerable amount of employment opportunities. However, the complex nature and the different stakeholder involvement negatively contribute to the construction project efficiency due to the occurrence of the dispute. However, the project risks which were not assigned are in the early stage of the dispute continuum model in the construction projects. Risk allocation of the construction projects was done through the procurement systems. Therefore, the focus of this research was to investigate the causes of disputes based on the traditional and design and build procurement systems in the Sri Lankan construction industry. The method adopted was mixed-method research. There, semi-structured interviews from 10 construction industry professionals were conducted to contextualize the dispute causes with procurement systems. For validation, interview findings were presented through a questionnaire survey to 40 industry professionals and made them to categorize the dispute causes based on the procurement systems. Design errors, unrealistic expectations, inadequate/incomplete specifications, quality of design, availability of information, ambiguities in contract documents, tendering, risk allocation, and unforeseen changes are only relevant to the traditional procurement system. Several other disputes such as variations initiated by the owner, change of scope, payment delays, delays in work progress, weather, site conditions, time extensions, the financial failure of the contractor, and quality of work, are common dispute causes for traditional and design and build procurement systems. The research finding signifies that the dispute causes in a traditional procurement system immerged because of the employer, contractor, project, design, and contract documentation. In design and build contract, the disputes are mainly due to the design and the contract documentation of the project. Hence, the risk allocation of each procurement system has made the changes in dispute occurrence in construction projects. Therefore, the causes of disputes which can occur in using different procurement systems should consider when selecting a procurement system for a construction project.

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A hybrid system for non-hybrid vehicles

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The environmental impact of automobile usage has been on the rise for the past several decades and has become one of the world's major ecological and social problems. Alternate technologies such as electric cars, hybrid vehicles, and fuel cells are necessary and should be implemented to monitor or avoid the future worsening of Air Quality Index. The emergence of hybrid electric vehicle (HEV) technology, it is seen as a ready-to-use alternative option in terms of infrastructural limitations. Over the past few years, several manufacturers have implemented hybrid systems across several vehicle models to increase fuel efficiency and to reduce emissions. City traffic jams nowadays are constantly devastating. The continuous short stops of vehicles can cause the frequent occurrence of idle engine conditions and excessive fuel consumption. Usually, the hybrid car achieves higher fuel economy and lower emissions than traditional internal combustion engine cars, leading to fewer emissions. Hybrid vehicles will reduce air pollution by up to 90% from smog-forming pollutants and slash carbon dioxide emissions in half. Therefore, hybrid vehicle demand is growing, ensuring energy saving and reduction of emissions by equipping with hybrid idle system and brake energy recovery system and driving assistance. The aim of this project is to design a hybrid system for non-hybrid vehicles with a view to improving fuel efficiency and reducing the potential for greenhouse gas emissions. An attempt was made to develop a hybrid system that includes idle start-stop driving assistance using cheap microcontrollers. To validate this hybrid system, it can be equipped with an electronic fuel injection system on any form of non-hybrid vehicle.

Keywords: Hybrid vehicles, fuel injection system, on-hybrid vehicles, hybrid, pollution

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Automated clutch system for left leg disabled persons

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The goal of this project was to build a device to effectively control the clutch of a manual transmission vehicle that can be used by left leg disabled people as well as others. The inspirations for this project include those who wish to be able to drive a manual transmission vehicle because of their interest in recreational driving or because they own one-of-a-kind car. Automatic transmission cars are generally expensive for them to afford. This system converts the existing manual transmission into semi-automatic transmission. The automated clutch operating system uses the existing clutch pedal mechanism system. By adding this system, the gears can be changed without operating the clutch pedal by the foot. In this project testing and research was done in several areas including the analysis of the electronic system present in the selected car and analysis of the clutch pedal depression. This leads to the design and fabrication of an ergonomic interface refining existing concepts to allow those without the use of their left leg to maintain full control of the clutch of a standard manual transmission vehicle. Some products offer control of the clutch pedal to the user by the means of a hand interface such as the 'Duck Clutch Control System of Elap UK' and the 'Alfred Bekker Manual Hand Clutch'. However, these products are expensive, invasive, and take away the full experience of driving a manual transmission of the car. In this project, we were able to design a clutch control system, which is fully automatic with reduced components and with a simple installation process. The system functions perfectly in all driving conditions such as starting the vehicle on a level road, starting the vehicle on a hill, descending a hill, and sudden braking on a traffic condition.

Keywords: Auto clutch, disabled people, semi-automatic, manual, transmission

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Computational simulation of cymatics with experimental analysis

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Cymatics is a visual representation of sound and vibrations, on surfaces of plates, diaphragms, and membranes, in the forms of auditory-images. The surfaces that are exposed to these vibrations are sprinkled with fine particles that accumulate at nodes, to create visualizations of a specific geometry which is unique to the particular frequency. The focus of this research is to design an experimental platform, dedicated towards observing the behaviour of cymatics, through the analysis of such visualizations (Chladni patterns). This is further investigated by performing numerical modelling using finite element simulation. Aluminum (Al) plates of 2 mm thickness—having three shapes, consisting of identical surface area—were used for both experimental and finite element analysis (FEA). FEA was performed using ANSYS simulation software and patterns were derived for different vibrational frequencies. The results demonstrated that 60% of the experimental imagery conforms with the visualization generated by ANSYS software. Additionally, the lowest average frequency error and average deviation for similar images were found to be 9.2 % and 2.8 mm, respectively for the triangular shape plate, validating that the shape of the plate plays a paramount role in cymatics analysis. An image processing technique was used to determine the deviation between the images created by the experimental platform and FEA for all three shapes. 2D Image processing technique was considered on the planner dimension of the required testing images. A black colour backgrounded image represented the testing plates having a vibration feature. A white colour sand line was used to track the cymatics pattern for 2D image processing. The patterns of the simulated image obtained from from ANSYS was compared with the 2D image which was obtained from a USB camera. The results demonstrate that Chladni patterns are best represented by a triangular shaped plate.

Keywords: Cymatics, finite element analysis, Chladni patterns, vibration, resonance

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Development of an automatic industrial idly making machine

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The commercial production of 'idly', a South Indian healthy food variety, involves long working hours in a heaty environment and physical strain on the hands. An automatic idly making machine which could be used by industries, hotels/food outlets, etc., to make idly, efficiently and effectively, was designed and developed in this study. The machine was designed and developed using SolidWorks software and optimized before fabricating the beta prototype. The machine consists of three units; dispensing, conveying, and steaming. The dispensing unit was developed with 8 streams of volumetric dispensing, such that the idly batter from the batter tank will be dispensed by the press of linear actuators to the idly mould plates, which will be positioned right beneath the dispensing system. The conveying unit advances each idly plate in a similar manner until a batch is completed. Then the dispensed batch will be steamed under a steaming unit and thereafter, dispensing of the next batch takes place. These processes are repeated continuously until user input target is reached. It produces idly with a 57.4% reduction of time consumption, 75% reduction in human involvement and 76% increment of the productivity. The machine can produce different sized idly. The developed machine can produce 512 idly/hour with one operator. The total cost of the machine is around LKR 1,416,000 and it could put into the market with a selling price of LKR 2,000,000. The cost it saves per day was estimated to be around LKR 1,493. For an industry which produces 1000 idly per day, the payback period would be 44 months. Even though the machine was designed for idly making, the design of the dispensing unit and conveying unit can be modified for making other types of food such as string hoppers and pittu, which are cooked by steaming.

Keywords: Automatic idly making, dispensing, steaming, idly batter

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Pressure sensing device for diabetic foot ulcer monitoring

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The design of a pressure sensing circuit and related parameters are discussed in this paper. Patients with diabetes often lose the sense of pain in their feet, resulting in inadequate pressure under their feet. A circuit is proposed to measure the pressure on the foot with the help of a force sensing resistor. The objectives of the research are to design and fabricate a hardware component that has the capability to measure foot pressure during gait, implement a method to transmit sensor values to a device wirelessly and display sensor data in real time. The sensor acquires the pressure on the foot and the first metatarsal, the fifth metatarsal, the mid foot and the heel were considered as the main pressure points of foot. Four-layer type force sensitive resistors, microcontroller, blue tooth device and lithium polymer battery were kept under the rubber slipper and data was recorded. The calibrated instrument tested for different weights ranging from 49 kg to 96 kg. The results indicate that the instrument gives accurate measurements in the range of 60 kg to 80 kg. The data were transferred through blue tooth device connected to the patient's mobile phone. This device can be recommended for diabetic patients in the weight range of 60–80 kg.

Keywords: Foot pressure, senser, diabetic patient

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401/D

Identification of an earthworm using molecular barcoding COI region from Polonnaruwa area

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Molecular techniques are helpful in the identification of earthworm species, especially when morphological characters are not taxonomically informative or difficult to discern. There are no reports on previous studies that have investigated molecular-based methods or combined morphological and molecular methods for earthworm taxonomy in Sri Lanka. The focus of the present study was to make the first approach using DNA barcoding to smoothen the way towards determining the earthworm richness in Sri Lanka. This study evaluated the use of both morphological and DNA barcodes to identify earthworm species inhabiting the Thamankaduwa in Polonnaruwa district of Sri Lanka. Adult clitellate earthworms were dissected and external and internal morphological identifications were conducted using 4 selected samples. According to morphological keys, resulting taxonomic features revealed that the earthworm belongs to the genus *Megascolex*. For molecular identification, genomic DNA extraction was carried out using 4 selected samples, and amplification of mitochondrial COI region was performed from extracted DNA. Sequences obtained were subjected to Basic Local Alignment Search Tool (BLAST) searches and compared to sequences available in GenBank. Results revealed 79.73% sequence similarity for the COI gene in Megascolecidae sp. Furthermore, it showed an A+T% bias, which is commonly observed in earthworms. Phylogenetic analysis performed using the Bayesian analysis showed that the obtained sequence was most closely related to *Megascolex laingii*. However, according to the morphological comparison, this finding was not fully supported, indicating the need for further taxonomic identification of this species. The average interspecific distance of sequences used for this study was 0.18%, giving a sequence threshold of 1.8%. About 95% of congeneric species pairs showed at least 15% sequence divergence, while levels of sequence divergence within a species were lower than 4%. This indicates a good separation of these species by genetic distance using the COI barcode. In conclusion, both morphological and molecular techniques confirmed that the studied earthworm belongs to the genus *Megascolex*. However, a further internal morphological examination is essential to identify the studied earthworm species to the species level.

Key words: *Megascolex*, earthworm, molecular barcoding

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402/D

Characterization of venom proteins of jellyfish *Catostylus* sp. from Beruwala, Sri Lanka

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Jellyfish venoms are rich sources of bioactive molecules synthesized to capture prey or deter predators. Many of these molecules are proteins with unique properties, which can elicit toxic effects in a local and systemic manner in humans. Therefore, the present study aimed at investigating the potential toxin proteins underlying the significant toxic effects of the crude venom extracted from jellyfish *Catostylus* sp. nematocysts. Jellyfish specimens were collected from the Beruwala coast and identified as *Catostylus* sp. using morphological and molecular approaches. The crude venom extract was prepared by sonicating nematocysts of jellyfish specimens, and the total protein content was estimated using the Bradford assay. The SDS-PAGE was used to determine the molecular weights of proteins in the venom extract. Tryptic digested peptides of the extracted proteins were then analyzed by nano-liquid chromatography-tandem mass spectrometry (nanoLC-MS/MS), and all MS/MS spectra were searched by ProteinPilot software. A total of 13 toxin proteins were identified, in the molecular weight ranging from 4,318 to 184,923 Da, revealing the complexity of *Catostylus* sp. venom. Evaluation of the crude extract showed 12.56±0.07 µg/ml of protein content. The overall protein composition of jellyfish venom was dominated by potassium channel toxin alpha-KTx. Also, toxin proteins phospholipase A2 and A1, small cysteine-rich protein, fragments of snake venom serine protease pictobin, thrombin-like enzyme elegaxobin-1, toxin BmKaTx10, CrTX-A, Turripeptide VIII-01, venom factor, and putative antimicrobial peptides were recorded. In conclusion, the significant toxin group of the venom of *Catostylus* sp. was neurotoxin. However, further research to confirm the physiological activities of identified toxin proteins is warranted.

Key words: Jellyfish, *Catostylus* sp., venom proteins, neurotoxins

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403/D

Experimental approach in conservational biological control of *Spodoptera frugiperda* (Lepidoptera: Noctuidae): use of the prey detectability of arboreal tiger beetles in Sri Lanka

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Beetles in agroecosystems considerably contribute to natural pest control based on their different behavioral tactics in hunting and discriminating prey species. With highly specialized anatomical adaptations for predation, Arboreal Tiger Beetles (ATB) are voracious visual predators that feed on various small invertebrates. Though ATBs are frequently found in forest habitats with less vegetation, recent studies have recorded them from agroecosystems in Sri Lanka. Thus, this study aimed to identify ATBs' role using endemic *Derocrania sitiscabra* as a potential biocontrol agent of Fall Armyworm (FAW) larvae; a polyphagous pest in Sri Lankan agroecosystems. A laboratory-based cafeteria experiment was conducted to determine ATBs' choice on life vs. dead prey, the most preferred live prey, and the most favorable FAW larval instar stage. The effect of prey choice on larvae, in the presence of its most favorable prey was determined using Mann-Whitney (MW) U-test ($\alpha = 0.05$) in Minitab 19 software. The degree of individual diet specialization was quantified by experimentally testing individuals ($N = 9$) over time through repeated trials using minced meat, salmon fish, red fire ants (*Solenopsis geminate*), earthworms, and laboratory-reared 1-6 larval FAW as prey. ATBs' general feeding pattern preferred live prey over dead, and red fire ants were selected the most. The 2nd instars of FAW were the most preferable to the predator-prey body ratio as small prey is easier to manipulate & bite and shortens the handling time. According to the MW U-test ($w = 213$; $p = 0.66$), the presence and absence of red ants did not affect the prey choice of ATBs on 2nd instars in conditions having the same number of prey items, same observation time, and duration. As visual predators, ATBs' foraging decision is based on its evaluation of the overall size and the movement of prey. The larvae that displayed frozen behavior as an adaptation to misplead the predator, were avoided. This provides insights into biological control of FAW in Sri Lanka. However, field-based studies with a higher prey/predator density are vital to assess any harmful ecological implications of ATBs upon infested fields.

404/D

Metagenomic assessment of archaeal diversity in surface waters of Mahapelessa and Wahawa hot springs of Sri Lanka

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Archaea are well known for their adaptations to extreme environments such as submarine volcanic vents, solfataric hot springs, or soda lakes. There are several hot springs in Sri Lanka; however, most of them have not yet been explored for the presence of archaea and require comprehensive studies to unravel their unknown and untapped phylogenetic and functional diversity. The objective of this study was to perform a metagenomic analysis on two major hot springs in Sri Lanka to uncover the resident archaeal diversity. Water samples (n=2 from each well) were collected from Mahapelessa (44.5 °C, pH=8.14) and Wahawa (42.8 °C, pH=7.17) hot springs located at Hambantota and Ampara districts, respectively. Genomic DNA was extracted from the water samples (6 replicates) using modified Boom's method and was subjected to 16S rRNA metagenomic sequencing using ARC 787F 5'-ATTAGATACCCSBGTAGTCC-3' and ARC 1059R 5'-GCCATGCACCWCCTCT-3' primers on an Illumina platform at Macrogen Inc., South Korea. The results were analyzed using EzBioCloud: Metagenomics data analysis software to identify archaeal diversity (Operational taxonomic units/ OTU), their relative abundance and alpha diversity indices in each hot spring. OTU analysis was carried out with a cut-off similarity of 97%. The 16S rRNA gene amplicon of V5-V8 region metagenome sequencing uncovered a unique taxonomic diversity of the resident thermophilic archaeal communities in these hot springs. A total of three archaeal phyla were observed, and among them, Thaumarchaeota (88.78%) was dominant in Mahapelessa, and Euryarchaeota (99.19%) was dominant in Wahawa hot spring. The low abundance of phylum Bathyarchaeota (0.1%) was detected in Mahapelessa hot spring. Genera *Halalkalicoccus, Halobacterium, Methanobacterium*, and *Methanosarcina* were unique to Mahapelessa, while genera *Halorubrum, Methanolinea*, and *Methanosaeta* were unique to Wahawa. Genus *Methanocella* was common to both hot springs. All identified genera belonged to the phylum Euryarchaeota. Among them, *Methanocella arvoryzae* (6.697%) and *Methanosarcina acetivorans* (0.002%) were identified up to species level from Mahapelessa and *Methanocella paludicola* (42.276%) was identified from Wahawa hot spring. This study gives insight into the vast archaeal diversity present in Mahapelessa and Wahawa hot springs.

Key Words: Metagenomic, archaeal, diversity, surface waters, hot springs

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405/D

Seasonal and spatial variability of prevalence of dengue and its transmitting vectors in the Matale district

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Dengue fever is a mosquito-borne viral disease with increasing importance due to its rapid spread, inadequate control, and lack of vaccines. In recent decades, dengue has spread within the Matale district. In Matale district, a highly localized pattern of transmission can be seen, and urban centers such as Matale Municipal Council and neighboring sub-districts such as Ukuwela, Rattota report high caseloads. Assessing the relationship between the dengue vectors, the seasonal variation, and the dengue transmissivity can help identify early warning indicators for dengue risk. Here, we investigate the relationship between vector indices and dengue cases. We obtained entomological surveys from the regional malaria office in Matale for 2015–2020. The daily/ weekly and monthly dengue case data for 2004–2020 were obtained from the Regional Director of Health Services. From the larval survey reports, a time series of monthly averages of the Breteau index (BI), container Index (CI) and premises index (PI) were developed per each MOH for the mosquito species *Aedes aegypti* (A. Ae) and *A. albopictus* (A.Ab) for 2015–2020. We computed the monthly average of the entomological indices by health sub-district (MOH). Cross-correlation analysis was carried out with the weekly dengue case data and entomological data with various lags. *A. aegypti* prevalence is lower than that of A.Ab. The seasonality of the averages of vector indices for the two species showed that A.Ab. mosquito a bimodal seasonality peaks in April to June and October to December. Cross-correlation between the dengue vector species shows that the dengue cases correlated statistically significantly with A.Ae. obtained 1–13 weeks prior. The dengue cases did not have a statistically significant correlation with A.Ab. in most of the MOH areas in Matale district except in urbanized MOH (Ukuwela, Rattota, Naula).

Key Words: Dengue, dengue vectors, seasonality, Matale, Knuckles

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406/D

Indoor and outdoor biting behaviour patterns of malaria vectors in Batticaloa and Mullaitivu districts, Sri Lanka

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The biting behaviour of anophelines is an important determinant of malaria transmission. Bionomics of malaria vectors such as peak biting hours, dynamics of indoor and outdoor biting preferences, and temporal variations of human feeding behaviours are essential in planning vector control activities such as Long-Lasting Insecticidal Nets (LLINs) and personal protective measures. Therefore, the objective of this research was to study the biting behaviours of malaria vectors at selected study sites in the Batticaloa and Mullaitivu districts. Human landing night collections were carried out between 1800 and 0600 hours at monthly intervals from January 2019 to December 2019. All human landing night collections indoors and outdoors yielded 414 anophelines belonging to eight species, of which 90.1% was *Anopheles culicifacies* Giles and 5.5% was *An. subpictus* Grassi. The other anopheline species were *An. tessellatus* Theobald (1.2%), *An. pallidus* Grassi (1.2%), *An. varuna* Iyengar (0.7%), *An. vagus* Dönitz (0.5%), *An. jamesii* Theobald (0.5%) and *An. peditaneatus* Leicester (0.2%). Human biting behaviour of *An. culicifacies* was predominant in both Batticaloa and Mullaitivu study sites with relative biting preference 69% and 100%, respectively. Further, *An. culicifacies* biting in both indoors and outdoors was prevalent throughout the year in both study sites. Human feeding behaviour of *An. culicifacies* was higher in January and October in Mullaitivu and May and October in Batticaloa study sites. The human landing activity peaked during 1900–2100 and 0400–0500 hours in Batticaloa, with the highest human landing density of 0.65 mosquitoes/person-hour outdoors and 0.25 mosquito/person-hour at indoors. In Mullaitivu study site, human landing activity peaked during 2000–2400 and 0200–0500 hours with the highest human landing density of 1.3 mosquitoes/person-hour at outdoors and 0.7 mosquitoes/person-hour at indoors. The study shows that the primary vector, *An. culicifacies* biting activity is high throughout the night, with similar indoor and outdoor patterns. Outdoor biting behaviour of *An. culicifacies* is more prevalent than indoor. Hence, all these factors need to be taken into consideration when planning and implementing malaria vector control activities in these two districts.

Key Words: Biting behaviour, malaria, vectors, Batticaloa, Mullaitivu

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407/D

Comparative assessment of soil quality in paddy and abandoned paddy lands for better land management

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Rice is the main source of food for more than half of the world's population and it is the staple food in Sri Lanka. Industrialization and urbanization combined with the population growth put a strain on available agricultural lands in urban areas. The focus of this study was to assess and compare the soil quality in paddy and abandoned paddy lands in selected five Grama Niladhari Divisions (GNDs) in Biyagama Divisional Secretariat Division (DSD). The GNDs were Pahala Biyanwila Central, Pahala Biyanwila East, Pahala Biyanwila West, Makola North Central, and Makola North Pahala. Among the selected five GNDs, ten sampling sites separately from paddy lands and abandoned paddy lands were selected based on judgmental sampling technique. Three soil samples were collected at a depth of 0–15 cm from each paddy site and abandoned paddy site during August and September 2020 (after rice harvest). The soil quality was examined through selected physicochemical parameters: temperature, color, particle density, pH, electrical conductivity, salinity, total nitrogen content, extractable phosphorous, organic matter and organic carbon content, and oil and grease content. The APHA and EPA standard procedures were followed for analyzing physicochemical parameters of soil quality. The results of physicochemical parameters were analyzed using MINITAB 14.0. One-way ANOVA was used to determine the variation among the sites, separately in paddy sites and abandoned paddy sites. Two sample t-test was used to compare each physicochemical parameter in paddy sites and abandoned paddy sites. When compared the soil quality in paddy and abandoned paddy lands, soil temperature, particle density, soil pH, electrical conductivity, salinity, total nitrogen, organic matter, and organic carbon are not significantly different with paddy and abandoned paddy lands (Two-sample t-test, $p > 0.05$). However, soil extractable phosphorous, as well as oil and grease content were significantly different between the paddy and abandoned paddy lands (Two-sample t-test, $p < 0.05$). It is concluded that low soil phosphorous and high oil and grease content have influenced the lands to be abandoned. Since clay particles are covered by oil and grease, it acts as a barrier to the adsorption of phosphorous. Suitable soil management strategies should be applied to reduce oil and grease to improve the soil quality in abandoned paddy lands.

408/D

The determination of soil organic carbon stocks in Salt Marshes at Northwest coast of Sri Lanka

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Salt marshes combined with mangroves and seagrasses are important coastal wetlands that can act as natural carbon sinks with a promising potential in climate change mitigation. The unique capacity of the wetland soil to capture and retain greater stocks of Blue Carbon, has widened the global research interest in incorporating coastal wetlands into carbon crediting frameworks. However, the Blue Carbon literature in South Asia undermines salt marshes due to the lack of scientific studies on these ecosystems. The present study focuses on quantification of belowground carbon stocks of salt marshes in Wedithalathive Nature Reserve to investigate the carbon storage potential in salt marsh soil. A total of 36 soil cores were sampled from vegetated and non-vegetated plots at the 4 study sites of Vellankulam, Illuppaikadavai, Wedithalathive and Adampan. Sediment characteristics such as dry bulk density (DBD) and soil moisture content were assessed during the analysis of samples and Loss-on-Ignition technique was applied collectively with a carbon conversion factor to determine the soil organic carbon (SOC) stock over 5 depth intervals (0–5 cm, 6–15 cm, 16–30 cm, 31–45 cm and 46 cm belowground). The organic carbon stocks in belowground biomass and sediments in 50 cm depth varied from 48.18 ± 5.6 Mg C ha^{-1} to 108.08 ± 8.51 Mg C ha^{-1} across the observed four sites. The %SOC content displayed a gradual decrease over the depth profile, and the surface layer was found to have a significantly high SOC density with the lowest DBD value compared to the deeper intervals. The percentage soil moisture positively correlated with percentage SOC values. In site-wise analysis, Wedithalathive demonstrated a significantly greater SOC stock out of the 4 study sites. As the first comprehensive analysis, current findings shed light on the scarcely available national level salt marsh carbon literature, and it emphasizes the capacity of salt marshes as a valuable carbon sink. Furthermore, it will serve as baseline information to promote future research to mobilize conservation efforts and to improve blue carbon storage estimates in coastal wetlands of Sri Lanka.

Keywords: Wetlands, blue carbon, salt marshes, soil organic carbon

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409/D

In vivo sub chronic nephrotoxicity induced by hybrid type star fruit (*Averrhoa carambola*) juice

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Averrhoea carambola (star fruit) is a popular fruit with high nutritive value. Between two available varieties, fresh juice of hybrid type fruit is more attractive due to its sweet taste, compared to the sour tasted wild type. However, due to the high content of oxalic acid and presence of a neurotoxic compound called caramboxin, star fruits are considered as a risk factor for development of nephrotoxicity in consumers. Therefore, the present study was designed to evaluate sub chronic toxic effects induced by continuous consumption of hybrid type star fruit juice in Wistar rats. Ethical clearance was obtained from the Ethics Review Committee of University of Sri Jayewardenepura. Fresh juice (2 ml) of semi-ripened hybrid type star fruits were fed orally to the test group of male Wistar rats (n=6), while the control group was fed with 2 ml of distilled water. After treating for 90 consecutive days, blood and urine were collected and subjected to biochemical, haematological and urine analysis. The harvested kidneys were observed for histopathological changes on H and E stained sections. Blood parameters such as red blood cell, total white blood cell, monocyte, granulocyte, lymphocyte and platelet counts and values of haematocrit, haemoglobin level, mean corpuscular volume, mean corpuscular hemoglobin, mean corpuscular hemoglobin concentration and red cell distribution width showed no significant (p>0.05) difference between the two groups. Blood cells also did not exhibit any abnormal morphology on the blood picture. The volume, glucose, protein, pH and specific gravity in urine samples did not indicate any difference between the two groups. Although serum urea, AST and ALT levels did not show a significant change, serum creatinine level exhibited a significant increase (p=0.004) in the test group compared to the control group. In kidney histology, abnormal features such as renal tubules dilation, flattening of lining cells of renal tubules, neutrophil infiltration and interstitial edema were prominent in the test group. The results of the present study suggest that continuous consumption of hybrid type star fruit does not develop an anemic condition or liver damage. However, increased serum creatinine level and histopathological observations of renal tissue revealed that there are nephrotoxic changes.

Keywords: *Averrhoea carambola,* nephrotoxicity, hybrid type, star fruit

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501/E1

Enhancement of the fill factor of cuprous oxide homojunction solar cells

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Cuprous oxide is a non-toxic low-cost photovoltaic material, which has the potential to replace expensive Si based solar cells. With the direct band gap of 2 eV, theoretical energy conversion efficiency of Cu_2O is 20%. Even if the short circuit current density (J_{sc}) of Cu_2O homojunction solar cells have been developed to the theoretical limit, open circuit voltage (V_{oc}) and the fill factor is yet to be improved. This low fill factor followed by low V_{oc} is due to the existence of p-type conductivity in n-type Cu_2O trap states and low transmittance of the window layer. In this investigation, we were able to increase the fill factor of Cu_2O homojunction device. n-Cu_2O films were electrodeposited on Ti substrates in baths containing 0.1 M sodium acetate, 0.01 M cupric acetate at -200 mV potential with respect to Ag/AgCl electrode. A Pt plate was used as counter electrode. Bath pH was adjusted to 6.1 and the temperature was maintained at 55 °C. After 60 minutes of deposition, samples were annealed at 100 °C for 24 hours and 175 °C for 30 minutes, respectively. Expectation of annealing was to eliminate the p-type conductivity in n-Cu_2O. Electrodeposition of p-Cu_2O was carried out in a bath containing 4 M NaOH, 3 M lactic acid and 0.4 M $CuSO_4$. Bath pH was adjusted to 13.0 and the temperature was maintained at 60 °C. Thicknesses of the n-Cu_2O and p-Cu_2O films were calculated to be 2.2 µm and 0.1 µm, respectively. After the deposition, bi-layers were exposed to ammonium sulphide vapor to form a thin CuS layer to remove the surface states so that it would make an ohmic contact with Au front contacts which is grown by sputtering. Final devices were characterized by obtaining I-V measurements and it was observed that p-type response of the device has disappeared and the fill factor is improved from 25% to 36%. Photoactive performance of the device improved from J_{sc} of 9.25 mA cm^{-2}, V_{oc} of 449 mV, and efficiency of 1.04 to J_{sc} of 10.11 mA cm^{-2}, V_{oc} of 425 mV, and efficiency of 1.55 under AM 1.5 illumination without and with improvement of the fill factor, respectively.

Keywords: Cu_2O Electrodeposition, Cu_2O Homojunction, fill factor

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502/E1

Development of CdS thin films for H₂S sensing applications

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Production of H_2S due to eutrophication of water bodies in urban areas is a major problem for the residents and commuters because of its irritant nature. Therefore, detecting H_2S is important to improve health and well-being of residents and commuters. Out of various types of commercially available gas sensors, semiconductor gas sensors (SGS) are considered as a set of versatile sensors. The most common sensing materials used in SGS are metal oxides. However, due to their drawbacks, now metal sulphides are being extensively investigated as a novel gas sensing material. In this study, CdS which is a group II-VI metal sulphide semiconductor with a band gap of 2.42 eV, is investigated as a suitable candidate for the H_2S sensing application. A three-electrode electrolytic system consists of a saturated calomel reference electrode, Fluorine-doped tin oxide (FTO) glass substrate (1×3 cm^2, sheet resistance: 7Ω/sq) working electrode, and high purity carbon counter electrode was used in electrodepositing of CdS material in an aqueous electrolyte containing $CdCl_2$ (0.10 mol/L) and $Na_2S_2O_3$ (0.01 mol/L) precursors. The CdS depositions were carried out in the cathodic deposition potential (CDP) range of 0.65 to 0.70 V and pH range of 1.5 to 2.0 at temperature of 55 °C for 30 minutes at the stirring rate of 60 rpm. After the depositions, samples were annealed at 400 °C for 10 minutes and gas sensing measurements were carried out by measuring resistance of the deposited films in the absence and presence of H_2S gas (6.9×10^3 Pa, 29 °C, 2 min) in a closed gas chamber. Subsequently, films were characterized for their crystalline structure and surface morphology using X-ray diffraction and scanning electron microscopy. The sample grown at CDP of 0.67 V at pH of 1.5 was found to have notable material properties and shown 1.2 Ω average change in resistance with respect to the initial average resistance of 36.0 Ω while exposing to H_2S gas.

Keywords: Gas sensor, cadmium sulphide, H₂S sensing, electrodeposition

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503/E1

The study of electrophoretic deposition kinetics of graphene oxide using quartz crystal microbalance

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Electrophoretic deposition (EPD) is a simple and cost effective processing method to fabricate uniform coatings through precise control of EPD parameters. Recently, Graphene Oxide (GO) has been fabricated on various conductive substrates by EPD method. These GO films with enhanced properties are used in a wide range of applications including electrochemical sensors, biosensors and energy related materials. For these applications, it is required to have control over the film coverage. Therefore, a deeper understanding of the experimental factors that control the EPD process of GO is beneficial to fabricate coatings with enhanced properties. In this study, the early stages of deposition kinetics of GO under different EPD parameters were measured quantitatively using nanogravimetric technique. Quartz crystal microbalance (QCM) is an *in situ* real- time nanogravimetric technique used to measure adsorption and desorption mass with nano gram resolution. The kinetic measurements of GO deposition were carried out by measuring the mass deposited on a gold quartz crystal microbalance sensor for a range of deposition time (10 s to 300 s) and EPD voltage (5 V to 15 V). The QCM data shows a linear relationship for the deposited mass at the initial stage of deposition and at lower voltages (<13 V). However, at higher EPD voltage (>13 V), the growth of GO film is limited due to the passivation of the electrode. Furthermore, the data also indicates an increase in the statistical error for mass deposited over a longer period (>200 s) and higher voltages (>13 V). During EPD, the charged GO particles are deposited depending on their attractive forces towards the active electrode and repulsive forces among them. At the initial stage of deposition and at lower voltages, GO particles are deposited having much space between them to form homogeneous films. Conversely, at high voltage and high deposition time, non-uniform unstable films are formed. Thus, these findings will contribute to the existing yet limited pool of knowledge on the preparation of well controlled EPD GO films for a range of applications.

Keywords: Graphene oxide, electrophoresis, thin films, kinetics

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504/E1

Development of a simulation model to estimate the risk of an asteroid colliding with the Earth, based on the trajectory, velocity of the asteroid, and the location of the Earth

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Asteroids are small bodies that orbit around the sun on trajectories that are dominated by solar gravitational attraction. Predicting trajectories of asteroids traveling into the inner solar system is a necessity to mitigate the risk of potentially threatening asteroids to Earth. Inverse problem and the least square method are the foundation for most of the orbital computation methods developed over the past decade. Including linear, semi-linear, and non-linear methods, various new solutions to the inverse problem of orbit computation have been devised throughout the past few years. Asteroid observations from ground and space observation centers using radar, laser, and other methods have gained the interest of scientists. Many types of research have been carried out on determining trajectories for Near-Earth asteroids but further studies are being done to find a more accurate method. The main aim of this research was to develop a computer simulation model to predict the asteroid trajectories. The model was developed using basic equations of an ellipse in a 2-D cartesian coordinate system. Eccentricity, perihelion distance, semi-major axis, inclination, mean anomaly, period of an asteroid and a term introduced to cover the perturbation effects were used to create the equation. These results were obtained only considering the sun's gravitational attraction force on the asteroid. The developed equation was used to create a computer simulation model. This simulation can predict the distance between Earth and an asteroid up to several future decades so that we can identify the potentially threatening near-Earth asteroids early enough to take an action. Data obtained using the simulation were compared with the data available in the NASA JPL small body database browser website. The mean percentage error for distance between Earth and a given asteroid at a given date was below 20% for each asteroid compared to available NASA data. This research was conducted as an initial step to develop a more efficient and precise trajectory determination model than the existing ones. The accuracy of this simulation model can be increased by incorporating the gravitational effect of other planets, nearby asteroids, and the effect of solar wind into the perturbation term.

Keywords: potentially hazard near Earth asteroids, asteroid trajectory determination

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505/E1

Mode identification of oscillations of Delta Scuti type stars using high temporal resolution Kepler data

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Asteroseismology is the astrophysical science that studies the oscillations in the light curves of variable stars to understand the internal stellar structure. This research aimed to construct light curves from the Kepler mission data and calculate basic internal properties of the selected stars by analyzing the modes of the stars. Accordingly, photometric data of Kepler mission are taken to conduct an asteroseismic investigation on three chosen Delta Scuti type variable stars. The names given from the Kepler catalogue for the selected Delta Scuti stars are KIC 4048494, KIC 4077032 and KIC 8623953. To conduct the research on the star KIC 4048494, two months of short cadence data were taken; for the star KIC 4077032, one month of short cadence data was taken; for the star KIC 8623953, three months of short cadence data were taken. The data were taken from the KASOC database and further corrections to eliminating photometric outliers were performed. These high-resolution data were used to construct power spectra that can resolve frequencies up to 1.16 µHz. Light curve analysis for each of the variable stars is conducted and presented. The pulsation frequency modes were determined using the Period04 software which is a C++/Java based program, dedicated to statistical analysis of large astronomical time series. There are numerous unknown oscillation types which exist for the Delta Scuti type variable stars. The main frequency identification and determination of frequency combinations were done and the pulsation constant (Q) for each and every frequency was calculated. The radial fundamental mode of each star was determined by observing their period ratios and considering their amplitude variations. The resulted frequencies of fundamental radial modes for the stars KIC 4048494, KIC 4077032 and KIC 8623953 were redefined as 127.992±0.005 µHz, 73.048±0.014 µHz and 315.473±0.004 µHz, respectively.

Keywords: Delta Scuti stars, photometry, oscillation modes, Stellar pulsations, asterosiesmology

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Development of target actuator system and cryo-control system of polarized fixed-target at Fermilab SpinQuest experiment using Delacor framework

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The main goal of the E1039 experiment at Fermilab, USA is to measure the single spin asymmetry of the Drell-Yan process on a transversely polarized target that can be used to determine the sign and magnitude of the Sivers Asymmetry. The nuclear instrumentation group at the Faculty of Technology, University of Colombo is collaborating with SpinQuest and responsible for developing target actuator and cryo-control systems for the experiment, using LabVIEW. In this study, status of developing above systems using a queued message handler design pattern in Delacor implementation will be presented. The Delacor Framework which is an add-on available for LabVIEW, has great message handling and continuous measurement logging capabilities. The key tasks of the system for target actuator are inserting and removing target material in and from the beam line and tracking its position. For these, two modules; one for high resolution stepper motor driver and another for ADC which is connected to the string potentiometer, were implemented. Command libraries were implemented separately for stepper motor driver and the string potentiometer. Each command library is a collection of separate LabVIEW programs of all necessary commands for an instrument such as initialization of communication with motor driver, moving the motor to a certain position, etc. A Helper Loop was introduced in addition to the main message handling loop, to monitor the ADC output value continuously to keep track of the position of the target. The code is hosted on a dedicated computer located in the SpinQuest experimental control room and communicates directly with the motor drivers via Ethernet.

Keywords: SpinQuest, Delacor Framework, helper loop, target actuator

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A simulation-based study on transmitter coil geometries to enhance the efficiency of Wireless Power Transfer (WPT)

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Wireless Power Transfer (WPT) technology uses a time-varying electromagnetic (EM) field to transfer power from a transmitting source to a receiving device according to Faraday's Law of electromagnetic induction. The WPT systems usually consist of transmitter and receiver coils located in the near field that are designed to resonate at the same frequency. This enables resonator coils to exchange energy efficiently via coupled mode resonance. However, in the existing WPT systems, the generated EM fields propagate as nondirectional EM waves. Consequently, a significant amount of energy would be off-targeted, wasting a considerable amount of useable energy. According to the EM wave propagating properties, the shape of the transmitter coil can be optimized to directionalize the transmitted EM field. By directionalizing the generated EM fields, the WPT efficiency can be enhanced. This study is primarily focused on presenting a novel method to enhance the wireless power transmission efficiency and the transmitting range of an overall WPT system by modulating the geometry of the transmitter coil. In this study, a novel wireless power transmitting coil design is proposed, and the proposed coil design consists of a curved shaped array of resonant coils, which can directionalize the generated EM fields in a WPT system. The proposed transmitting coil structure is developed by placing an array of coils on a concaved shape surface and the 3D model is designed by using a 3D CAD design software and simulations are performed in "EMS" simulation software. Based on simulation results, it can be concluded that the EM field intensity, efficiency, and the transmission range of a WPT system can be enhanced by directionalizing the transmitter generated EM fields to reduce the wastage of the useable energy in the generated EM fields. Furthermore, this proposed transmitting coil design can be used to generate and transmit EM energy, targeting a receiver fixed at a specific point.

Keywords: Wireless Power Transfer (WPT), transmitter coil geometries, antenna design, power transfer efficiency

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A case study on the increase of RF levels in the proximity of a mobile phone when making and receiving a call

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Currently, people spend most of their time with mobile phones due to the pandemic situation; specially, children use mobile phones to continue their studies. Staying close to mobile devices, which use radiofrequency electromagnetic radiation (RF-EMR) may cause serious health issues, especially for children and pregnant women because they are more susceptible to this radiation. Some studies show that RF-EMR can induce changes in the central nervous system and exposure to the EMR emitted by cell phones can cause behavioural difficulties in children such as emotional and hypersensitivity problems. In this study, increase of the RF levels were investigated near a mobile phone in sleep mode, while a call is being received and while a call is taken. The selected mobile phone is placed at a location having poor signal reception (only one bar) and SLT Mobitel was selected as the network carrier within GSM900/GSM1800 network bands. The reason for selecting poor signal reception is that at this level, the mobile phones emit maximum RF radiation. The data were collected at four distances from the mobile phone display and for each location ten root mean square (RMS) electric field strengths were measured by using Spectran HF6065 spectrum analyzer and specific absorption rate (SAR) values for the human brain ware calculated based on the measured electric field values. Comparisons were made for the measured and calculated values using international reference levels published by International Commission on Non-Ionizing Radiation Protection (ICNIRP). According to the results, 0.150 ± 0.001 V/m was the highest average electric field strength observed and it was detected when receiving a call. Reason for obtaining highest electric field strength when receiving a call could be because the receiving antenna is located closer to the display of the selected mobile phone. The maximum increase of the electric field strength is 782.3% compared to the background average electric field strength (0.017 ± 0.001 V/m). However, the measured maximum electric field strength is 0.36% of the maximum permissible value (41.25 V/m) for general public and the calculated maximum SAR for the human brain for the above maximum electric field strength is 1.68×10^{-5} W/kg, and it is 0.00084% of the maximum permissible value (2 W/kg) for the general public. Further studies are underway to study possible health risks related to cell towers and cell phones.

Keywords: Mobile phones, radiofrequency electromagnetic radiation, health issues

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Understanding Horizon Content Knowledge: A review

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The Mathematical Knowledge for Teaching (MKT) that a mathematics teacher requires has been explored by researchers in the mathematics education field. MKT has emerged as a promising framework to define, assess and develop those knowledge requirements. Horizon Content Knowledge (HCK) is a powerful domain in MKT which is generally viewed as an awareness of broader mathematical landscape. However, HCK is often categorized as the conflictingly defined and the least understood domain. Researchers are continuously working on understanding, re-conceptualizing HCK and empirically proving its importance in teaching and student achievements. Many definitions presented for HCK are not specific, subject to clarification, and often encounter criticism. The purpose of this review is to capture the essence of various interpretations presented for HCK for future work. This review uses a qualitative approach, and the selection is limited to articles with different interpretations of HCK. The concept of HCK was originally defined as a kind of a "peripheral vision" and the awareness of the broader mathematical landscape. Some scholars included "Advanced Mathematical Knowledge" that a teacher acquires in undergraduate levels as part of HCK while others argue academic knowledge itself does not guarantee effective teaching, but ought to understand connections among structures and ideas related to the discipline. Many have perceived HCK as "Elementary perspective of advanced knowledge" and a few have complementing definitions for it. It is also viewed as an orientation to, and familiarity with, the discipline related to teaching content and "hearing" students' mathematical insights. Further refinements have been made to include the knowledge of history of mathematics and knowledge of applications to other subjects. However, it is understood that many of these components pertaining to HCK domain are implicitly included in many definitions, even though it may look different at a glance. Our findings indicate the role of the horizon knowledge is so broad that it has led educators to present different interpretations. It is understood that defining HCK as "what else" knowledge that teachers should possess, permits no boundaries for the conceptualization and also varies due to the dynamic nature of the knowledge demands in the future curricula.

Nanoencapsulation of amoxicillin in chitosan-tripolyphosphate nanoparticles for enhanced gastric retention time

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Over the past few decades, the field of medicine has progressed at a breakneck pace, and recent advancements in drug delivery have provided promising solutions to the persisting problems of limited efficacy and low site-specificity of many drugs. Nanosized drug carriers have increased in popularity because of the tuneable chemical and physical properties that allow for selective accumulation in the affected region. The use of polymeric nanoparticles for the oral drug delivery route shows great promise due to their ability to protect the drug from the harsh environment of the gastric tract as well as allowing for controlled release of the drug. This work aims to provide a foundation for the development of a more effective, sustained oral drug delivery platform, to prolong dosing intervals for the antibiotic Amoxicillin, which is a cornerstone in the treatment of peptic ulcers caused by the bacteria *Helicobacter pylori*. Chitosan is a biodegradable, natural polymer with inherent antibacterial activity, which served as reason for its selection as the encapsulating polymer for the nanoparticles. The particles were fabricated by the ionic gelation technique which uses the positive charge of the chitosan molecule to form a complex with tripolyphosphate (TPP), a negatively charged crosslinker. The optimum concentration of chitosan was 2.0 mg/mL, and the formulation showed encapsulation and loading efficiencies of 96.23% and 58.94%, respectively as determined by UV-Vis spectrophotometry. The nanoparticles were characterized using FT-IR, SEM and XRD. The SEM images showed that the size range of the nanoparticles was 100 nm to 1 μm, and the drug was found to lose its crystallinity and exist in the amorphous form upon encapsulation according to the XRD and FT-IR spectra. Drug release kinetics were fitted to the Korsmeyer-Peppas model and showed a sustained release profile with a non-Fickian release mechanism. All analysis experiments were conducted in triplicate. According to the results, our developed formulation shows promise as a controlled release vehicle for the oral delivery of Amoxicillin and can be used as a framework to develop more effective oral drug delivery platforms in the future.

Keywords: Nanoencapsulation, chitosan, amoxicillin, sustained release

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Plant extract-based synthesis of zinc oxide nanoparticles and evaluation of their antidiabetic and antioxidant effect

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Type 2 diabetes mellitus and cancer are two of the most common non-communicable diseases in the modern world, and neither has a permanent treatment. However, the widely used chemically produced drugs have several limitations, forcing scientists to look into new approaches. Nanotechnology and the use of natural products are two fascinating topics that are still in the early stages of development but have the potential to provide a wide range of therapeutic benefits. Hence, this study was focused on combining nanotechnology and natural products to biosynthesize ZnO nanoparticles using *Adenanthera pavonina* and *Passiflora foetida* fresh leaves. Alpha-amylase assay and 2-diphenyl-1-picrylhydrazyl (DPPH) free radical scavenging assay were carried out to evaluate their *in vitro* antidiabetic and antioxidant properties, respectively. The results of selected assays for biosynthesized ZnO particles were compared with chemically synthesized ZnO particles and fresh leaf extracts. According to the findings of the alpha-amylase inhibition assay, *A. pavonina* fresh leaf extract showed a lower alpha-amylase inhibiting ability (31.90% / 100 µl) than *P. foetida* fresh leaf extract (73.75% / 100 µl). However, *A. pavonina* extract-based ZnO particles had a higher alpha-amylase inhibiting activity (96.17% / 100 ppm) than *P. foetida* extract-based ZnO particles (13.19% / 100 ppm). Interestingly, chemically synthesized ZnO particles also showed some alpha-amylase inhibition activity (50.00% / 100 ppm). DPPH free radical scavenging assay revealed that the fresh leaf extracts of two selected plants had a slightly higher antioxidant effect than their ZnO particles. *A. pavonina* fresh leaf extract showed lower radical scavenging activity (RSA) (57.29% / 50 µl) than *P. foetida* fresh extract (90.58% / 50 µl), whereas ZnO particles made from *A. pavonina* extract had a higher RSA (62.63% / 100 ppm) than ZnO particles made from *P. foetida* extract (55.96% / 200 ppm). Chemically synthesized ZnO particles prepared had no antioxidant action compared to others. Hence, *A. pavonina* and *P. foetida* fresh leaf extracts and the extracts incorporated ZnO particles could be exploited in the development of antioxidants, and antidiabetic therapeutics.

Keywords: Antidiabetic, antioxidant, *A. pavonina*, *P. foetida*, ZnO particles

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CRISPR/Cas9-mediated K/O of the allosteric activator binding domain of PFK-1 as a novel therapeutic approach for cancer

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Cancer is one of the most deleterious diseases and is the second leading cause of death around the world. Current treatment methods available for cancer affect both cancerous and surrounding non-cancerous cells, leading to several adverse side effects. Therefore, there is an urgent need to develop effective new treatments that selectively target tumor cells to reduce the risk of side effects. The metabolic profile of cancer cells typically includes increased consumption of glucose and preferential production of lactate, even in the presence of oxygen (Warburg effect). Therefore, therapeutics that can decrease the rate of glycolysis would be particularly effective against cancer cells and may have minimal adverse effects on the noncancerous cells. The main goal of this research project is to downregulate the activity of PFK-1 in human MCF-7 cancer cells by knocking out the allosteric activator binding domain (C-terminal domain) of the enzyme using the CRISPR/Cas9 genome-editing tool. A specific target site that is needed for the K/O of the regulatory domain was elucidated via bioinformatic tools, followed by the design of target-specific crRNA sequence via the CRISPR design tool by 'Horizon discovery group company' and the repair donor template via the ApE tool. Then the crRNA, which is specific for the PFK-1 was cloned into pSpcas9 (BB)-2A-Puro plasmid and the recombinant plasmid was verified using colony PCR and sequencing. Next, the recombinant plasmids were transformed Into the *Escherichia coli* Top 10 cells for the amplification and upon extraction, those recombinant plasmids were transfected into MCF-7 cells. In there, an optimization was also performed to find the most suitable ratio of PEI:DNA for the transfection and then the transfected cells were identified using the puromycin selection. From the results obtained so far, it was found out that the effectively designed recombinant plasmid with the CRISPR construct is successfully transfected into the MCF-7 breast cancer cells and the most effective PEI:DNA ratio for the transfection is 6:1. Future work includes clonal expansion, SDS- PAGE, and a western blot to verify the truncated protein. Finally, the effect of the gene modification is expected to be assessed in the context of tumor proliferation, growth, and survival.

Keywords: Cancer, CRISPR/Cas9, PFK-1, regulatory domain, crRNA

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Development of attachable single-use wearable cellulose-based curcumin skin patch for breast cancer prevention

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As at the end of 2020, breast cancer is considered the world's most prevalent cancer. In addition to the conventional treatment approaches such as chemotherapy and radiotherapy, recent attention has focused on developing preventive care approaches. It is believed that preventive care will be a better alternative to reduce initial hazards that lead to cancer. Among the different preventive medications, the use of curcumin as a natural plant derived material has gained attention over the years due to its remarkable antioxidant, anti-inflammatory and antitumoral properties that are exceptionally important in cancer prevention. In that sense, transdermal delivery of drug compounds targeting breast cancer has taken many contemplations over the years. Transdermal delivery would allow localized drug application, thereby minimizing the first pass metabolisms. In this regard, this study has focused on the fabrication of a transdermal skin patch via the electrospinning technique using polyethylene oxide (PEO) and ethyl cellulose (EC) as the polymers. An optimization procedure was conducted to obtain beadless fibers. Once these systems were optimized, curcumin was used as a potential drug material with various beneficial properties (such as anticancer, anti-inflammatory and antioxidant) to be entrapped inside the nanofibers. The ease of obtaining elctrospun nanofibers as paper patches made them more attractive to be formulated into a single-use breast pad. Prepared fibers were characterized using SEM, FT-IR, DSC and XRD while their drug releasing ability was assessed over a period of time. In addition, transdermal penetrability was also assessed. The results indicated that a higher content of curcumin is released in a periodical manner from PEO:EC system. Transdermal drug delivery assessed by UV-Vis spectral analysis confirmed the penetration of curcumin through the skin membranes.

Keywords: Cancer prevention, cellulose, curcumin, electrospinning

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The changes of proximate composition, cyanide content, and shelf life of minimally processed cassava *(Manihot esculenta)* under the low temperature storages

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Cassava *(Manihot esculenta)*, which belongs to the family *Euphorbiaceae* is one of the energy-rich foods grown in tropical regions. Sri Lanka has a surplus cassava production throughout the year. Cassava plays a vital role as an exporting commodity. Exporters use low temperatures while exporting cassava and nowadays there is a new trend of using minimally processed-blanched foods. However, there are no studies to explain the changes in the nutrient content of local cassava cultivars at low temperatures. Hence, this study investigated the changes of proximate composition, cyanide content, and shelf life of minimally processed-blanched cassava at low temperatures. The most popular exported local cassava cultivars, namely "MU 51" and *"Suranimala"* were selected for this study and subjected to the normally exported method and minimally processed-blanched method. All samples were stored at refrigerated (13 °C, 80% RH) and freezing (−4 °C, 80% RH) conditions for a maximum six-week period. Proximate composition (AOAC, 2000), cyanide content, and keeping quality (cooking time, weight loss percentage, microbial analysis) of the samples were determined at one-week intervals. Results explained that the moisture content of blanched samples of both cultivars significantly ($p \leq 0.05$) differed with stored temperature and it was reduced by 0.8% in MU 51, and 7.8% in *Suranimala* at freezing conditions. Meanwhile, fat, protein, fiber, ash, and carbohydrate content of blanched samples significantly ($p \leq 0.05$) differed with stored temperature during the storage time. The weight loss percentage was decreased by 0.41% in blanched MU 51, and 0.24% in blanched *Suranimala* samples at freezing conditions. The blanched-frozen sample of *Suranimala* showed the lowest cyanide content (0.95 mg/kg), the lowest cooking time (570 s) and no detectable microbial count at the end of the storage time because blanching drastically reduces the cyanide content and initial microbial load. Furthermore, blanching and freezing soften the tissues of cassava pieces. This study revealed that freezing conditions and blanching retain the keeping quality of cassava while reducing the cyanide content.

Keywords: Export cassava, minimally process, blanching, MU 51, *"Suranimala"*

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Investigation of the antioxidant activity of *Careya arborea* (kahata) – lemongrass oil loaded microcapsules

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Historical evidence proves that humans have been interconnected with nature since ancient times. Ethnopharmacological drug discovery is used to find novel treatment by utilizing traditional herbal remedies. This research was mainly focused on investigating the antioxidant activity of stem bark extract of *Careya arborea* and the *C. arborea* extract - lemongrass oil loaded microcapsules. Previous investigations revealed the influence of antioxidant property of plant extracts and essential oils in finding treatments for wounds. The ability of antioxidants to scavenge free radicals and prevent tissue damage is important in wound healing. *C. arborea* extracts have proven antioxidant, antibacterial and anti-inflammatory properties. In this work, *C. arborea* powder and lemongrass oil loaded gelatin/sodium alginate microcapsules were prepared by using complex coacervation, one of the most common methods of microencapsulation. Microencapsulation is an important technique which, protects the active core ingredients and at the same time, facilitates the control release of the core material. For the investigation of antioxidant activity, 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay and Folin-Ciocalteu assay were used. Percentage radical scavenging activity (% RSA) was calculated by using DPPH assay, and ascorbic acid was used as the reference. Folin–Ciocalteu assay was used to determine the antioxidant capacity (AOC) by using pyrogallol as the standard. *C. arborea* powder displayed 91.1% RSA, while 32.5% RSA was shown by the ascorbic acid reference. Synthesized microcapsules also showed 72.7% RSA, which implies that the antioxidant activity remains even after microencapsulation. According to the Folin-Ciocalteu assay, *C. arborea* powder showed 889.4 µg PGE/mL AOC, while the synthesized microcapsules showed 341.9 µg PGE/mL AOC. On the other hand, lemongrass oil showed 7.5% RSA and 111.3 µg PGE/mL AOC. As a result of the study, it can be concluded that microcapsules enriched with *C. arborea* powder have the potential to be developed into wound healing treatments.

Keywords: *Careya arborea*, lemongrass oil, microencapsulation, complex coacervation, antioxidants

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Electrospun poly(N-isopropylacrylamide) based tri-polymer system for thermo-responsive delivery of Diclofenac

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Electrospun thermoresponsive polymers have proven useful in biomedicine as wound dressing materials. Poly(N-isopropylacrylamide) (pNIPAM) is one such thermal responsive polymer that undergoes a sharp phase transition at a lower critical solution temperature (LCST) of 32 ºC in aqueous solution. When the temperature is raised above the LCST, pNIPAM rapidly changes from being hydrophilic (linear state) to hydrophobic (globular state) and enables thermo-responsive drug release. However, electrospinning pNIPAM alone is a difficult process. Therefore, in this work we have developed a novel polymer blend composed of poly(vinylpyrrolidone) (PVP), ethyl cellulose (EC) and pNIPAM to facilitate the spinning process. The addition of PVP helps to increase the spinning rate (2.0 ml h^{-1}, which is 4x faster than previously reported work from a bi-polymer PNIPAM /EC system) and fastens the spinning process to generate fibers. The model drug Diclofenac sodium (DICLO) was incorporated to different ratios of PVP/EC/pNIPAM. PVP weight percentage was optimized and fixed at 40% (w/w) for all electrospun formulations. The pNIPAM percentage was varied as 55, 45, 35 and 25% (w/w) for each formulation. The electrospun drug loaded fiber series was subjected to SEM and DSC characterization. *In-vitro* drug release studies for the mats carried out at two different temperatures, 37±0.5 °C and 25±0.5 °C, at pH 7.4 resulted in thermoresponsive DICLO release for all four formulations (n=3). After 24 h time duration, the highest drug release of 90.54% was observed from the mat containing the highest loading of pNIPAM at 25 °C and the lowest DICLO release of 38.30% was observed from the same formulation at 37 °C. Thus, the novel electrospun PVP/EC/pNIPAM system shows good potential as wound dressing materials with thermoresponsive DICLO release.

Keywords: Thermoresponsive, diclofenac, drug delivery, wound dressing, electrospining

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Extraction, physicochemical and structural characterization of pectin from tender king coconut kernel

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Pectin is a natural polysaccharide, which has gained increasing attention due to its biomaterial properties and biomedical activities. The study was focused on the tender king coconut kernel (KCK) which can be used as a source of pectin. In this study, pectin from king coconut was successfully extracted by a chemical extraction process. The extracted pectin was characterized and evaluated for its physicochemical properties by Fourier transform infrared (FT-IR) spectroscopy, ash content, equivalent weight, methoxyl content, and acetyl content. The antioxidant activity of pectin was evaluated by 2,2-diphenyl-1-picrylhydrazyl (DPPH) method. Pectin was analyzed for mineral composition. In addition, the king coconut kernel was subjected to proximate analysis. Pectin was successfully extracted from dry king coconut kernel with a yield of about $3.00 \pm 0.36\%$ (dry basis) as a brownish and odorless fine powder. FTIR results showed that pectin from king coconut kernel has similar characteristics with that of commercial pectin. The chemical properties of pectin such as ash content, equivalent weight, methoxyl level and acetyl content were $3.00 \pm 0.06\%$, 1123.78 ± 19.39, $6.82 \pm 0.10\%$, $0.08 \pm 0.00\%$, respectively. Based on both FT-IR results and the value of methoxyl content, pectin can be categorized as low methoxyl pectin. In addition, extracted pectin showed a moderate antioxidant activity with the IC_{50} of about 55.70 ± 35.24 ppm. These results suggest that pectin from king coconut kernel has the potential to be used as a biopolymer for biomedical applications with a low-methylated pectin and a moderate antioxidant activity.

Keywords: King coconut, polysaccharide, pectin, biopolymer, antioxidant

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A facile greener approach to synthesize curcuminoids incorporated layered double hydroxides

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Natural plant-based compounds are increasingly gaining scientific attention as preventive medicine and efficient active ingredients in pharmaceuticals. Among the pharmacopeia of traditional medicines, curcuminoids derived from *Curcuma longa* are at high priority due to its superior antioxidant and antibacterial activities. However, utilization of curcuminoids is limited due to its poor bioavailability and photo-stability. This study focuses on the stabilization of curcuminoids derived from a natural extract of *Curcuma longa* between the layers of layered double hydroxides (LDHs) using a simple and green mechanochemical grinding approach. This facile synthetic approach offers many advantages over the traditional co-precipitation method. Structural and morphological characterization of the synthesized curcuminoids incorporated Layered Double Hydroxides (Cur-LDHs) composites were evaluated. The nanosized hydrotalcite-like layered morphology of Cur-LDHs was confirmed by transmission electron microscopy imaging. Successful incorporation of curcuminoids into LDHs was confirmed using powder X-ray diffractogram. There was a significant peak shift in the *(003)* diffraction peak of nitrate-LDHs from 8.90 Å to 7.66 Å. Moreover, Fourier transform infra-red spectroscopy evidence confirmed the weak electrostatic interactions between the curcuminoids and LDHs. The successful incorporation of curcuminoids into LDHs was further attested by the X-ray photoelectron spectroscopic analysis. It clearly depicts the electron density variations that arise in Mg^{2+} and Al^{3+} ions in the presence of curcuminoids between layers of LDHs. Interestingly, Cur-LDHs obtained from mechanochemical grinding methods have a higher thermal stability compared to isolated curcuminoids due to formation of the strong hydrogen bonding and electrostatic interactions between curcuminoids and LDHs. The decomposition temperature of curcuminoids has been increased from 375 °C to 412 °C by confirming the thermal stabilization of curcuminoids in the LDH matrix. The release behavior of incorporated curcuminoids were tested at pH 5.5 buffer solution and data fitted into the zeroth order kinetics by suggesting that the release mechanism is based on the curcuminoid dissolution without forming aggregations. The release profile exhibits slow and sustained release of curcuminoids from LDHs. Thus, we can assert the aptitude of Cur-LDHs as an advanced biomaterial which would be advantageous in pharmaceutical/cosmeceutical applications.

Keywords: LDH, curcuminoids, mechanochemical

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Electrospun polyethylene oxide/cellulose acetate nanofibers incorporated with a nanocomposite for the removal of heavy metals from water

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At present, electrospun nanofibers are extensively utilized in addressing various environmental issues, especially to account for water quality problems. Their unique structural characteristics including extraordinary surface area and interconnected porosity have aided in gathering more interest towards water purification. The ability to incorporate other nanomaterials into nanofibers presents an opportunity to develop high performance water treatment technologies that are energy efficient. Hence, nanofibers are found to be suitable for the removal of a wide range of pollutants of chemical and biological nature. The major objective of the present study was to synthesize a novel efficient adsorbent to remove Pb(II) and Cd(II) in water. Accordingly, polyethylene oxide/ cellulose acetate (PEO/CA) was selected as the most appropriate polymer blend, incorporated with synthesized HAp/Zr/CTS (Hydroxyapatite/Zr/Chitosan) nanocomposite to enhance its adsorption efficacy. The so-formed composite mat PEO/CA/HAp/Zr/CTS and neat mat were fabricated by electrospinning and were characterized. Fourier transform infrared (FT-IR) analysis confirmed successful synthesis of fiber mats. X-ray diffraction (XRD) analysis explained the crystal structure of synthesized material. Thermogravimetric analysis (TGA) evaluated the thermal stability and the volatile component content. Scanning electron microscope (SEM) data indicated the texture of fibers on nanocomposite incorporation. The electrospun mats were then subjected to adsorption studies to analyze the effects of parameters such as contact time, pH and initial concentration on Pb(II) and Cd(II) removal. The maximum adsorption capacity for the neat mat was 51.02 mg/g and 1.40 mg/g for Pb(II) and Cd(II), respectively. For the composite, adsorption had been improved to values of 90.91 mg/g and 6.59 mg/g for Pb(II) and Cd(II), respectively. Experimental data fitted better with Langmuir isotherm model for both neat and composite mat. Leaching studies were carried out and it exhibited quite low levels of Ca(II) leaching from the composite mat and almost zero leaching of Zr(IV). According to the attained results of the study, PEO/CA/HAp/Zr/CTS fiber mat was recognized to be exhibiting a higher efficiency in the removal of Pb(II) and Cd(II) ions, thus suggesting it to be improved as a promising material that can readily be used in water purification applications.

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Fluorescent silica-nanomaterials as a developing agent in the detection of latent fingerprints

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Latent fingerprint detection plays a major role in forensic science. Numerous techniques have been developed for the visualization of fingerprints, among which, nanoparticles are potential candidates due to their high selectivity and sensitivity compared to conventional methods. Out of different types of nanoparticles that have been used so far, silica nanoparticles provide a convenient approach due to their synthetic simplicity, biocompatibility, ease of surface modification, and high surface to volume ratio. In this study, fluorescein isothiocyanate (FITC) encapsulated silica nanoparticles were prepared with Stöber and reverse microemulsion methods. FITC was conjugated to 3-aminopropyltriethoxysilane to achieve covalent attachment with the silica matrix, which reduces dye leakage. The nanoparticle surface was modified with carboxyl groups to facilitate binding with proteins and amino acids in the fingerprint residue through peptide bonds. The nanoparticles were characterized using scanning electron microscopy (particle size 742 nm and 139 nm for Stöber and microemulsion, respectively), fluorescence spectroscopy (emission at 521 nm) and X-ray diffraction ($2\theta = 22.66°$). Functionalization and dye doping were characterized using Fourier transform infrared (FTIR) spectra. Two different experiments were done in fingerprint development. Firstly, to study their suitability to develop latent fingerprints on four non-porous substrates (aluminum foil, plastic, stainless steel, and glass slide), the synthesized nanoparticles were applied onto the substrates and illuminated under UV light for visualization. Secondly, they were aged for different time intervals (5 min, 30 min, and 3 weeks after deposition) their ability to develop fingerprints. Luminescent nanoparticle powder works well on aluminum substrate and elicits satisfactory results on other substrates. For aged fingerprints, aluminum foil produces a clear ridge pattern while the remaining substrates produce diffuse fingerprint images. While both types of silica nanoparticles are potential candidates for latent fingerprint development, reverse microemulsion method was the best with a clearer ridge pattern being revealed. Chemically stable covalent attachment between dye conjugate and silica matrix reduces the dye leakage, in the range of 14%-16%. It ensures that FITC-doped silica nanoparticles have a minimum dye leakage during the application and storage process which makes them a potential agent for latent fingerprint development.

Keywords: Fingerprint, silica, microemulsion, latent, forensic

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Development of biodegradable polymer films with fish waste in Sri Lanka

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Rising environmental pollution caused by extensive usage of petroleum-based plastic packaging has led to growing research attention regarding the development of biodegradable polymers from renewable resources. Biowaste is an excellent source of biopolymer that can be used to fabricate biodegradable films and coatings. In this study, protein and chitosan were successfully extracted from fish and prawn shell wastes, which are commonly available waste materials in Sri Lanka, to investigate their film-forming ability. Protein was recovered by the alkaline extraction and isoelectric precipitation. Chitin extraction was achieved by three successive steps of deproteinization, demineralization, and discolouration. Furthermore, an alkaline hydrolysis step was used to convert extracted chitin to chitosan. Polyvinyl alcohol (PVA), commercial chitosan and extracted chitosan were incorporated into fish protein isolate in different blend ratios to obtain several composite films. Solvent casting technique was applied to fabricate protein-based films. Prepared protein films were evaluated using tensile strength (TS) and elongation at break (EAB) measurements, water vapour permeability (WVP) study, Fourier transform infrared spectroscopy, X-ray diffraction analysis, water solubility test, moisture absorption test, and degradability studies. Fabricated protein films had TS values ranging from 21.33-119.97 MPa, which indicated that the protein films relatively maintained sufficient tensile characteristics to resist external stress during the packaging of materials. An increment in both TS (119.97±19.12 MPa) and EAB (243.85±18.76%) was observed as the amount of PVA incorporated into protein films increased, while protein films exhibited lower TS (21.33±7.63 MPa) and EAB (9.24±10.66%) when mixed with commercial chitosan. However, a comparatively higher TS (114.50±8.96 MPa) was observed for protein films incorporated with extracted chitosan. The addition of commercial or extracted chitosan into protein films remarkably enhanced the water-resistance as well as barrier properties against moisture, whereas increasing PVA concentration resulted in higher water solubility, WVP and moisture absorption. The protein film incorporated with extracted chitosan exhibited the lowest WVP ($2.06×10^{-11}$ g/Pa s m). All the films were transparent and increasing PVA and chitosan concentrations resulted in higher transparency. Films were stable for a period of two months under ambient conditions and transparency remained without the appearance of any mold growth. Biodegradation studies were carried out according to ASTM D 5998-18. Protein films had relatively higher aerobic biodegradation compared to the positive control (cellulose) at the end of the 5th week of study based on the released CO_2 amount, which suggests that the fabricated films were readily biodegradable when submerged in soil.

Keywords: Fish waste, protein films, biodegradable, chitosan, polyvinyl alcohol

Application of cellulose nanocrystals as a green filler for the development of sustainable rubber latex-based coatings

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Although coatings are a rapidly developing entity in the paint industry, most paint coatings encounter cracks over time. This study mainly focused on developing a sustainable paint coating to remediate the problem of cracking. In this regard, natural rubber (NR) latex–cellulose nanocrystal (CNC) based nanocomposites were prepared and the optimized nanocomposite was incorporated into the paint formula as the polymer component. CNCs were used as the nanophase of the nanocomposite and extracted from microcrystalline cellulose (MCC) using alkali pre-treatment followed by acid hydrolysis. Morphological analysis, chemical properties, crystallinity and crystallite size of CNC were investigated. The average particle sizes of MCC and CNC were approximately 30 μm and 10 nm, respectively while CNC appears to be brittle and wrinkled. All FT-IR absorption bands and XRD diffraction peaks obtained for CNC and MCC were characteristic of cellulose I. NR was used as the polymer phase of nanocomposite due to its extraordinary elasticity. In this study, the CNC loading varied from 0 to 7.5 phr and mechanical properties of NR/CNC nanocomposite were investigated using tensile testing. The highest average tensile strength (TS) was achieved when 5.0 phr of CNC was used. Furthermore, TS of nanocomposite increased when CNC content was increased up to 5.0 phr and TS decreased when CNC content is higher than 5.0 phr. In addition, a decrease in elongation at break values with increasing CNC loading was observed. The paint coating was developed by replacing the conventional acrylic polymer with the optimized NR/CNC nanocomposite. However, after applied and thoroughly dried, optimized nanocomposite incorporated paint mixture was started to peel off from the surface, indicating poor adhesion property. Therefore, a polymer blend with nanocomposite and acrylic polymer was used in the paint mixture at a blending ratio of 3:1 and it exhibited a logical average TS. Furthermore, it was well-dispersed and dried completely within 5-6 hours upon application on the surface. The novel paint mixture was stable and no visual defects were detected after 6 months. This study shows that the 3:1 polymer blending ratio incorporated paint has the potential to be used as a sustainable paint coating.

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The effect of zirconia doping into hydroxyapatite-based nanocomposites in defluorination of water

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Elevated levels of fluoride in ground water are identified in many parts of the world and long-term consumption of water with fluorides above the permissible levels has resulted in adverse health effects. As far as the defluorination methods are concerned, adsorption is considered as one of the best methods. Hydroxyapatite (HAP) based nanocomposites are considered promising adsorbents due to their nontoxicity and biocompatibility. As per the literature, the incorporation of HAP with organic polymers such as chitosan (HAP-CTS) and montmorillonite (HAP-MMT) could improve fluoride adsorption. The major objective of the present work was to identify the effect of incorporating zirconium (Zr) into these nanocomposites to enhance fluoride adsorption. Here the zirconium was selected due to its nontoxicity and high affinity of zirconia towards fluorides. Zr was incorporated into HAP-CTS and HAP-MMT via an *in-situ* precipitation method in different ratios of Ca:Zr. Comparative adsorption studies of these nanocomposites indicated that HAP-CTS with Ca:Zr ratio 8:2 (Z-HAP-CTS 8:2) as the most promising material while Zr-HAP-CTS 6:4 gave the second-best improved sorption properties. These nanocomposites were characterized by scanning electron microscopy (SEM), Fourier transform infrared (FT-IR) spectroscopy (as well as by X-ray diffraction and subjected to detailed adsorption studies. Adsorption data were fitted into Langmuir, Freundlich and Temkin models and the Freundlich isotherm was found to be the best model for the Zr-HAP-CTS 8:2 nanocomposite. This indicates the muli layer adsorption and the maximum adsorption capacity was 20 mg/g. To study the applicability of the synthesized materials in real world applications, gravity filtration studies were carried out using actual water samples contaminated with 2.5 ppm initial fluoride concentration. From the study, a breakthrough capacity of 4000 ml/g was obtained by considering the breakthrough concentration as 0.5 ppm when the water sample was passed through a gravity column with a 1 cm diameter at a flow rate of 10 ml/min.

Keywords: Hydroxyapatite, zirconium, chitosan, adsorption, fluoride

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Graphene oxide, carboxymethyl cellulose (CMC), and montmorillonite (MMT) based nanocomposite for the removal of hardness in water

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The contamination of water is a major problem in many parts of the world and will eventually lead to freshwater scarcity. The hardness of groundwater is the most common problem associated with water quality, mainly due to the high concentrations of calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions in groundwater. These elevated levels of hardness in water could cause adverse health effects such as chronic kidney disease of unknown etiology (CKDu) and difficulties such as scaling on pipes and fabrics, as well as lead to an odd taste. Therefore, this research was carried out to develop a novel, nontoxic, biodegradable, graphene oxide (GO), cross-linked carboxymethyl cellulose (CMC), and montmorillonite (MMT) clay-based nanocomposite as an effective adsorbent to remove the hardness of water. In this context GO was synthesized using the modified Hummers method and the cross-linked CMC was produced using CMC powder and acetic acid. Cross-linked CMC was used to facilitate improved sorption properties and antifungal activity of the composite. MMT clay was added in different ratios as a constituent material. Initially, several materials were fabricated using different compositions in the form of thin film membranes. To identify the performance of the composite material and constituent materials, the solubility and adsorption properties of the developed material towards Ca^{2+} and Mg^{2+} were investigated. The results reveal that the nanocomposite synthesized using GO, cross-linked CMC, and 2.50 g of MMT (GO-CMC-MMT-3) is the best material to remove water hardness. Characterization using SEM analysis, FT-IR, XRD, and UV-visible spectroscopy confirmed the successful synthesis of the material. Further studies were carried out for the GO-CMC-MMT-3 membrane to identify several parameters that have an impact on the adsorption (Ca^{2+} and Mg^{2+}) process from aqueous solutions. According to that, the optimum pH for the adsorption was found to be between pH 6-7 and the optimum contact time was found to be 45 minutes. In addition, the results of the adsorption isotherm data were fitted to both Langmuir and Freundlich models. The Langmuir isotherm model was identified as the best-fit with maximum adsorption capacities of 6.46 mg g^{-1} (Mg^{2+}) and 7.98 mg g^{-1} (Ca^{2+}) indicating the formation of a cation monolayer on the homogenous adsorption sites of the nanocomposite.

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Zinc complexes bearing novel sulfonamide ligands towards biological applications: Crystal structures and molecular docking studies

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Use of metal complexes in medicinal chemistry possibly stems from the ability of the metal center to bind with negatively charged biomolecules such as proteins and nucleic acids. With the intention of identifying novel drug leads, two novel zinc complexes; [Zn(N(SO$_2$pyridine)dpa)Cl$_2$] (C1) and [Zn(N(SO$_2$methylimidazole)dpa)Cl$_2$] (C2) derived from novel sulfonamide ligands; N(SO$_2$pyridine)dpa (L1) and N(SO$_2$methylimidazole)dpa (L2) were synthesized and characterized. Structural data from X-ray diffraction studies of L1 and L2 confirm that the S-N bond lengths (1.6331 (12) Å and 1.6196 (6) Å) are within the accepted range of sulfonamide bond lengths. The S=O, C-N and C-S bond lengths of the ligands lie within the normal range. A trigonal planar geometry can be suggested around sulfonamide nitrogen atom of both ligands since the bond angles around the nitrogen atom are approximately 120°. L1 crystalizes in the triclinic form whereas L2 crystalizes in the orthorhombic form. As expected, the S-N bond length of C1 has not changed upon forming the metal complex as the sulfonamide nitrogen is not bound to Zn. The Zn metal center exhibits a tetrahedral geometry; it binds with two chlorine atoms and coordinates with the ligand through the two pyridyl nitrogens forming an eight membered chelate ring. The bond angels around the sulfonamide nitrogen are around 120° in C1, confirming that the sp^2 hybridization remains unchanged upon binding with Zn. High energy absorption bands which appeared in the region of 200-300 nm of UV-Vis spectra indicate the intra-ligand л- л* and n-л* transitions. Ligands display high fluorescence intensities and they were lowered in complexes; C1 and C2 possibly due to the quenching of fluorescence upon binding to the metal. *In silico* analysis of drug-likeness indicates that both ligands comply with the Lipinski rule of five. Both ligands were predicted to bind with GABA-A receptor with a calculated binding affinity of -6.0 kcal/mol. Furthermore, L1 was predicted to bind with cyclooxygenase-2 with a calculated binding affinity of -7.0 kcal/mol. The synthesized ligands and zinc complexes have the potential to be investigated towards biological applications as novel drug leads.

Keywords: Zinc, sulfonamide ligands, pyridine, methylimidazole

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Development and characterization of an amperometric biosensor using Metallothionein for identification and quantification of lead (Pb^{2+}) ions

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Lead accumulation in the body can cause severe damage to human health, particularly affecting the nervous system in young children. Hence, determining the amount of lead in drinking water is useful to prevent accumulation in body, which leads to lead poisoning. It is noteworthy that a large fraction of the population that is affected by lead contamination in drinking water lives in the developing world. Hence, this research focuses on the development of an amperometric biosensor to quantify Pb^{2+} ions. The protein metallothionein (MT) was used as the Pb^{2+} recognition molecule in the biosensor. MT was isolated from *Staphylococcus warneri* TWSL_6 strain and physically adsorbed onto paper discs. The loading volume of MT was optimized to be 6 µl from 7.8 µg/µl MT solution. The MT-loaded paper discs were placed on the electrode system which consists of Ag/AgCl reference electrode, and two graphite paste electrodes as working and counter electrode. The metal ion-MT binding will cause the space-charge in the aqueous solution to move closer to the sensor because of changes in the protein conformation. This system was tested with 1 µM to 1000 µM concentrations of Pb^{2+} in 10 mM KCl as the supporting electrolyte. The cyclic voltammograms of the samples were obtained by applying potential from -1 V to +1 V and the current produced at -0.43 V was used for the calibration plots. Thus, the amperometric transducer detects this change directly. There was a clear increase in current for the analysis of Pb^{2+} when carried out with MT-loaded discs. The calibration plots were studied under three sub-series. The same electrode set-ups were used for each sub-series throughout the experiment. The Pb^{2+} concentrations ranging from 650 µM to 1000 µM gave a linear trend (R^2=0.97) with a slope of 5×10^{-9} A/µM for MT-loaded paper discs. The slope and the linearity (R^2) were determined to be 2×10^{-8} A/µM and 0.98, respectively for Pb^{2+} concentration series in 10 mM KCl medium ranging from 50 µM to 500 µM with MT-loaded paper discs. The sensitivity of the device is 2×10^{-7} A/µM with an R^2 of 0.85 in the Pb^{2+} concentration series in 10 mM KCl medium ranging from 1 µM to 50 µM. Hence, the LOD value of the developed biosensor is 5.24 µM and the LOQ value is 17.45 µM. It can be concluded that metallothionein can be used successfully for the Pb^{2+} ion detection in amperometric biosensors.

Keywords: Amperometric paper-based biosensor, metallothionein, lead (Pb)

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Synthesis of novel benzodioxan and biphenyl based dien sulfonamide ligands and their platinum(II) complexes

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Eventhough thousands of platinum drugs have been synthesized and screened for anticancer activity, treatment has become limited due to toxicity and drug resistance. Understanding specific targets in cellular pathways and designing novel Pt drug candidates offer a powerful approach to cancer therapy. An amphipathic ligand system would be the best approach for synthesizing novel platinum complexes to target cells. This could be achieved by incorporating a lipophilic aromatic ring system to the hydrophilic diethylenetriamine backbone via a sulfonamide group simultaneously giving enhanced fluorescence activity. In this study, two novel bidentate ligands (L1 = $N(SO_2)$(bzd)dienH, L2 = $N(SO_2)$(4-Mebip)dienH) and their corresponding novel platinum complexes (C1 = $[Pt(N(SO_2)$(bzd)dienH)$Cl_2]$, C2 = $[Pt(N(SO_2)$(4-Mebip)dienH)$Cl_2]$) were synthesized and characterized by ^{1}H NMR, FT-IR, UV-Vis and fluorescence spectroscopies. The high energy bands observed between 200-300 nm due to π→π* transitions and n→π* transitions in absorption spectra of the free ligands and platinum complexes. The S-N stretching observed in FT-IR spectra at 932 cm^{-1} for L1, and 913 cm^{-1} for L2, are consistent with related compounds. ^{1}H NMR spectra obtained in DMSO-d_6 were utilized for structure elucidation. Signals observed at 3.00-2.30 ppm region in ^{1}H NMR were assigned to aliphatic protons in ligands. In the complexes, signals at 6.02 ppm, 6.84 ppm and 7.64 ppm in C1 and 6.05 ppm, 6.90 ppm and 7.77 ppm in C2 were assigned to NH peaks and confirmed the formation of complexes in which the new ligands display bidentate denticity (central N2 and terminal N1) vs tridentate. Emission spectra were recorded in methanol, and the $N(SO_2)$(bzd)dienH ligand showed enhanced fluorescence intensity at 331 nm, whereas its bidentate complex showed quenched fluorescence with a blue shift. Similarly, $N(SO_2)$(4-Mebip)dienH ligand showed high fluorescence intensity, while its bidentate complex showed lower intensity. The sulfonamides linked to diethylenetriamine can conjugate with small biomolecules. The ligands presented by us possess high fluorescence activity, allowing them to be used as diagnostic tools. In the near future, the synthesized novel bidentate platinum complexes will be investigated for their potential as anticancer drug leads.
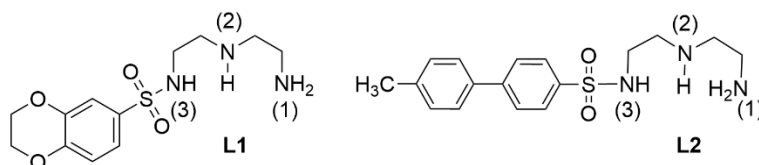
Figure: Line diagram of newly synthesized dien ligands; L1 = $N(SO_2)$(bzd)dienH, L2 = $N(SO_2)$(4-Mebip)dienH

Keywords: Diethylenetriamine, benzodioxan, biphenyl, platinum

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A potentiometric ion selective sensor based on piperine for determination of Fe(III) in the presence of Fe(II)

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Ferric ion is one of the most essential transition metal ions, which plays a vital role in many biological systems. Both deficiency and excess of Fe(III) ions can cause serious disorders such as anaemia in humans and chlorosis in plants. Therefore, quantitative determination of Fe(III) ions is crucial for maintaining the balance of many biological and environmental systems. The purpose of this study is to develop and characterize a potentiometric solvent polymeric ion selective membrane electrode for the determination of Fe(III). Piperine was used as the ion selective ligand. The complex formation constant (log β_{ILn}) of piperine ligand with Fe(III) in the polymeric membrane is determined as 1.04 ± 0.04 using the sandwich membrane method. Apart from the ionophore, the membrane consists of a PVC matrix with ortho-nitrophenyloctyl ether (NPOE) as the plasticizer and potassium tetrakis (4-chlorophenyl borate) as the ion exchanger. The mass ratio of components of the membrane was maintained to be 1:1:66:132 (piperine : ion exchanger : PVC : NPOE). The ion selective electrode (ISE) was calibrated for different Fe(III) concentrations in 0.02 M citrate buffer medium using open circuit potential (OCP) measured against Ag/AgCl reference electrode. The response curve showed a super-Nernstian slope with the value 30.4 mV/decade with a limit of detection (LOD) of 1.26×10^{-4} M. The electrode equilibrated with a less than 10 s response time and the reported results were quite reproducible. Most importantly, the ISE showed higher selectivity towards Fe(III) over many other cations such as Fe(II), Cr(III), Al(III), Ba(II) and K(I) with selectivity coefficients -6.04, -3.68, -3.27, -6.80, -3.93, respectively which were determined within a concentration range from 1×10^{-4} M to 1×10^{-1} M. The selectivity coefficients are quite promising as it exhibits the ability of the ISE to distinguish between Fe(III) and Fe(II), which is a major interfering cation in Fe(III) determination. Thereby the developed ISE could be used in quantitative determination of Fe(III) ions. Further experiments are being carried out to improve the lower detection limit that is required for biological sample analysis.

Keywords: Fe(III) ion selective, potentiometry, solvent polymeric membrane electrode, piperine, complex formation constant

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Catalytic activity of green synthesized iron-palladium bimetallic nanoparticles on Sonogashira and Stille cross-coupling reactions

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Catalytic applications of plant extract mediated green synthesized bimetallic NPs have attracted significant interest as an eco-friendly method. The Sonogashira and Stille carbon-carbon cross-coupling reactions are widely used in the synthesis of complex organic molecules. The objective of this research was to investigate the catalytic activity of Fe-Pd bimetallic nanoparticles, synthesized using banana leaf extract of *Musa Paradisiaca,* on Sonogashira and Stille cross-coupling reactions. Banana leaf extract (BLE) was prepared by boiling fresh banana leaves (50 g) in deionized water (150 mL) for 30 minutes. The UV-Vis spectrum of the BLE showed peaks at 200-270 nm range and 350 nm, which correspond to the polyphenolic compounds that can act as reducing, capping and stabilizing agents during nanoparticle synthesis. $PdCl_2$ (0.050 M) and Fe_2O_3 (0.0028 M) were used as precursors to synthesize the bimetallic nanoparticles. Synthesized Fe-Pd nanoparticles were characterized by X-ray diffraction. Reflections at 39.82^0, 46.31^0 and 67.65^0 are well indexed to the (111), (200), and (220) planes of crystalline palladium. The powder X-ray diffraction study confirmed the crystal structure of zero-valent Pd. The synthesized Fe-Pd nanoparticles showed magnetic properties which is an important feature for catalytic reusability. The catalytic activity of synthesized Fe-Pd NPs was studied in Sonogashira and Stille C-C cross-coupling reactions. The optimum reaction conditions for Sonogashira C-C cross-coupling reaction of bromobenzene and phenylacetylene were found out to be 0.63% Fe-Pd nanoparticles (with respect to bromobenzene) in water (solvent) using K_2CO_3 (2 mmol) as a base at 60 °C for 30 min. The purified product, diphenyl acetylene was isolated in 47% yield. Stille cross-coupling reaction was carried out using Fe-Pd NPs (2% w/w, relative to bromobenzene) as the catalyst and K_2CO_3 (2.0 mmol) as the base at 80 °C in water for 1 h. The Stille cross-coupling reaction of bromobenzene with tributylphenylstannane yielded pure biphenyl in 87%. It can be concluded that Fe-Pd bimetallic NPs synthesized using banana leaf extract can be applied as a catalyst on Sonogashira and Stille cross-coupling reactions.

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Coarse-grained molecular dynamics simulations study on localized membrane curvature induced by the tetanus toxin and lipid composition

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Tetanus toxin (Tetanospasmin), a proteinaceous toxin secreted by Clostridium tetani bacteria, is responsible for the inactivation of inhibitory interneurons leading to tetanus. The internalization mechanism of the toxin into the neurons has not yet been definitively identified. The focus of this coarse-grained molecular dynamics (CGMD) simulation study was to determine the capability of the tetanus toxin to generate localized membrane curvatures that could act as the trigger to clathrin mediated endocytosis. CGMD simulations were carried out with protein attached and detached membranes to identify the toxin's capability of inducing membrane curvatures. A dipalmitoylphosphatidylcholine (DPPC) membrane (>1700 DPPC residues) with the potential of -70 mV yielded a 0.004 Å^{-1} positive curvature after 400 ns, and reversed potentials (+70 mV) yielded a -0.002 Å^{-1} curvature. Increment of the applied potential to +/- 140 mV leads to produce rapid curvatures (0.003 Å^{-1} and -0.007 Å^{-1} after 50 ns, respectively). Increasing the membrane negative charge by introducing 1,2-dioleoyl-snglycero-3-phosphoserine (DOPS), dipalmitoylphosphatidyl -inositol (DPPI) lipids and additional monosialotetrahexosylganglioside (GM1a) toxin receptors at -70 mV resulted a higher induced curvature, which was highly pronounced with the presence of the toxin. Unsaturated lipid tails showed a drastic increase in the curvature of 0.006 Å^{-1} after 115 ns at -70 mV. Incorporation of large headgrouped lipids into the bilayer showed a -0.007 Å^{-1} curvature even in the absence of the toxin at -70 mV producing a reduced curvature even with a higher overall charge and unsaturations in the membrane. The study suggests that the tetanus toxin is capable of inducing membrane curvatures, and the magnitude of the curvature depends on the applied potential, membrane charge and nature of the lipids.

Keywords: Tetanus toxin, molecular dynamics simulations, membrane curvature

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Developing a conductive textile rayon fiber

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Electrically conductive textile fibers are the key component of electronic textiles, and is used in a wide range of fields such as military, sports, medical and entertainment fields. However, the conventional textile fibers are intrinsically insulators. Hence, conventional textile fibers should be integrated with conductive substances to make them conductive. In this research, the regenerated cellulose fibers (RF) were synthesized, and prepared typical RFs were transformed into conductive RF by dip coating with poly (3,4-ethylenedioxythiophene): poly (styrene sulfonate) (PEDOT: PSS) polymer. The electrical conductivity of PEDOT: PSS coated RFs were enhanced by multiple coating with PEDOT: PSS and post treatment with polar solvents such as ethylene glycol (EG), glycerol and 1M H_2SO_4. The electrical resistance of treated RFs was measured using two-point probe method along the fiber maintaining a distance of 1 cm between the probes. Furthermore, chemical and physical characteristic of the resultant RFs were investigated. The electrical resistance of the bare fibers was reduced from mega-ohm range (23.5 ± 0.71 MΩ) to kilo-ohm range (30.5 ± 0.54 kΩ) after treating with PEDOT: PSS polymer. The resistance of coated RF was reduced with increased density of polymer layers, where the five-time PEDOT: PSS coated fiber [PEDOT (5×)] showed an average resistance of 1.73 ± 0.07 kΩ. The one-time PEDOT: PSS coated fiber [PEDOT (1×)] after EG treatment showed very low resistance (1.38 ± 0.10 kΩ) compared to other post treatment solvents because EG causes conformational changes of the PEDOT: PSS structure. According to the SEM analysis, the PEDOT (5×) fiber has a dense network of polymer on the fiber surface while [PEDOT (1×)] EG post treated fiber has smooth dispersion of polymer on fiber surface. [PEDOT (1×)] EG post treated RF has high breaking load (0.2 N) than PEDOT (5×) RF (0.02 N). Both the RFs have a similar washing stability with tetrachloroethelene solvent. Furthermore, [PEDOT (1×)] EG post treated RF exhibited reasonably good stability when washed with aqueous detergent. It was observed that the [PEDOT (1×)] EG post treated fiber has better conductance, mechanical strength, and washing stability than other studied fibers. Hence, it can be investigated further in the development of conductive textiles.

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Towards an approach for the creation of digital archives for two-dimensional (2D) artefacts in Sri Lanka

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An archive creation of cultural heritage has become one of the crucial activities in society and creating digital archives for 2D artefacts has several issues. The objective of this research is to propose a novel approach to make digital archives of 2D mural paintings in Sri Lanka. By analysing a case study of digital archives of mural painting in a historical temple, Bellanwila Viharaya documented by Lal Hegoda, authors identified several issues related to the process of creating digital archives. Therefore, authors continued the literature review in the area of digitizing 2D images and identified that panoramic images which is an application of image stitching technique in computer vision can be applied to create digital archives. Panoramic image is the process of combining multiple photographic images with overlapping fields of view of a large mural painting which can not be focused as a single image. Authors researched on the 2D digital archive and identified software tools that are used for creating panoramic images. Two available software tools, Photoshop and Hugin were tested and identified some drawbacks. Accordingly, a new algorithm was proposed to create digital archives for 2D artefacts. New algorithm has several steps: image acquisition, pre-processing, sorting, feature detection and matching, homography, blending, fine-tuning and displaying output panorama. Large-scale 2D mural paintings in three main temples in Sri Lanka were used as the dataset to evaluate the proposed algorithm. A subjective evaluation of the experts in the area of visual arts was conducted for the dataset to determine the level of quality of 2D digital archive developed using the proposed algorithm comparing two available software tools. The collected data related to the quality attributes: colour balance, noise and distortion with the overall quality were analysed. It was identified that the percentage of higher-level overall quality of generated digital archives using the proposed algorithm is 92.86% and is higher than by using the other two software tools; Photoshop (35.71%) and Hugin (14.28%), respectively. Moreover, it can be concluded that the proposed approach is effective for creating digital archives and can be used to make a digital repository for 2D artefacts in Sri Lanka.

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Deep learning approach to predict Brown Plant Hopper incidence on the rice plant with climate change

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Brown Plant Hopper (BPH) incidence on the rice plant is a huge problem in the agricultural field. Damage causes by the BPH is very high in rice cultivation and has highly influenced farmers who cultivate rice. Minimum and maximum temperature, morning and evening relative humidity, rainfall, sunshine hours and the wind velocity are the climatic factors that influence the BPH incidence. This study was carried out to identify the relationship between BPH incidences on rice plant with climatic factors and to build a suitable model to predict BPH incidence to the rice plant. A dataset collected from the rice research and development institute in Batalagoda, Sri Lanka for the period 1ˢᵗ January, 2014 to 31ˢᵗ of May, 2020 was considered for this study. In BPH data, there are numerous missing values and thus, missing value imputation techniques were followed to fill the missing observations. Linear interpolation, backward forecasting, using average of two seasons and the specified packages in R software; namely, mice, amelia and missForest were used as the missing value imputation techniques. Among them using average of two seasons in the rice cultivation, 'Yala' and 'Maha' was the best method for missing value imputations. To identify the relationship between BPH and climatic variables, two machine learning techniques Feed-Forward Neural Network (FFNN) and Recurrent Neural Network (RNN) were employed. By adjusting parameters in the two neural network models, FFNN model with three hidden layers of hidden neurons 1,1,3 and RNN model with two hidden layers of hidden neurons 1,3 were considered as better models. Comparing the aforementioned two models, RNN model exhibits the least mean squared error and mean absolute error which were 0.4696 and 0.4285, respectively. This study is a good approach to the experts who are interested in the agricultural fields to do more studies in the pest incidences to the rice plant using the advanced techniques. These findings may also be helpful for the agricultural sector to improve their traditional methods to an advanced level with the technology.

Keywords: Brown Plant Hopper, Feed-Forward Neural Network, Recurrent Neural Network

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Digitization of national identities of citizens using Blockchain Technology

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Every citizen holds a unique identity, which they use to prove themselves as an authentic citizen in a situation where they are requested to do so. These identities hold a very crucial part, for both the provers and the verifiers, because it is one of the most reliable sources of proof for a citizen. As technologies evolve, these manual identities are becoming easier to tamper and that eventually leads to several false claims and fraudulent activities. Hence, it is becoming harder for a verifier to trust this information and the verification of the authenticity of such false identities is not an easy process. Therefore, the digitization of identities is one of the key steps for a nation when moving forward into a digital era. However, it is not quite as easy as being implied, because this sensitive information should be handled with the highest security and it should not be prone to any digital vulnerability. Therefore, this research proposes a way to digitize the identities of citizens in a very secure manner by deploying the control to the user without relying on any remote data storage. This solution proposes to store transactions of identities from the origin (government) to citizens inside a public distributed ledger, known as a blockchain that helps the verification of transactions to prove the legitimacy of an identity. The main advantages of this approach are that the users will have control over their identities, can decide with whom they want to share their identities and can also be revoked anytime per the wish of the user. The verifiers will be able to verify the identities by checking whether the transaction of this information (identity) from the government to the prover (citizen) has been recorded within the blockchain. Hence, this would bring a very secure and reliable digitization solution for a government to manage their citizens' identities.

Keywords: National identity, digitization, Sri Lanka, Blockchain

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Musical instrument identification by the selection of predominant features

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Selection of predominant features is an emerging field in the machine learning approach. In this research study, we present the effort of three feature selection methods; ranking selection, random selection, and sequential forward feature selection (SFFS). Firstly, we extract 44 features for 20 musical instruments with three musical families by the Audio Content Analysis tool. However, not all features are necessarily used to identify the musical instrument. Therefore, the predominant features are to be selected for each musical instrument. The ranking method finds the highest rank feature in order. The random selection does the random order and the sequential forward feature selection method selects the optimal best set of features. Overview of the feature selection order is dependent on the musical instrument. Despite that, the number of predominant features detected by the other two selection methods is taken to be equal to the number of predominant features to be detected in the SFFS method. Using them in the support vector machine (SVM) classifier, the musical instruments were identified and the accuracy values were recorded. The accuracy of the SFFS method from the response received is greater than the other two methods. Therefore, we decided to choose the predominant feature that was detected from the SFFS method. The automated musical instrument identification system was developed with 21 SVM classifiers with predominant features. It is classified as polyphonic music. The selection of the set of predominant features differed from one musical instrument to another and spectral features have been more influential than other features.

Keywords: Predominant features, feature selection, musical instrument, identification, method

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A machine learning-based predictive model to identify bond violators in the public university system

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Academic staff members of public universities violating the terms in their agreements with the employer and thereby with the Government of Sri Lanka when obtaining overseas leave is a serious issue in the public university system. From a sustainable development perspective, it is vital for a country to have highly skilled intellectual capital in the higher education system to train the required workforce to the country as well as to lead advanced research and other technology transfer initiatives. However, due to various reasons, a significant percentage of the academic staff members who obtain paid leave to study in developed countries to fulfil their postgraduate qualifications do not return after completing their studies, even though they have signed a bond before going abroad. According to a list published by the University Grants Commission (UGC) of Sri Lanka in 2018, 486 academics have not returned to Sri Lanka after completing their postgraduate studies, owing 813 million rupees as the total bond value to be paid. With the data science boom, many organizations have looked forward to predicting employee attrition or churn, aiming at recruiting and retaining the right talent to the organization. However, such an analysis has not been conducted in the state university system to date. Machine learning, which is a branch of artificial intelligence is a fast-growing technology that helps to recognize patterns from data. This research study is an attempt to build a machine learning-based classification model to predict the bond-violating behaviour of academic members in the public university system using the publicly available data on the Internet. The publicly available data such as the data made publicly visible on social media accounts by their owners, research repositories, university websites, as well as the published list of bond-violators by the UGC, enables to construct of a dataset of bond violators and non-violators, which could be used to train supervised machine learning models for binary classification. This study presents the modelling details, preliminary results, and subsequent analysis of the results.

Keywords: Brain drain, university academics in Sri Lanka, machine learning

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Is an IoT based operational air quality monitoring system feasible in Sri Lanka?

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Air pollution has risen inexorably in parts of Sri Lanka over the last decades and there is a need for authoritative information on prevailing air quality to inform mitigation actions. The availability of low-cost air quality sensors, Internet of Things (IoT) technologies, advances in air quality (AQ) and wind modeling, and information and communication technologies provide an opportunity for such information. Here, we report an effort to develop and operationalize such a system for AQ monitoring in Western Sri Lanka. Our goals were to: (i) provide detailed AQ monitoring, (ii) facilitate access to AQ information, and (iii) serve as a resource for research, education, and training. To this end, we reviewed low-cost air quality sensors, and calibrated four of the better rated instruments locally against an expensive EPA certified instrument in the US embassy in Colombo. The calibration for particulate (pm2.5, pm10) data showed excellent fidelity. Twenty of these instruments were deployed in Colombo, Puttalam, Kandy, Digana, Akurana, Nawalapitiya and Nachchaduwa where the impacts of various pollution sources (transport, industries, biomass burning and transboundary) and pollution transport (wind effects and topography) pose challenges and unique vulnerabilities. Using the online data streams, we present the monitored data in near-real time through portals at www.cleanair.lk and www.fect.lk, trilingually. The travel restrictions, lockdown and security suspicions challenged our work in the last two years. Nonetheless, this work, has provided a proof-of-concept of the feasibility of IoT-based operational air quality monitoring system in Sri Lanka. Our portal was presented with a competitive award by the Information and Communication Technological Agency of Sri Lanka in 2020. Using data from our weather stations, we were able to use wind and particulate data for forensic analysis of pollution spikes in November 2019, impacts of covid curfews and impacts of xpress pearl ship fires. These efforts show that with modest resources, motivated personnel and support from citizens, one can sustain a state-of-the-art IoT enabled air quality system at pilot scale.

Keywords: IoT, air quality, instrumentation, environmental technologies

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Non-verbal communication-based emotion detection in online interviews

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The outcome of interviews is strongly influenced by the behavior of the interviewed candidate. In some situations, the answers given by the candidate do not reflect the true feelings or the actual potential of the candidate for the interviewed job position. Usually in interviews, it is not possible to use extra devices to detect the confidence level of the given answers. The situation has become very critical in online interviews, which are happening in abundance at present. In online interviews, the candidate faces the interview panel virtually, limiting the opportunity of the panel to observe facial expressions, body language and other soft skills of the candidate. Analyzing the required soft skills for a particular job is a good parameter in the long term for a candidate to hold on to the job. Hence, selecting the most suitable candidate who is good 'on paper' as well as good 'in person' is very challenging. This research proposes a method of identifying emotions of candidates based on a captured video sequence of the candidate during the interview to identify the evoked emotional states and the characteristic expressions of the human face. The primary objective of an emotion recognition system is to interpret the input signals from different modalities and use them to convey information about the interpreted emotion. The system consists of four main modules: image pre-processing, feature extraction, identification of feature occurrences and intensities, and classifying emotions. Based on an emotion model, the system will be able to predict the confidence level of the candidate. Thus, it is expected that fine-grained speaker-specific continuous emotion recognition system developed in this research will help the interview panels to identify the most suitable candidate in online interviews. Emotions will alter the message significantly: often, it is not what has been said that is most relevant, nor how it has been said. Faces tend to be the most obvious means of contact between feelings. However, as opposed to the voice and other modes of speech, they are often easily manipulated in reaction to various social circumstances.

Keywords: Facial expression, emotion recognition, Artificial Intelligence

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Identifying hate content with Facebook posts in Sinhala language using emoticons and reactions-based text analysis

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The escalating popularity of online social networks has become an integral part of the communication medium. Facebook is the most widely used social media platform, which enables people to express their opinion widely online in Sri Lanka. Such platforms bring novel opportunities but also poses several malicious phenomena such as the propagation of hate speech online with its anonymity and mobility. Hate speech on Facebook is significantly ramping up and it is paramount to prevent the dissemination of hate online. However, automatic hate speech detection is challenging in low-resourced settings and with morphologically rich languages like Sinhala. Meanwhile, much expressive facilities are being introduced frequently in Facebook. There is a new generation of emoticons, called emojis, which have dominated the social media platforms representing the thoughts, feelings, moods and emotions of a user to facilitate more expressive text content in computer-mediated communication. The emoticons dominated the sentiment associated with the text segment. Moreover, Facebook users can react to a post with different emotional reactions: love, haha, wow, sad, care, and angry. However, the sentiment inherited from reactions towards a Facebook post has not been supported by empirical evidence. In this paper, we present an experiment of effective identification of hate content in Facebook posts in Sinhala, by incorporating the impact of sentiment expressed by emoticons and reactions to FB posts for the linguistic text classification. The corpus was constructed from 2049 Facebook posts in the Sinhala language, annotated for hate/non-hate/undecided by human annotators using a crowdsourcing platform. The results evidenced that all the classifiers (Random Forest, Support Vector Machine, and Naïve Bayes) performed well when considering emojis embedded in the linguistic text and the reactions by users to the post. Finally, the study experimentally verified that the text analysis with machine learning algorithms considering emoticons embedded in FB posts and reactions to posts significantly improves hate speech classification accuracy by 97%.

Keywords: Hate speech, social media platforms, emoticons, reactions

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Exploring the critical factors influencing online examinations

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With the outbreak of the Covid-19 pandemic, there are less options to conduct examinations physically and most of the universities in Sri Lanka started conducting online examinations. Yet researchers have assessed the online examinations throughout the pandemic, there is only a few research done to evaluate the current state of practices in this field. This study investigates the critical factors influencing online examinations in higher education, predominantly as a case analysis in the Sri Lankan context. Based on the systematic review of literature, the empirical and practice gaps were identified and based on the discoveries of this research, the critical factors that influence the online examinations were identified as the perception of educators, perception of students, pedagogical alignment of examinations, availability and the affordability of the technology and country's resource position. From these factors, a conceptual model has been developed and the inter-relationships among them were also identified. Research data are collected through online surveys from postgraduates and undergraduates, (a sample of 80) who have faced at least one online exam, interviews (20 interviews) with educators and technical experts in the field, and resource persons of the "Nenasala" center. A mixed-method approach was used to analyze both qualitative and quantitative data. Students' perception, educators' perception, and the pedagogical alignment regarding online exams have been explored thus, outlined complications and suggested implications can be used when steering the online exams. Furthermore, the feasibility of conducting online exams at "Nenasala" centers has been explored for the students who have various issues, and the student's willingness to do so has been also evaluated in this study. Moreover, the current state of technologies that are being used by state universities in Sri Lanka has been explored and the drawbacks and suggestions were also presented in this paper. Thus, inferences from this research would be beneficial to the university community around the world to perform high-quality and trustworthy online examinations. The discoveries of this research help to comprehend and improve the current chaos and the suggestions can be used even after the pandemic period to enhance distance education.

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Effectiveness and impact of paddy production policies in Sri Lanka: 1998 to 2018

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Successive governments in Sri Lanka (SL) have introduced several policies related to paddy production since independence to make the country self-sufficient in rice at a cost to the economy. Hence, the main objective of this study is to evaluate the effectiveness and impact of government policies on paddy production in SL from 1988 to 2018. The study collected secondary data on seasonal paddy production by district, gross fixed capital stock in agriculture per farmer, land availability, seasonal average rainfall, temperature, rolling five-year standard deviation of nominal rate of assistant, road length, telephone penetration, cereal self-sufficiency, policy variability of all paddy growing areas and used in linear panel model to identify the impact of policies. The effectiveness of policies was estimated using indices such as producer support estimates (PSE) and market price support estimates (MPS). Irrigation, paddy farming and diversification, land, fertilizer subsidy, climate change adaptation, research and development, paddy marketing and trade policies are the broad categories of policies introduced in the last two decades. Paddy production has been increasing on average at about 4.08 percent annually since 1998, with the improved access to inputs such as fertilizers and seeds through government policies. However, there is no statistically significant difference in paddy production among different years which indicates that the increase in paddy production is marginal over the years. The rice imports are insignificant when compared to the local production during the study period. PSE and MPS are negative which indicate that the government policy instruments prevailing in Sri Lanka induces a lower farm gate and domestic market price thereby discouraging commodity production. According to the analysis, improved access to information (0.443, significant at 0.1 significant level) has a positive effect while climate variables; specially, rainfall (-0.004, significant at 0.05 significant level), has a significant negative effect on seasonal paddy production by district, which highlighted the need for more climate resilience policies and markets that are better developed and improved access to information. Agricultural policies, which move away from market-distorting measures and blanket income transfers, and policies focus on strategic investments and climate risk management which assists and enhances farmers' capacity on adaptation to rainfall variability, are recommended.

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Consumer perception and buying behavior of dried fish: A case study in Kurunegala and Gampaha districts

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Dried fish acts as a rich source of animal proteins (<56.84%), minerals (<29.19%) and lipids (<18.45%), thus contributing towards the nutritional security of human beings. The consumption of dried fish has increased locally as well as globally. Food safety, convenience of buying, versatility, affordability, quality and quantity are other applicable attributes of the buyers. Despite plenty of research on fish and meat products, studies on the buying behaviour of dried fish are scarce. Thus, the objective of this work is to analyze consumers' perception and buying behavior of dried fish in Sri Lanka. Pre-tested structured questionnaires were distributed among 60 dried fish consumers by using Snowball sampling in Kurunegala (n=30) and Gampaha (n=30), which represent the highest dried fish consumption districts in Sri Lanka. Variables were selected on physical quality attributes of dried fish by using published research material. Data was analyzed using descriptive and non-parametric statistics including Chi-square and Friedman test. Buying from retailers are common in both locations; Kurunegala (73%) and Gampaha (56%). A significant relationship is noticeable between buying frequency and product sale promotion methods (x^2=20.303, p=0.016) from both districts. All perceived a quality deterioration along the supply chain where consumers in Gampaha believe hypermarkets as the source for higher quality dried fish products (x=3.13, p=0.00, x^2=25.875). Appearance is valued over texture, odor, breakage and shelf life by consumers in Kurunegala (x=4.02, p=0.00, x^2=45.926) and Gampaha (x= 3.79, p=0.025, x^2=12.859) while breakage is indicated the least value in both Kurunegala (x=1.97) and Gampaha (x=2.72). A tendency towards locally produced dried fish consumption is significant in both districts rather than imported dried fish ($x_{Kurunegala}$=1.79, $x_{Gampaha}$=1.67, p=0.00). More than 86% consumers are willing to pay high prices depending on the quality of the product. Value additions and standardized handling practices need to be introduced and practiced throughout the value chain to ensure the quality of dried fish. Quality packing, free from mold and discoloration would be advantageous for better appearance of the product. Texture, odour and shelf life are the other important attributes that determines the buying behavior. This calls for careful attention on hygienic practices and quality consciousness in dried fish processing and handling along the supply chain to expand quality production on fair price.

Keywords: Consumer attitude, dried fish, quality measures, price, purchasing behavior

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Farm gate price determinants in small-scale maize production: A case study in Anuradhapura district

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Maize (*Zea mays*) is the second largest cultivated crop apart from paddy in Sri Lanka. A significant price gap is noticeable between farm gate prices (FG) and retail prices of maize. This paper examines the price determinants influence on FG price of raw and dried maize produced by small-scale maize (SSM) producers in Anuradhapura. A sample of 100 SSM farmers were selected using simple random sampling technique, from proportionately selected five divisional secretariat divisions (DSDs) in Anuradhapura district based on the highest production. Thus, the sample comprised with small- scale maize farmers from Galenbidunuwewa (27), Kebithigollewa (18), Thalawa (25), Kekirawa (13) and Thirappane (17). A questionnaire survey was administered for primary data collection considering the variables of marketing practices and production management factors. Secondary data of average FG prices of maize were obtained from Hector Kobbekaduwa Agrarian Research Institute. Data was analyzed using inferential (ANOVA) and descriptive statistics. The findings revealed that many farmers sell their harvest through multiple buyers including middlemen (19%), retailers (1%) and a majority is sold to both middlemen and retailers (80%). Buyers prefer to buy dried maize at high prices than raw maize. Highest FG prices were obtained via seed maize for agricultural purpose from type of market (p=0.000), transporting by lorry from transport mode (p=0.032) with highest storage availability (p=0.001), and stored mostly in houses (p=0.008). Full-aware (p=0.000), quality concerned (p= 0.001) maize farmers who were not used post-harvest methods (p=0.012) gained high FG prices. Quality management factors like seed color (p=0.000), moisture content of seeds (p=0.000), maturity level (p=0.000) and removing damages (p=0.000) influenced the FG price of maize. Quality improvement (92%), post-harvest handling (74%), effectiveness of agronomic practices (89%), infrastructure facilities (97%), awareness programs (100%), input provisioning (100%) and agricultural extension services (97%) were requested for better quality production. Information dissemination and establishment of competitive markets were mostly affected for fair FG prices of SSM farmers in Anuradhapura district.

Key words: Farm gate price, maize production, maize buyers, price determinants, quality

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Gender inequality in holding leadership positions of academia: Evidence from the state universities in Sri Lanka

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Gender inequality remains one of the major challenges for human capital development. United Nations (UN) Sustainable Development Goal (SDG 5.5) aims to ensure women's effective participation and equal opportunities in leadership positions (UN, SDG report). Female employees face discrimination at the workplace and they continue to be underrepresented in leadership positions. Over the last few decades, scholars as well as policy makers emphasized the importance of establishing gender equality in leadership. However, most of these studies focused on corporate and political leadership and less attention is paid to gender inequality in leadership in academia. This study aimed to identify why female academics do not get into the leadership positions as male academics and to make recommendation to ensure the gender equality in leadership in academia. This study designed as two stage study, where the first part of this study was designed to understand the current composition of male and female in leadership positions in academia. To attain this objective, secondary data were collected from the published documents of University Grant Commission. These data showed that only a few female academics are holding the leadership positions. The second part of this study was designed to understand the reasons for why female academics do not get the leadership positions on par with male academics. To answer this question, we collected data from the female academics in state Universities of Sri Lanka via an online survey. The study results showed that family responsibilities, partner employment, previous experience, perception of it as an unattractive career option, and jealousy and discrimination from male academics as main reasons of female academics not getting into the leadership positions. Thus, we recommend policy makers to provide facilities such as day care centers, training programmes, equal opportunities for both male and female in committee and boards (e.g., senate), and encouragement for them to participate in leadership positions. Thus, this study provides a significant contribution to the theory and practice.

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Household preferences for cleaner energy alternatives in Sri Lanka: A discrete choice model application

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Transitioning to more efficient energy alternatives, particularly cleaner cooking facilities can lead to positive outcomes in terms of poverty elimination, health, and livelihood development which cannot be underestimated. Therefore, the aim of this study is to explore the household behavior and choices for switching to cleaner alternatives from traditional cooking stoves. We applied an environmental economics approach; a discrete choice experiment with the local community in the Anuradhapura district of Sri Lanka where a considerable number of households use traditional cook stoves. Data were collected from a randomly selected sample of sixty households using a structured questionnaire followed by the choice experiment. A conditional log it model was used to estimate the determinants and willingness to pay. The attributes considered include reduction in fuel wood usage, amount of smoke and stove costs. Results highlight that monthly usage cost of fuel, and the amount of smoke were significant determinants affecting transition. Households were concerned about the health impacts as well as convenience and durability of the new stoves. Relative strength of factors was assessed by computing marginal willingness to pay, which highlighted that respondent were willing to pay more for improved stoves emitting less smoke. Households also emphasized the importance of government support in various forms. The positive affinity among households to switch to cleaner alternatives signal the need for promotion and awareness of these sources. Moreover, it is important that governmental and non-governmental organizations incentivize them with monetary and non-monetary support as this transition also contributes to greenhouse gas emissions reduction from biomass burning.

Keywords: Cleaner energy, cooking stoves, choice experiment

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Agricultural production and food and nutrition security: A South Asian perspective

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Food and nutrition insecurity is the largest single risk factor faced by South Asia despite recent developments as it holds more than 40 percent of hunger in the world. It has become a huge burden for the health of the population in the region. The study examines the role of agricultural production, particularly rice production in improving the region's food and nutrition security. The study was carried out using secondary data gathered from FAOSTAT and World Bank databases. A fixed effects panel regression was carried out using SPSS version 16.0. Results reveal that there is a beneficial role in production of rice on upgrading the nutrition condition of the region. A 1% increase in rice production contributes to 4.77% decrease in prevalence of undernourishment. Other associative factors of nutrition security in the region are GDP per capita and population growth rate. Food availability dimension of food security is examined by using average dietary energy supply adequacy. It was revealed that average dietary energy supply adequacy is significantly influenced by production of rice, GDP per capita, population growth rate, and inflation and government expenditure on agriculture sector. These factors also showed a significant impact on food accessibility examined using the food price index. The results suggest increased agricultural production in the region may contribute to overall economic growth by improving the availability and accessibility of food, which is the foremost step in achieving food and nutrition security. This calls for tailored, systematic and cross sectorial actions across the region to increase production and support vulnerable households to improve the level of national food and nutrition security.

Keywords: Food security, nutrition security, rice production, South Asia

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Marginalization effects on the sociocultural status of Yakkure and Henanigala indigenous groups in Sri Lanka

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Sri Lankan indigenous people (IP - Vedda people) are considered a specific group of people due to their cultural and biological uniqueness. The majority of them continued their traditional lifestyle with their valued cultural system until they were resettled by the development projects initiated during the mid-20th century. Marginalization is both a process and a condition that prevents individuals or groups from full participation in social, economic, and political life. People can be marginalized due to multiple factors; sexual orientation, gender, geography, ethnicity, religion, and displacement/resettlement. Political discrimination may marginalize some ethnic groups, migrants, or particular regions of the country. Social discrimination can impact a wide range of groups and Economic marginalization can prevent equal access to basic services, income opportunities, and access to jobs. This research was conducted specially to find out 'the way IP become a marginalized population and how the marginalization effect on their life'. Among a few of the indigenous groups that can be seen in Sri Lanka, Yakkure IP belong to Polonnaruwa district and Henanigala IP belong to Ampara district were selected for the study. Empirical data were gathered through ethnographic methods. The research was conducted from 2014 to 2019. Ethical clearance was obtained from the Ethics review committee of the Faculty of Medical Sciences, University of Sri Jayewardenepura. Among the above-stated factors, displacement/resettlement is identified as the major factor behind the marginalization of Yakkure and Henanigala IP. From 1963 onward these people have not considered as a separate ethnic group in the censuses. Due to the impact of the development projects, they were resettled into new villages, new occupations were introduced, and paddy lands were provided. Assimilation with other populations, and lesser cultural adaptation has transformed them into marginalized communities. Both the Yakkure and Henanigala IP now have forgotten their traditional identity and acculturated into the dominant Sinhalese. Traditional language, religious practices, and rituals are no longer performed due to their tendency towards Buddhism. However, the forced resettlement disturbed their cultural system and not being able to socialize well into the newly introduced market economy ultimately turned them into marginalized populations. Then marginalization affects every aspect of their life and caused problems such as Insufficient lands, debt burdens, land mortgage, minor marriages, alcoholism, poverty, lower levels of education, unemployment, cultural loss, and language loss. These people should consider as a living heritage and government-level policy decisions should be taken to preserve their culture as cultures cannot be restored.

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Power distance on employee performance in agro-based small-medium enterprises (SME) in Sabaragamuwa province

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Organizational culture directly influences employee performance and labor productivity. Geert Hofstede evaluated the organizational culture over four dimensions; namely, power distance (PD), uncertainty avoidance (UAD), individualism (IDV), and masculinity (MAS) by assigning equal weights to each component in generating the indices. Power distance influences employee performance, labor productivity and profitability of a firm. Hofstede (1984), identified power distance as the extent to which the members of a society accept that power in institutions and organizations is distributed unequally. Despite Sri Lanka having an estimated power distance index (PDI) of 80, adequate research has not been carried out on agro-based industries. Thus, this study attempts to calculate the PDI of four agro-based SME categories including dairy, tea, plant production (ornamental plants, timber plants), and agro-input supply. Quantitative data were collected by administering a questionnaire survey (n=60) with operational-level employees adopting simple random sampling technique. The Northouse leadership questionnaire was used to assess the leadership styles. Variables of consultation by superiors, respectability for superiors, conflicting relationship with superiors, and interactions with superiors were used to calculate PDI. All variables were quantified using a five points Likert scale. Democratic leadership was profound in all four categories due to harmoniousness within employees and their leaders in enterprises. Thus, a moderate power distance (PDI dairy= 67.71; PDI tea=49.52; PDI plant= 65.21, and PDI agro-input= 49.24) was resulted. Although Hofstede identified Sri Lanka as a high-power distance (80) country in the year 2011, the calculated value for the agro-based industry (57.92) indicated moderate power distance. It indicates better human relationships within agro-based enterprises and their productivity. It is necessary to improve the two-way communication channel between employees and leaders, provide better guidance to employees to reduce power distance and thereby improve the performance level.

Keywords: Agro-industry, employee performance, Hofstede dimensions, leadership styles, power distance index

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Perception of tea sector officers on banning chemical fertilizer in the industry

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Considering the lethal impacts of inorganic fertilizers, the Sri Lankan Government has banned inorganic fertilizers to promote organic fertilizers. However, the perception of ground-level people has not been considered before taking such a decision. Therefore, this study aims to explore the tea sector officials' perception on this government decision, as they are also the growers and proprietors who are involved in the tea sector. The convenience sampling technique was used in selecting a sample of 30 officials who are actively involved in the tea sector. A Google form questionnaire was prepared and sent via emails to collect primary data from tea sector officials. The five-point Likert Scale was used as the measurement technique and collected data were analyzed using Wilcoxon signed-rank test. According to the Wilcoxon signed-rank test, they carried a good perception regarding the timeliness (T=3.682; p=0.000) and feasibility of promoting organic fertilizer (T=4.893; p=0.000). However, their perception on the practicability (T=0.494; p=0.621), potential profitability (T=1.095; p=0.273), and strengthening Sri Lankan economy (T=1.505; p=0.132) were not significant (confidence level=0.05). However, officials deflected questions about the lack of availability, accessibility, increasing cost of production, and practicability in implementing the proposed decision. Furthermore, results revealed that the decision of promoting organic fertilizer may have a positive impact on society as well as on the environment. From a societal perspective, respondents revealed that promoting organic fertilizer will eventually result in creating new employment opportunities (T=4.428; p=0.000), reducing non- communicable diseases (T=4.696; p=0.000), earning extra income (T=4.681; p=0.000) and poverty reduction of the country (T=4.041; p=0.000). Moreover, the study revealed that the suggestion of the majority (43.3%) of the respondents is to continue tea cultivation with more organic and less inorganic fertilizers. The present study concluded that promoting organic fertilizer will be beneficial under specific circumstances such as enhanced availability. Hence, the findings of this study provide an overview for the Sri Lankan policymakers to become more concerned about banning chemical fertilizers outright and promoting organic fertilizer in Sri Lanka.

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The impact of socioeconomic factors on urban residential garden management: A case study in the Gampaha divisional secretariat area

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With rapid urbanization and limited availability of land, the conservation value of residential landscapes is becoming increasingly apparent. These urban landscapes enable people to reconnect with nature, while providing a variety of ecosystem services. The present study evaluated the socio-economic and knowledge-related drivers responsible for residential garden management in the Gampaha Divisional Secretariat (DS). A pre-tested questionnaire was administered to collect the socio-demographic details and garden management practices of 50 randomly selected households located within a 2 km radius from the city center. The physical conditions of the surveyed gardens, garden design characteristics, maintenance level of soft and hard landscape materials were evaluated through a garden survey, which was conducted during July to December, 2020. The Chi- square test of association was used to identify the significant socio-economic factors that influenced the quality of home gardens. The majority of respondents were 51-65 years old (41.7%), followed by >65 years (25%) and 36–50-years old (25%). Around 45.8% of the study population had completed a degree, while 41.7% had completed Advanced Level. Retired household heads dominated the sample (37.5%), followed by people occupied in the private sector (29.2%). Most families resided in privately owned houses (95.8%) for more than 20 years (75%). A high fraction of home gardens was either self-designed (37.5%) or non-designed (37.5%), while a professional landscape designer had designed only 16.7%. Nearly 66.7% of the gardens were maintained by the family members, while 29.2% of the gardens were maintained by skilled labourers. The majority (54.7%) of families spent only one day per week to maintain their home gardens. Interestingly, only 8% of residential gardens were of "high quality", in terms of the design, plant composition, and maintenance, while 11% were "poorly designed". According to the Chi-square test, only occupation, number of family members, number of residential years, designer of the home gardens, and time spent on garden maintenance were significantly associated ($p<0.05$) with the overall quality of the residential gardens. Residential landscapes have a high spatial heterogeneity with a complex suite of factors. Therefore, understanding the socio-economic drivers of urban residential garden maintenance is critical to ensure successful implementation of policies to conserve urban biodiversity, as residential landscapes make up a significant percentage of urban spaces.

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Identifying the typology of tea smallholding development societies in Matara district, Sri Lanka

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Tea Smallholding Development Societies (TSDS) are farmer organizations in the tea smallholding sub-sector in Sri Lanka, established through a Parliamentary Act in 1991. They are managed by an elected committee and set up to assist members on extension, inputs, marketing, welfare and credit facilities. Evidence shows that the tea smallholding sub-sector is facing a crisis, which implies that there is a shortfall in TSDSs' performance. This study attempts to identify and classify the TSDSs in Matara district through multifunctional activities. The efficiency of TSDS was assessed based on its level of intervention in twelve activities. A sample of 25 TSDSs was selected from Matara district from three strata identified through preliminary studies. Samples were drawn randomly within the strata. Data were collected using structured interviews with a standard questionnaire. TSDSs were assessed using the 0-10 score scale based on the level of engagement in identified activities. The majority of TSDS (72%) in the district show the lowest level of efficacy (≤4 score) in terms of the execution of multifunctional services. The basic functions such as identification of the needs of members and administrative activities are not appropriately implemented by most of the TSDS in the region. In reviewing the outcomes of General Meetings, there appears to be a lack of policy dialogue within organizations. Production support packages (inputs, resources, credit, and extension) are poorly implemented by the majority of the TSDSs and only 4-16% of TSDSs received satisfactory scores (≥5). Market-oriented activities are at a very low level (≤2) and can be seen only in two TSDSs. Although welfare programmes are motivational, only 28% have implemented such to enhance the livelihoods of the members. Sign test revealed that the sample did not perform satisfactorily on any of the reviewed tasks. A cluster analysis indicated three clusters. Relatively highest centroid values for variables were observed in the first cluster (C1), which has two TSDSs. The most poorly performing cluster (C2) has 64% observations. It is noteworthy that the centroid values of only two variables were exceeded five, even in the highest performing cluster. Further exploration of inter-cluster variability would help to understand the factors that make them effective.

Poster Presentations

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Relationship between unexplained subfertility and sedentary lifestyle behavior among women in the urban city of Colombo

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Infertility is defined as the absence of conception after 12 months of regular, unprotected intercourse. Unexplained infertility is infertility which is idiopathic. The objective of this study was to identify the relationship between unexplained infertility and sedentary lifestyle behaviour, body mass index, body fat and sedentary occupation among young female population in urban city of Colombo. A case-control study was conducted among 250 women (125-infertile/case group/125-fertile/control group) in the age group of 18–32 years, who were clinically diagnosed with infertility, while pregnant mothers in their first trimester at gynaecology wards at three government hospitals in Colombo district were taken as the control group. A convenient sampling method was used. Details and medical history of the women were collected in an interviewer-administered questionnaire. To evaluate the activity level (sedentary lifestyle behavior), the short form of the International Physical Activity Questionnaire (IPAQ) was used. BMI was calculated according to the standard equation and SFT was measured by using skin fold caliper. Data were statistically analyzed using SPSS software version 23.0 using Pearson Chi-Square test. A significant positive association ($P<0.05$) was found between obesity and female infertility. There was a significant association of high fat content levels and female infertility. A significant positive association ($P<0.01$) was found between low IPAQ scores (sedentary lifestyle behavior) and female infertility. Women aged ≥28 years and sedentary occupations were found to be associated with infertility ($P<0.01$). Finally, it is concluded that there is a significant association between unexplained infertility and sedentary lifestyle, obesity, increased skin fold thickness and age 28 years or more among women in the urban city of Colombo.

Keywords: Unexplained infertility, International Physical Activity Questionnaire, BMI (Body Mass Index), SFT (Skin Folder Thickness), occupation

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Factors associated with anaemia among lactating mothers up to six months postpartum in a selected medical officer of health area in Colombo

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The severity of postpartum anaemia (PPA) is classified according to haemoglobin (Hb) concentration; mild (110-119 g/L), moderate (80-109 g/L) and severe (<80 g/L). However, no consensus has been established on the duration of the postpartum period. Generally, it is considered as up to 6 months post-delivery and is divided into three phases as acute (first 6-12 hours), sub-acute (2-6 weeks) and delayed (up to 6 months). The aim of the present study is to assess selected factors associated with anaemia among lactating mothers up to 6 months postpartum. This cross-sectional analytical study was conducted in the Dehiwala Medical Officer of Health area in Colombo from September 2020 to May 2021. Lactating mothers (n=67), 1-6 months post-delivery, were selected via a community-based convenience sampling method. Data were collected via a self-administered questionnaire and Hb counts were recorded according to their clinical records. The proportion of anaemia among lactating mothers was 30.6% including mild (16.7%) and moderate (13.9%) anaemia. However, cases of severe anaemia were not encountered. PPA was associated with low Hb count at first antenatal clinic visit (p=0.020). Nevertheless, PPA was not associated with socio-demographic parameters, duration of pregnancy, type of delivery, birth order, birth interval, 6-month exclusive breast feeding, attendance to pre pregnancy, antenatal and postnatal clinics, intake of iron, folic acid and other supplements in postpartum period, and nature of dietary iron intake. Majority of lactating mothers (92.5%) in the study population had either satisfactory or good knowledge on iron and folic acid intake in pregnancy and postpartum period. In conclusion, nearly one third had mild or moderate anaemia even though a majority were aware on iron and folic requirement during pregnancy and postpartum. More attention on incidence of PPA will pave the way to reduce its burden.

Keywords: Postpartum anaemia, anaemia, iron intake, pregnancy

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Development of a guide for drug-nutrient interactions for healthcare professionals

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A large amount of literature is available to suggest that many clinically significant interactions exist between prescription drugs/medications, and the nutrients present in food. Awareness of healthcare professionals (HCPs) about interactions between drugs and food or drugs and nutrients is important to improve patients' health and prevent adverse effects associated with those interactions. However, easy access to information about drug-nutrient interactions (DNIs) is not always available. Therefore, it is a difficult and complex problem to accurately determine the effects of food and nutrients on a particular drug. The objective of this study was to help the HCPs and adults to become aware of DNIs by developing a booklet (guide) comprised of drug-food and drug-nutrient interactions as a printed reference material. Potential DNIs were collected by reviewing the literature and referring drug-related institutional publications of the past 15 years. There were around 145 potential DNIs discovered across 95 different drugs or drug categories. Furthermore, a preliminary survey was conducted to assess the knowledge and awareness of DNIs among 10 participants in each group of physicians, dietitians, pharmacists and adults who were accessible during the Covid-19 pandemic by using a pre-tested interviewer administrated questionnaire. Findings showed that 90% of studied HCPs considered DNIs to manage such interactions while 70% of adults had heard or experienced DNIs. Furthermore, findings of the survey confirmed that lack of information sources was the major barrier of HCPs for managing DNIs. Collected information on potential DNIs were presented in a tabular form under the gastro-intestine disorders, cardiovascular diseases and infectious tabular form. Additionally, mechanisms of DNIs, guidelines for counseling, medical nutrition therapy for medication side effects and micro-nutrient food sources were also compiled as a coloured, pictorial, A5 size booklet. The content validity of the developed booklet was done by doctors, dietitians and pharmacists via an online questionnaire. The developed booklet was simple and user-friendly. Having a booklet with updated information on DNIs for HCPs and adults will be helpful for management of DNIs and prevention from adverse effects of DNIs.

904/A

Development of a guide on sodium content in food for hypertensive and normotensive people

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Hypertension (HTN) is a public health issue and the prevalence of hypertension is 26.1% in adults of age 18-69 in Sri Lanka. It is evident from several studies that dietary sodium reduction is an important measure for hypertension management and that food selection is a vital part when it comes to lowering sodium intake. In order to make lower sodium food choices, it is important that consumers are knowledgeable about sources of sodium, and its recommended levels of daily intake. The absence of any guide on sodium content of commonly consumed food in Sri Lanka prompted us to conduct this study to develop a guide on sodium content of commonly available food items for hypertensive and normotensive people in Sri Lanka. A preliminary survey was conducted with 30-60 years age range, 30 hypertensive patients to identify the dietary patterns, sodium rich foods that they consume, daily sodium intake and commonly available food using a pre-tested interviewer administered questionnaire, two 24-hour dietary-recalls, a food frequency questionnaire and direct observation of food available at markets and home-gardens. Sodium content of commonly available foods was determined using Sri Lankan, Indian and ASEAN food-composition tables and food labels. Food was categorized into low (<120 mg/100 g), medium (120-600 mg/100 g) and high (>600 mg/100 g) sodium containing food according to the sodium content in 100 g of food. A booklet was developed by including functions of sodium, sodium rich food items, tables of food categorized according to sodium contained in per-portion of 61 commonly consumed food items and instructions on how to refer the booklet. The results of the preliminary survey showed that the mean intake of sodium (2298 ± 751 mg) was higher than the recommended daily intake (1500 mg/day) of hypertensive adults. The developed booklet consists of photographs of one portion of commonly consumed food with sodium content in "mg". High, medium and low sodium containing food was indicated with the colours of red, yellow and green, respectively. This developed booklet may be a useful guide to select low sodium food for hypertensive patients to manage their condition and for healthy adults to prevent hypertensive condition.

Keywords: Guide-booklet, hypertension, normotensive, sodium content

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905/A

Contamination of groundwater and soil as well as risk of further transmission due to COVID19 infected and other burials: Does Sri Lanka's environment pose a unique risk?

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COVID-19 is spread mainly through close contact from person-to-person or respiratory means. However, concerns have been raised of possible transmission through contact with infected persons, either dead or alive. Concerns over contamination of the land and groundwater as a result of the burial of COVID19-infected bodies, as well as subsequent human re-infection, have led to a change in Sri Lankan policy, which has allowed both burials and cremations from April 11, 2020. After the ban of a year, burial is only permitted in Oddamavadi in the Batticaloa district. Here, we solely consider whether Sri Lanka's terrain, rainfall, temperature, soils, and groundwater are unique. An appointed panel of medical specialists and an ecological scientist argued that the unique rainfall, temperature, soils, and groundwater warranted taking the precautionary principle - that is unless one can prove that burials are safe with certainty that it should not be permitted given the risks. In most burials in Sri Lanka, the body is either placed in a wooden coffin or wrapped in cloth. In the latter case, the grave is at least 8 feet deep and in places with no water bodies or nearby wells. Wastewater from the COVID infected persons particularly that are exposed in drains routed to tanks, or rivers, do require attention to avoid human and animal exposure. The groundwater depth in Sri Lanka is deep and mapped so that aquifer contamination can be avoided by choice of burial sites and site inspection. If there is leaching from the burial sites, there may be risks of transmission of some bacterial diseases but not viruses such as Covid19. Sri Lanka's climate, topography, soils, drainage all show diversity, but all of this is not unique in comparison to the globe. Scientific understanding of the mechanisms of covid-19 transmission and the role of the environment is needed to mitigate the risks from burial choices and practices. The 1000-fold greater risks from contamination of wastewater from patients has not received the attention of environmental scientists or public health officers given to the impacts of burials nor have the precautionary principle been operative here.

Keywords: COVID19, ground water contamination, burials

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A preliminary study on food consumption patterns and preferences of school children in Sri Lanka

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Information regarding food habits and preferences of school-children is valued in implementing measures for a healthy future generation. The aim of this study was to analyse the food-related habits, food consumption frequencies of the main food groups and preferences towards certain food groups among children and adolescents in Sri Lanka. The study was carried out with 93 adolescents (11–19 years) and 72 children (6–10 years) using a structured, self-administered questionnaire and the data were analysed descriptively. The meals of school children mainly comprised of breakfast, lunch and dinner (>85%) and a considerable number has equal responses to the afternoon snack (~44%) by both groups. The percentage consumption of different food types by adolescents at least once a day varied as follows; fruits 63.5%, green leaves 66.6%, vegetables 92.5%, yams 41.9%, cereals including rice 79.6%, pulses 19.3%, nuts and seeds 9.7%, fish 77.4%, meat 37.6%, milk 66.7%, dairy products 43.0%, and eggs 57.0%. Children had nearly the same consumption pattern with slight deviations in consumption of fruits (77.8%), nuts and seeds (18.0%), meat (27.8%), milk (76.3%), dairy products (52.8%) and eggs (50.0%). Preferences towards lunch packets, bakery products, desserts and snacks were more or less similar for both groups. The most preferred food items during school intervals were rice and curry (71.0%) by adolescents whereas milk rice/ rice and curry (51.4%) by children. Both groups show less preference towards boiled pulses and buns. Children and adolescents preferred buttery flavour and cheesy flavour, respectively as spreads for bread. The highest preferential taste for the snack products was revealed as sweet. The majority of the children (61.1%) and adolescents (51.6%) consumed food from fast-food restaurants less than once a week. Findings highlighted low intakes of pulses, nuts and seeds, yams, meat, dairy products and eggs. This shows the need of introducing healthy meals and healthy snack products for school children.

Keywords: Consumption patterns, food preferences, child and adolescent nutrition

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907/B

Nutritive and physico-chemical properties of unfermented coconut (*Cocos nucifera* L.) sap by a novel sap collection method

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Coconut (*Cocos nucifera* L.) sap is a natural phloem juice obtained by tapping of immature coconut inflorescence. The nutritive coconut juice is utilized by wild microbes and its natural quality is affected during harvesting. To protect the quality attributes of coconut sap, several preventive measures are used such as coating of lime ($Ca(OH)_2$), adding bark of Hal tree (*Vateria copallifera*), Mangosteen (*Garcinia mangostana* L.) or Kahata (*Careya arborea roxb.*) into the burned clay pots which also affect to the quality of fresh sap. The novel sap collecting device is a recent innovation by Coconut Research Institute, Sri Lanka to collect coconut sap with its natural quality. Therefore, the objective of this research was to evaluate the nutritional and physicochemical properties of unfermented coconut sap collected by two methods; namely, adding Hal bark to the clay pots of 4 L (TM) and novel sap collection method (NSCM) which is comprised of a cooling compartment. Samples were collected from twelve coconut palms (Dwarf variety, 45 years old) during 12 hour intervals (from 6 pm to 6 am). The sap was filtered to remove debris and was stored at −18 °C. Volume, pH, total soluble solids, alcohol content, total acidity, colour (organoleptic and CIELAB), sugar profile (High-Performance Liquid Chromatography), total phenols, EC50 (DPPH assay), ascorbic acid equivalent antioxidant capacity (AEAC), ascorbic acid content, and mineral content were determined. Data were analyzed by t-test and ANOVA using Minitab software. The results revealed that coconut sap collected from NSCM has a significantly high pH (5.99), moisture (83.20%), sucrose (13.71%), and total sugar (19.99%) compared to the sap collected from TM. In contrast, the sap of TM was significantly rich with total phenolic (65.90 mg GAE/100 mL), EC50 (143.03 mg/mL), AEAC (0.2568 mg ascorbic acid in 1 g sample), browning index (6.76) and yellowing index (15.92). Moreover, Ca (39.3 mg/L), Fe (3.08 mg/L), Mn (0.96 mg/L), Sr (0.14 mg/L), and Ba (0.33 mg/L) were significantly high in sap from TM mainly due to Hal bark. Hence, the novel sap collection method is a better approach for collecting high-quality unfermented coconut sap with its natural quality for coconut sap-based products.

Total phenolic, total flavonoid contents and antioxidant capacity of the different parts of *Adhatoda vasica* (L.) Nees

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Adhatoda vasica (L.) Nees belongs to the family Acanthaceae and is a well-known medicinal plant used in traditional systems of medicine globally. Different parts of *A. vasica* have been used for the treatment of various ailments, mainly for respiratory tract-based ailments considering the vast range of chemical components present in it. Age-related diseases including cancer have become a huge problem and there is an impact on herbal natural medicine to minimize those complications by neutralizing free radicals, which cause damage to body cells. The present study was conducted to quantify the total antioxidant capacity (TAC), total phenolic content (TPC), and total flavonoid content (TFC) of different parts of *A. vasica* using ferric reducing antioxidant power (FRAP) assay, modified Folin-Ciocalteu method and colorimetric method, respectively. Mature leaves, immature leaves, flowers, bracts, soft stems, the bark of mature stem and roots of *A. vasica* were collected from the Kegalle district of Sri Lanka in June to November, 2020 for the experiment. The results revealed that all tested parts of *A. vasica* contained marked amounts of TAC, TPC, and TFC. Among tested parts, immature leaves showed a significantly higher TAC (19.28 ± 1.96 mg/TE g DW) followed by flowers (16.97 ± 0.99 mg/TE g DW) and bracts (14.19 ± 1.85 mg/TE g DW). The highest TPC (11.33 ± 0.14 mg/GAE g DW) and TFC (16.66 ± 3.06 mg/RE g DW) were observed in flowers followed by bracts and immature leaves. Moreover, there were positive correlations of TAC with TPC (R^2 = 0.5411) and TFC (R^2 = 0.5209) revealing that phenolic and flavonoid components significantly contribute to the antioxidant capacity of different plant parts of *A. vasica*. According to the results, it can be concluded that immature leaves, flowers, and bracts of *A. vasica* contain marked amounts of bioactive compounds and hence could be effectively used as an antioxidant supplement in the pharmaceutical industry.

909/B

Identification of the adaptable chili (*Capsicum annuu*m L.) varieties for a high-temperature level under *in vitro* condition

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Chili (*Capsicum annuum* L.) is one of the most significant cash crops grown in the Kalpitiya peninsula where high temperature is one of the major constraints. Extensive irrigation is practiced to overcome this problem. And overutilization of groundwater creates several social and economic problems. Cultivation of the chili varieties tolerant to higher temperature levels is a potential approach to minimize the problem. Thus, four commercial varieties (Galkiriyagama, MICH HY2, Vijaya F1, Lanka hot) were screened for adaptability to a high-temperature level under *in vitro* conditions. The temperature-stress during the hot hours in Kalpitiya region was given by exposing the plants to a high-temperature level (34 °C) for 8 h, followed by 28 °C for 16 h representing the cool hours. The average optimal temperature for chili *i.e.* 28 °C was used as the control and provided throughout the day. Two factor factorial in a Completely Randomized Design was used with 25 seedlings per treatment. After 30 days, the number of leaves and roots, and the length of shoots and roots were recorded. Analysis revealed that the major factors were significant while the interaction effect was not significant. The temperature levels significantly affected all the parameters ($p<0.0001$) where a reduction was observed at 34 °C except in shoot length that gave a comparable performance. A significant difference was observed among the varieties for all the parameters ($p<0.05$) except for the shoot length. The effect of temperature on the parameters of each variety indicated their potential for adapting to higher temperature levels. In MICH HY2 and Vijaya F1, all the growth parameters were comparable at the tested temperature levels except the root length ($p<0.05$) where a reduction was observed. Lanka hot showed a significant difference only in the number of roots ($p<0.0001$). A significant reduction was observed in all the parameters of the variety Galkiriyagama ($p<0.05$) except the root length. Based on the results MICH HY2, Lanka hot and Vijaya F1 showed the tolerance to the tested temperature level.

Keywords: Adaptability, *Capsicum annuum* L., *in vitro,* temperature stress, tolerance

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910/B

Response of chili (*Capsicum annuum* L.) varieties for low nitrogen levels supplemented under *in vitro* condition

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Crops cultivated in sandy regosols in the Kalpitiya region are managed by frequent application of N fertilizer and heavy irrigation that leads to contaminating the groundwater table. One of the long-term sustainable strategies is the cultivation of the varieties with a higher response to the low nitrogen levels. Thus, four chili varieties (Kodian hot, Rajini, Super 874 F1, Gandhi F1) were tested against different N levels under *in vitro* conditions. Considering the concentration of NH_4NO_3 in the half-strength Murashige and Skoog medium *i.e.* 875.0 mg/L as the control, 656.3, 437.5 and 218.75 mg/L NH_4NO_3 were tested in a two-factor factorial Completely Randomized Design using thirty germinated seedlings per treatment. The leaf and root numbers and the shoot and root lengths were recorded after 30 days of subculturing into the treatments. The major factors, N levels ($p<0.0001$) and varieties ($p<0.0001$), significantly affected the growth performance of the seedlings whereas an interaction effect was not observed among them. Chili varieties showed a significant difference for all the parameters except for the root length. Super 874 F1 performed better for all the parameters except for the number of leaves that were comparable in all four varieties. It also showed the lowest sensitivity to the N supplement showing a comparable performance for the root parameters and for the leaf number, where the shoot length was comparable in the first two N levels *i.e.* 875.0 and 656.3 mg/L. The number of leaves of the variety Kodian Hot did not vary among the N levels, whereas the number of roots was significantly lowered at the lowest level of N ($p<0.05$). Rajini and Gandhi F1 varieties showed a higher sensitivity for the tested N levels by showing significant reduction for all the parameters in the media supplemented with 437.5 and 218.75 mg/L NH_4NO_3. Therefore, Super 874 F1 that showed a lower sensitivity to the N supplement was the best among others and was selected to evaluate the yield performance under field conditions.

Keywords: Half-strength MS medium, *in vitro* screening, nitrogen, variety performance

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Urban waste management in Embilipitiya urban council; a case study

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One of the major environmental concerns that Sri Lankan local authorities face today is managing urban waste sustainably. Therefore, it is important to identify the challenges and opportunities of current urban waste management systems, in order to reach optimum performances. This study evaluates the strengths, weaknesses, opportunities and threats (SWOT) of the urban waste management system in Embilipitiya where poor research data is evidenced. A pre-tested questionnaire-based key informant interviews, group discussions and site visits were performed with responsible officers, laborers and drivers to obtain information primarily. Secondary information was obtained through records of the urban council (UC). According to the SWOT analysis, a systematic waste collection routine, separated waste bin installation, solid waste recycling at an appropriate location, production of compost fertilizer and selling non-degradable waste could be highlighted as strengths. The identified main weaknesses were labour constraints in all waste management aspects, poor facilities for composting biodegradable waste and inadequacy of latest composting techniques, manual waste separation and poor source separation by the local community. There were several identified opportunities, which could be driven towards the effectiveness of the process. Introduction of a model compost bin to promote domestic composting techniques, engaging school students in composting, training the labour staff and seeking foreign funds for gully treatment and liquid fertilizer production were identified as opportunities. Furthermore, the deficit in treating the collected leachate, insufficient attention in promotion of novel research and development and lack of financial support were the identified threats. As one of the major urban councils in Ratnapura district, Embilipitiya accounts for a 65.29% fraction of bio-degradable waste daily. Around, 65% of the generated waste is treated and 35% is buried without treatment. As a suggestion, knowledge transfer on maintaining physico-chemical properties and the standard microbial combination could enhance current compost demand, strategically. Therefore, the SWOT analysis emphasizes that the Embilipitiya UC owns a good potential to maximize the current waste management process efficiently while mitigating prevailing shortcomings.

912/B

Evaluation of nitrate leaching from leafy red onion cultivation on regosols in Kalpitiya area

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Red onion (*Allium ascalonicum* L.) is one of the most widely grown cash crops in Sri Lanka mainly in the northern and eastern parts of the country. A promising problem in red onion cultivation is the leaching of nutrients, especially nitrogen, since this crop is mostly grown in sandy textured soils. Kalpitiya in the North Western province is an intensive vegetable cultivating area where the dominant soil type is sandy regosols. This study was conducted to quantify nitrate leaching from leafy red onion cultivation in Kalpitiya under the management practices of growers. Lysimeters with 0.28 m^2 area were installed 90 cm below the soil surface before the cultivation and allowed the soil to settle for two weeks. There was a 60 cm soil column above the drainage collection reservoir. The Jaffna local variety was cultivated under sprinkler irrigation and fertilizer was applied according to grower's practice, which was four split applications of urea at 40 kg/ac, onion fertilizer (12:9:9) at 50 kg/ac, blue granules (12:12:17) at 25 kg/ac and calcium nitrate at 25 kg/ac at ten-day intervals. This was replicated three times in 7.2 m^2 plots. Leachate samples of each replicate were collected from lysimeters at weekly intervals and leached volume was measured and the nitrate concentration was analyzed. Applied irrigation water volume and its nitrate concentration were also measured. Leafy onions were harvested 48 days after planting and the weight was recorded. The mean cumulative leached nitrate amount from a 7.2 m^2 area was 234.8 g. The concentration of nitrate in irrigated water was 6.88 ppm, which was also accounted for as an input source of nitrogen. According to the calculation, 400 g of nitrogen was leached per 100 kg of leafy red onion harvested according to growers' practices of fertilizer. These findings highlight the need for a novel fertilizer management approach for reducing nitrogen leaching in this cultivation system.

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913/B

Effect of organic and conventional fertilizers on soil properties and yield of coconut in the intermediate zone of Sri Lanka

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The prolonged conventional farming practices with the overuse of fertilizers and other chemicals are leading to a wide range of social and environmental concerns. Coconut is the most widely grown plantation crop in Sri Lanka and the growing trend of organic coconut cultivation poses a need on identifying the plant and soil fertility status of organically managed coconut lands in comparison with conventionally cultivated lands of similar field conditions. This study attempts to investigate the effect of organic manure-based nutrient management practice on soil physical properties and the yield of coconut in comparison with conventional fertilizer management. Soil samples from randomly selected twenty-four locations at each site and yield data were collected from a longstanding on-going field experiment with the treatment of poultry manure as an organic nutrient source together with sulphate of potash (SOP) as recommended, and treatment of inorganic fertilizer as conventional practice in two different coconut lands on Red Yellow Podzolic soils in IL3a, low country intermediate zone. The soil physical parameters were evaluated by analyzing soil bulk density, porosity, hydraulic conductivity and water holding capacity. Two sample t-test and analysis of variance were used to analyze the data using SAS statistical software. According to the results, water holding capacity was significantly higher in organic coconut land (79.7%) than conventional land (70.9%) indicating the soil's ability to withstand drought conditions. The hydraulic conductivity of organically managed soil was lower (0.73 ml/min/cm^2) compared to conventional treatment (1.06 ml/min/cm^2) corresponding to higher water holding capacity in organic treatment. There was no significant difference in the bulk density of organically cultivated (1.55 g/cm^3) and conventional cultivated coconut land (1.53 g/cm^3). There was a large variation in coconut yield over the years in the both organic and conventional systems. Five years yield records show no significant difference in yield of the two cultivation systems, which indicates the potential of organic manure when applied with mineral potassium source has the ability to maintain the same yield as the conventional fertilizer applications.

Keywords: Soil physical properties, conventional fertilizer, organic manure

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914/D

Cadmium and chromium concentrations in the root zone soil, roots and leaves of Spinach (*Basella alba*) cultivated using chemical fertilizers

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Spinach (*Basella alba)* is traditionally planted without the use of fertilizers. However, increased demand by consumers has resulted in mass scale cultivation of *B. alba* by adding chemical fertilizers. Being a high metal accumulating plant, there is a potential to build up toxic metals in the edible portions of *B. alba*. Therefore, the present study was conducted to assess the total cadmium (Cd) and chromium (Cr) concentrations in the root zone soil, roots and leaves of *B. alba.* Plants were grown with and without fertilizers in individual pots containing sandy loam soil. About 10g of solid fertilizer from the mixture (Urea, MOP and TSP = 2:1:1) was added to plants after two weeks of transplanting seedlings in pots. Cd and Cr concentrations in root zone soil (Cd_{soil} and Cr_{soil}), roots (Cd_{roots} and Cr_{roots}) and leaves (Cd_{leaves} and Cr_{leaves}) of *B. alba* were analyzed by atomic absorption spectrophotometry (detection limit:0.01 mg/L) by sampling 10 samples from each type during three sampling events (4 weeks, 8 weeks and 12 weeks after fertilizer application). Two sample t-test ($p < 0.05$) in MINITAB 17 software was used for the comparison of metal concentrations in fertilizer applied and fertilizer not applied samples. Mean Cd and Cr concentrations in the chemical fertilizer applied samples were higher than those of fertilizer not applied samples. Highest mean concentrations were recorded as; Cd_{soil}:1.9±0.2 mg/kg, Cr_{soil}:19.7±0.5 mg/kg; Cd_{roots}:2.8±0.2 mg/kg, Cr_{roots}:22.4±0.7 mg/kg; Cd_{leaves}:3.4±0.2 mg/kg, Cr_{leaves}:23.4±0.9 mg/kg). The mean Cr concentrations were greater than the mean Cd concentrations in all the samples. Cr and Cd concentrations in the leaves of *B. alba* collected from fertilizer applied pots exceeded the safe limits for consumption recommended by WHO/FAO (Cr:2.3 mg/kg, Cd:0.2 mg/kg). The mean bio-concentration factors of Cd and Cr were greater than one (highest values Cd:1.9±0.2 and Cr:1.2±0.1) indicating that there is a possibility of contamination Cd and Cr in the edible parts of *B. alba* due to urea, MOP and TSP applications.

915/D

Determination of antifungal activity of some endophytic fungi isolated from *Geophila repens*

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Geophila repens is a perennial herb with medicinal properties in the Rubiaceae plant family. Interestingly, the plant is reported to exhibit antifungal, antioxidant, antibacterial, and anticholinesterase activity. Previous studies have shown the antioxidant and antibacterial effects of this plant; however, these effects in relation to its inhabitant endophytes are poorly explored. The present study was conducted to isolate endophytic fungi and investigate the antifungal activity of different extracts of endophytic fungi prepared from *G. repens.* The *G. repens* plants were collected and was authenticated by National herbarium, Peradeniya. In order to isolate endophytic fungi of the plant, surface sterilized stem segments were cultured on PDA media for 10-15 days at room temperature. Four endophytic fungi (GR1, GR2, GR3 & GR4) were isolated and morphologically identified (*Trichophyton* spp., *Trichoderma* spp, *Aspergillus* spp., *Xylaria* spp, respectively). Ethyl acetate and methanol extracts of these fungi were prepared and each extract was tested for its antifungal activity and results were obtained by the mean of three replicates. Antifungal study was carried out by poison food technique using four endophytic fungi crude extracts of *G. repens* against *Aspergillus* spp., *Rhizopus* spp. and *Penicillium* spp. The intensity of the antagonistic activity was recorded on basis of the size of the growth inhibition from the place where fungus was inoculated to the edge of the spreading fungal mycelium. Remarkably the antifungal activity of four ethyl acetate extracts of endophytic fungi showed that, 80% inhibition of the mycelial growth of *Rhizopus* spp., *Penicillium* spp. and *Aspergillus* spp. at the concentration of 5 mg/ml with the positive control of Nystatin. Comparatively, the antifungal activity of methanol extracts showed poor inhibition (40%) against *Rhizopus* spp., *Penicillium* spp. and *Aspergillus* spp. but still it showed the antifungal activity. The result of antifungal screening showed that different extracts exhibit different extent of antifungal activity against all the fungi tested. All together, these results revealed that the four endophytic fungal strains isolated from *G. repens* has potential antifungal activity and further research is required to isolate and identify the active compounds.

916/D

Validation of diesel degradation potential of selected bacterial isolates from petroleum contaminated soil samples in Sri Lanka

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Petroleum, a natural fuel composed of hydrocarbon compounds, is commonly used as an energy source in industries and in daily life. Petroleum contaminants in soil may remain as persistent organic pollutants causing long-term damage to ecosystems. Bioremediation is an economical, eco-friendly treatment method for the recovery of soil quality following contamination. Indigenous bacteria from contaminated soil samples often possess metabolic processes for hydrocarbon utilization or degradation, which can be used to degrade and remove petroleum pollutants from soil during bioremediation. This study aimed to validate diesel degrading (DD) potential of selected bacterial isolates from a petroleum-contaminated soil sample in Sri Lanka, using redox assay techniques and spectrophotometry. Bacterial strains were isolated in Bushnell Haas mineral salt medium supplemented with crude oil, streaked on nutrient agar and sub-cultured. Fourteen fast-growing isolates were screened for DD potential using two redox indicator dyes 2,6-dichlorophenolindophenol (2,6-DCPIP) and 2,2-diphenyl-1-picrylhydrazyl (DPPH) to detect the degradation rate. Spectrophotometric readings for decolorization of dyes by each bacterial isolate were obtained where the amount of decolorization or oxidation coincided with the level of hydrocarbon utilization. Absorbance readings for each isolate were obtained in triplicates and expressed as mean±standard deviation. Statistical analyses were performed using R Studio 3.5 where absorbance readings from the 2,6-DCPIP assay were analysed using Two-way ANOVA and Tukey's test, and DPPH assay readings were analysed using Kruskal-Wallis test and Dunn's test. The isolation of DD bacteria here suggests the emergence of hydrocarbon degradation ability in indigenous soil bacteria following exposure to petroleum contaminants. The redox assays confirmed that all fourteen isolates could utilize diesel as the sole carbon source; isolates BN02, BN06 and BN44 from the soil sample showed the highest degradation rates in both redox assays (>88%). These results suggest that the DPPH redox assay is an effective method to validate the results of conventional hydrocarbon degradation analysis assays which use 2,6-DCPIP to assess degradation potential. This study can be expanded further to verify the efficiency, mechanisms of DD, molecular identification, and synergy of mixed bacterial consortiums in soil prior to exploring their potential in bioremediation of petroleum-contaminated soil.

917/D

Quality assessment of virgin and recycled papers available in Sri Lanka

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The permanence and durability of the recycled papers are important as in virgin papers to decide the ultimate end use. The main objective of this study was to assess the paper quality of recycled paper with aging compared to virgin papers. Three multipurpose virgin papers; 60GSM, 65GSM and 70GSM and three types of recycled papers; Brown Kraft papers, Yellow Kraft papers and White papers were collected. Physical parameters: grammage, thickness, burst strength, tensile strength, water absorptiveness (cobb60); chemical parameters: pH; and optical parameters: opacity, brightness, whiteness of the selected papers were tested in replicate using standard methods. Each test was carried out subjecting sample papers into accelerated aging (ASTM D4714 method) by keeping them in a controlled aging chamber at 50% relative humidity and 90 °C. Samples were tested after aging for 3 days, 7 days, 14 days, 21 days, and 28 days. Opacity has been decreased in virgin papers while increased in recycled papers with the accelerated aging. Other parameters have shown a decreasing trend over time. 70GSM virgin paper type was failed the water absorptiveness test after accelerated aging of 3 days. All the types of recycled papers were failed water absorptiveness test even before aging. pH changes were from alkaline to neutral (pH 9.1 to 7.4) in both virgin and recycled papers over time. Most of the time, overall change of parameters resulted after accelerated aging of 21 days, which is comparable to 7.4 years of natural aging. In conclusion, 70 GSM and all the recycled papers are not suitable for printing and writing but newspaper printing as they failed in Cobb60 test. 60GSM and 65GSM papers can be recommended for printing. Both the virgin and recycled papers can be used as archival or artist's paper for 7.4 years without discoloring or deteriorating. Recycled papers can be recommended for food packaging as they showed the highest permanence in terms of tensile and burst strength. However, as recycled papers failed Cobb60 test it is recommended to pack dry food to avoid moisture.

918/D

Assessment of mangrove restoration potential in the North Western province of Sri Lanka for climate change mitigation

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Climate change is a long-term alteration in average weather patterns which now define the world's local, regional, and global climates. The Paris Agreement is an international climate change treaty, and countries will present their climate action plans, referred to as Nationally Determined Contributions (NDCs). Sri Lanka presented NDCs in 2016. Accordingly, the coastal and marine sector has a restoration target of 10,000 hectares of mangroves as a coastal greenbelt with mitigation co-benefits. The identification of potential areas for mangrove restoration is imperative because mangroves cannot be restored where they did not previously exist. The main objective of this research was to identify potential areas for mangrove restoration within the North Western province and thereby contribute to meet Sri Lanka's NDCs on mangrove restoration for climate change adaptation. Most important physicochemical parameters such as salinity, pH, soil organic matter content, and soil water holding capacity of the samples collected from four different sites of mangrove habitats were determined. Samples were collected up to approximately 85 cm in four depths and were triplicated. Salinity and pH were measured using a calibrated multi-meter and soil organic matter content was measured using loss of ignition method. Two-way ANOVA ($p < 0.05$) in MINITAB 14 was conducted to analyse how parameters varied among each depth and sampling sites. The mean of soil salinity, pH, soil organic matter content, and soil water holding capacity ranged between 4.26% to 5.93%, 6.07 to 8.62, 3.40% to 9.31%, and 30.39% to 46.38%, respectively. No significant differences in physicochemical parameters were found among mangrove habitats and an abandoned shrimp farm where previously mangrove plants existed. Hence, abandoned shrimp farms and salterns can be used to restore the mangrove plants. The potential lands for restoring mangroves in North Western Province were identified in Chilaw, Kalpitiya, Mundel, Panirendawa, Puttalam, Vanathawilluwa, and Vennappuwa Divisional Secretariat Divisions. Among them, areas for which historical images in Google Earth Pro were available, were specially chosen to restore the mangroves. This study suggests that the assisted natural regeneration of mangroves in suitable abandoned shrimp farms by facilitating hydrology can be explored as the best option for mangrove restoration.

Keywords: Climate change, nationally determined contributions, North Western province, soil physicochemical parameters, potential lands

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919/E1

A simulation-based study on mesostructured material for 3D printed flexible applications

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Materials can be classified based on their physical and chemical properties. Strength and flexibility are two important properties of materials, and they vary according to the physical shape of the material. One of the emerging technologies in the design and manufacturing field is 3D printing technology and is used to build anything from small equipment to spacecrafts. The main disadvantage of this technology is the difficulty of producing flexible structures with considerable durability. One solution that can be used to avoid this issue is to use mesostructures as the interior structure of 3D printed objects. 3D printed mesostructures can be engineered to give desired physical properties in many applications. This study analysed the flexibility and durability of PLA (Polylactic acid) plastic-based mesostructures for flexible soles for footwear. Here, the same geometric shape was used keeping the density of the shape the same with deferent types of mesostructures. The method executed in this study can be applied to design flexible and reliable messostructure-based materials in general. The mesolevel continuum-based small structures provide a basis to design material structures to suit special processing methods and applications. When designing these structures, the focus is given to the deformation limits, flexibility, and form factor requirements of the final application. As a result of the study, a PLA-based flexible mesostructured basis for soles of footwear that can withstand the weight of an adult human and is resistant to gait movements was successfully designed and simulated. The results suggest that, after considering the shape of the structure and the forces it is expected to undergo, it is possible to design structures that can withstand different types of strains and pressures to facilitate the required flexibility by carefully selecting an appropriate mesostructured material-based basis. There are many benefits of these flexible materials. For example, new wearable devices can be conveniently designed, light vehicles such as aircraft can be made more robust by making mechanical parts that are resistant to movements and shocks and special tires may also be made to replace rubber tires in special vehicles such as rovers and other robotic equipment.

Keywords: 3D-printing, flexibility, mesostructured, strength

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920/E1

Indoor localization based on monocular vision and color signature identification

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Localization is a process to find a relative location and orientation which enables to trace the position of objects or human beings in an unknown or complex environment. Although GPS (Global Positioning System) is ideal for outdoor navigation, it is untrustworthy in internal spaces because there is no visual contact with the satellites. The challenge of indoor localization has been addressed by utilizing existing infrastructure or adding additional infrastructures. Landmark-based color signatures (codes) that are deployed onto the indoor can estimate the position with a high level of accuracy. Color signature improves detection accuracy by decreasing false detections since unique color codes are attached to the predefined indoor locations. This work aims to investigate a low-cost positioning system using monocular vision and color signature identification. The CMUcam5 Pixy2 is a vision sensor with an onboard internal image processor. It can be configured to track one or multiple colors, such as color codes in the range of its vision using its built-in color-based filtering algorithm called Color Connected Components (CCC). Pixy provides the location coordinate of the center of the color code in camera coordinates in pixels. However, the requirement is to determine the location coordinates in the world coordinate system. Therefore, it is necessary to transform the location coordinates obtained as pixel coordinates through image coordinates to world coordinates. Calibration is performed to obtain intrinsic and extrinsic parameters of the camera necessary for the coordinate transformations. The extrinsic parameters represent a rigid transformation from the 3-D world coordinate system to the 3-D camera's coordinate system. The intrinsic parameters represent a projective transformation from the 3-D camera's coordinates into the 2-D image coordinates. Non-blurry images of the check board patterns are used for the calibration process. The estimation results show the positioning accuracy ranging from 0.067 cm to 3.15 cm for the y-coordinate and 0.0133 cm to 1.45 cm for the x-coordinate.

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921/E1

Simulating the dispersion of pollutants from the fires on the X-Press Pearl ship

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The X-Press Pearl container ship caught fire on May 20, 2021, which lasted until an explosion led to the ship sinking on June 2, 2021. The ship was carrying dangerous cargo as classified by the International Maritime Organization. Plumes of pollutants arising from the burning ship was transport across the ocean and lands surrounding through advection and dispersion processes and plume dynamics in the lower atmosphere. Some pollutants even in trace quantities can lead to consequences in the atmosphere such as an alteration to the cloud microphysics leading to drop in rainfall in Sri Lanka and causing acid rain. We sought to identify the potential impacts on the atmosphere on the ground and above it in the air column. Materials as listed in the ship's cargo manifest were ranked by tonnage and their combustion product toxicity. To track the direction of the pollutant dispersion, the HYSPLIT model was used. To identify the impacted region at ground levels from toxicants released into the ambient air, the ALOHA model was attempted but not reported here. Trajectories from HYSPLIT showing mean air parcel movement at 100 m, 500 m, and 1000 m vertical height were computed every 12 hour from May 21 to June 2. These trajectories propagate towards parts of the Western Sabaragamuwa, Central, North-Western, North-Central, Eastern, and Uva provinces. The plume trajectories show dispersion from the ground level to the atmosphere up to 1500 m and extend beyond Sri Lanka. Air quality in the close vicinity was simulated to be affected by nitric acid, carbon monoxide, and methanol. The nitric acid, carbon monoxide, and methanol transport from the ship fires were detected in simulations at distances 10 km away. While our simulations were for these three gases, other hazardous pollutants such as persistent organic pollutants, heavy metals, and particulate materials could also be consequential. We shall update these simulations beyond the 10km range with more precise data as they become available.

922/E1

Flood area simulation of Attanagalu Oya basin

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Simulation of flood events is a significant tool for giving early warnings of extreme flood events to reduce vulnerability. Therefore, the objective of the present study was to simulate river flow variation and flood prone areas of Attanagalu Oya basin for the period of 2016-2018, using Hydrologic Engineering Center, Hydrologic Modeling System and River Analysis System, respectively (HEC-HMS and HEC-RAS). HEC-HMS model was calibrated using meteorological variables namely daily rainfall (mm) at the Henarathgoda rain-gauging station and daily evaporation (mm) at the Colombo agro-meteorology station. Soil Conservation Service-Curve Number (SCS-CN) loss model, SCS Unit Hydrograph transform model and Muskingum-Cunge routing model were selected to calculate runoff volume, direct runoff of the excess rainfall on the basin and outflow and storage flow of the channel, respectively. Daily water discharge rates were simulated at the upper-stream and the Dunamale gauging station. The optimized model parameters (hourly time of concentration: 99.76, SCS curve number: 92.82, hourly storage coefficient: 25.133) were obtained using model optimization, which minimize residuals of observed and simulated. Then, the model was validated for 2018 using the above optimized parameters. Model performance of HEC-HMS for the validity period stated that Nash-Sutcliffe Efficiency (0.760), percentage bias (13.21%), and root mean square error observation-standard deviation ratio (0.5). Simulated hydrograph in HEC-HMS for the upper-stream was input to HEC-RAS to simulate the flood area for May-July, 2018. Simulated flood area was compared with the actual flood map which was obtained from the Department of Irrigation. ArcGIS was used for georeferencing and measuring the overlapped flood areas. Overlapping area performances were evaluated by hit ratio (0.7160) where the best performance is given by 1, false alarm ratio (0.3290) where the best performance is shown by 0, critical success index (0.5387) where the best performance is given by 1, and bias (0.0262) where the best performance is shown by 0. According to the hit ratio flood maps were overlapped with 71.6 %. According to the results, it is recommended to use HEC-HMS and HEC-RAS with improved input variables and other model parameters to optimize the above performance indicators further, to simulate future flood in the basin.

Keywords: Attanagalu Oya, flood, HEC-HMS, HEC-RAS

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923/E2

Molecular investigation of the synergetic activity between Na$^+$/K$^+$ carrier ionophore antibiotics and fluoride

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The antibiotic resistance and host toxicity has limited the clinical use of many antibiotics. For example, membrane destabilizing Na$^+$/K$^+$ carrier 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. Nonetheless, valinomycin has exhibited remarkable inhibitory effects against coronaviruses, including SARS-CoV-2, the causative agent of the current global pandemic COVID-19. Therefore, translating such compounds to clinical settings requires them to remain non-toxic to the host. Fluoride is a toxic anion that has both antimicrobial and virucidal properties. However, the cellular uptake of fluoride is limited due to the bacterial cell envelope. Accordingly, compounds that enhance the permeability of cell membranes should induce strong fluoride toxicity in pathogens by enhancing fluoride uptake. Therefore, combination regimens such as ionophore antibiotics and fluoride may increase treatment efficacy, while lowering the doses of host-toxic antibiotics. In this study, we demonstrate that fluoride significantly enhances the antibacterial activity of the carrier ionophore antibiotics; valinomycin and monensin. Cell growth assays were separately performed by incubating the Gram-positive bacteria (*Bacillus subtilis, Bacillus megaterium and S. aureus*) at 37 °C with monensin (0.2 µg/ml) and valinomycin (50 µg/ml) with varying concentrations of NaF. Then, OD$_{600}$ of the cultures were measured after 16 hours of incubation. Our results demonstrate that the potency of monensin and valinomycin was increased by 5-fold and 2-fold, respectively, in the presence of sub-inhibitory concentrations of NaF (~100 mM). In contrast, neither of the antibiotics exert any synergism with fluoride against the Gram-negative bacterium *E. coli.* Overall, it can be suggested 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 insights to design novel and effective therapeutic combination regimens for deleterious diseases that have plagued humans.

Keywords: Valinomycin, monensin, fluoride, Na$^+$/K$^+$ carrier ionophore, Gram-positive bacteria

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924/E2

Synthesis of titanium dioxide nanoparticles using extract of *Azadirachta indica* flowers and their photocatalytic degradation ability with methylene blue

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Titanium dioxide (TiO_2) nanoparticles have been widely used in many applications due to its stronger oxidizing power, low cost, non-toxicity and high stability. In this study, anatase TiO_2 nanoparticles were synthesized using a green synthesis approach. *Azadirachta indica* (Neem) is abundant in Sri Lanka and several studies reveal that different parts of the plant consist of various bioactive compounds. Titanium tetraisopropoxide was used as the precursor and the flower extract of *Azadirachta indica* was used as the stabilizing and reducing agent for the synthesis of nanoparticles. The formation of nanoparticles was confirmed using UV-Visible spectroscopic data. The specific absorbance peak at 315 nm confirmed the formation of TiO_2 nanoparticles. The crystallinity and crystal phase of synthesized TiO_2 nanoparticles were analyzed using X-Ray powder diffraction (XRD). The distinct XRD peaks of corresponded to the tetragonal structure of anatase phase TiO_2 nanoparticles. The average particles size was calculated by Scherrer equation and was found to be 18.79 nm. The photocatalytic degradation of the synthesized nanoparticles was evaluated using methylene blue (MB). Degradation was carried out at pH values of 5, 7 and 8, under sunlight. The degradation was monitored using a UV-Visible spectrophotometer at 30-minute time intervals. The time taken for degradation was found to be dependent on the pH; a longer time of 240 minutes was recorded at pH 5 and a lower time of 120 minutes was recorded at pH values of 7 and 8. The results from this study reveal that the degradation percentage was dependent on the pH of the solution. The highest degradation percentage of 99.27% was attained at pH 8 at 165 minutes while 98.67% and 97.80% were attained at pH 7 and pH 5 at 240 minutes, respectively while the kinetic studies of the degradation of MB fitted to a pseudo-first order reaction. The rate constant of the reaction was found to increase with increasing pH among the studied reactions. The above results from the study showed that green synthesised TiO_2 could exibit effective photodegradation of MB.

Keywords: green synthesis, TiO_2, methylene blue, photocatalytic degradation

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925/E2

Evaluation of bioactivities of extracts obtained from the *Portulaca quadrifida* plant

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Melanin is a natural skin pigment, which is responsible for the colour of the skin, hair and eye in people. Tyrosinase is the rate limiting key enzyme, which controls the production of melanin at the first step of melanin production. Tyrosinase inhibitors reduce the tyrosinase enzyme from over stimulation. In this research, one sample of whole dried plant of *Portulaca quadrifida* was sequentially extracted into hexane, ethyl acetate, methanol solvents and another sample was extracted using water as the solvent. Then the total phenolic content, total flavonoid content, antioxidant activity and tyrosinase inhibitory potential were evaluated for all four extracts. These bioactivities were chosen in this study to find out an existence of a correlation between them since evaluated bioactivities are related to phenolics. Folin–ciocalteu reagent method was used to determine the total phenolic content where methanol and water extracts showed the highest amount of total phenolic content as 15.28 GAE g^{-1} and 11.37 GAE g^{-1}, respectively. To determine the total flavonoid content $AlCl_3$ colorimetric method was used where methanol and water extracts showed 44.1 mg g^{-1} and 18.5 mg g^{-1} amount of total flavonoid content. Antioxidant activity was determined using DPPH method. The methanol and water extracts showed high DPPH radical scavenging activity, 53.19± 0.06% and 45.17± 0.05%, respectively at a concentration of 0.4 mg/mL. Then the tyrosinase inhibitory potential of all four extracts were determined using anti tyrosinase assay. The methanol, water and ethyl acetate extracts showed 51.46±0.06%, 36.95±0.074% and 51.11±0.08% inhibitory effects against mushroom tyrosinase, at a concentration of 4 mg/ml, respectively. According to the obtained results, the methanolic extract of *Portulaca quadrifida* plant has displayed a specific correlation between the four bioactivities becoming the potent extract for all evaluated bioactivities. Therefore, the methanol extract of *Portulaca quadrifida* could be further studied to develop and modify agents related to the aforesaid bioactivities.

Key words: Antioxidant, inhibition, methanolic, *Portulaca quadrifida*, tyrosinase

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926/E2

Investigation of lead (Pb) concentration in road dust from large and small urban areas in Gampaha district, Sri Lanka

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Lead is a highly toxic metal that exists in the environment with heavy metal dust due to vehicular emissions on roadways as well as industrial production and operations. Acceleration of anthropogenic activities leads to the increment of heavy metal levels in the earth's crust. Gampaha district in Sri Lanka is one such hotspot that experiences extensive heavy metal contamination. Therefore, analysis of lead in road dust is vital to evaluate the pollution level and the threat to human health. The present study was carried out by selecting twelve sampling sites from large and small urban areas in the Gampaha district. Sampling sites lie in the GPS range of 6.96920 °N to 7.022829 °N and from 79.912284 °E to 80.049099 °E. Six sampling sites from large urban areas in the vicinity of the Colombo-Kandy main road (A1) and six sampling sites from small urban areas away from the A1 main road in the Gampaha area were selected. Deposited road dust samples were collected by the wiping method and analyzed in triplicate for six consecutive weeks from July to August 2020 while monitoring weather conditions. The preliminary factors that favor the persistence of heavy metals in the environment were investigated and analyzed; pH (7.1-8.0), conductivity (9.5-43.3 µS) and moisture content (0.6-1.4%) of road dust samples were found in the given ranges. The highest phosphorous (P) content (7.7 mg kg^{-1}) and the highest organic matter (0.9%) were found in road dust from large urban areas. The concentration of Pb was determined using atomic absorption spectroscopy. Pb content (15.1-71.1 mg kg^{-1}) was significantly high in road dust from large urban areas compared to small urban areas. Pb content in small urban areas was in the range of 0.7-5.8 mg kg^{-1}. Statistical correlation analysis between the concentrations of Pb-P (correlation factor r=0.768) and Pb-organic matter (correlation factor r=0.921) indicated positive correlations. It is necessary to further study and understand the health risks associated with heavy metal toxicity to make the findings of this study beneficial to mankind.

927/E2

Effect of commonly found organic acids in food industry for the degradation of cementitious materials

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Even though stainless-steel surfaces are considered to be the most preferred contact surfaces used in the food industry, cementitious surfaces are still used in local industries. In this study, we have focused on three different carboxylic acids, which are common by products of the food industry including citric acid, malic acid and acetic acid to evaluate their impact on cementitious materials. During the study, we used different concentrations such as 1 M citric acid, 1 M malic acid and 10 M acetic acid to treat with previously weighed small cement strips (2.5 cm × 2.5 cm × 0.4 mm) for one hour and the treated strips were analyzed with PXRD and FT-IR. These concentrations were selected due to the quick response and thereby to evaluate the aggressiveness of acids towards the cement matrix. According to visual observations, after one hour of dipped time, 1 M citric acid and 1 M malic acid have shown weight loss percentages of 15.05% and 15.24%, respectively while the cement strips dipped in 10 M acetic acid have shown complete dissolution. Powder X-ray diffraction (PXRD) results were taken for sand, ordinary portland cement (OPC), hydrated cement and for citric acid treated cement strip. FT-IR spectroscopic data were obtained for three different acid solutions and for treated cement strips, sand, OPC and hydrated cement. According to PXRD results, OPC has shown 2-theta values corresponding to hatrurite, calcium silicon aluminum sulfur, aluminum sulfide, and aluminum oxide. In contrast, hydrated cement has shown compounds including gypsum, alpha SiO_2, calcite, calcio-olivine, calcium silicate hydrate and calcium silicate. The 2-theta values for 1 M citric acid treated cement strips have shown silicalite, silicon dioxide, magnesium oxide, and calcite. FT-IR spectroscopic data have depicted different characteristic peaks corresponding to acid treated cement strips in comparison with hydrated cement. Hydrated cement has shown an IR peak at at 1004 cm^{-1} which is relevant for the calcium silicate hydrate bond (C-S-H). Acid treated cement strips have shown characteristic peaks for the COO^- group in the wavenumber range of 1538-1580 cm^{-1}. It can be concluded that different carboxylic acids have an impact on the crystal phases as well as the bond structures of hydrated cement.

Keywords: Carboxylic acids, cementitious material, calcium silicate hydrate bond

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928/E2

Evaluation of ultrafiltration combined with UV sterilization for the preservation of King coconut (*Cocos nucifera var. aurantiaca)* water

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Worldwide, king coconut water (KCW) is well known for its unique, refreshing and authentic taste. However, the enzymatic activity of peroxidases and phenol-oxidases limits the shelf life of KCW, altering sensory properties such as taste and aroma upon extraction of KCW from the fruit. The shelf-life of KCW can be improved by eliminating the enzymes which degrade quality of the nut water. Thermal treatment is the commonly applied method in extending the shelf life of KCW. However, undesirable changes in the physicochemical properties, nutritional quality, taste and other sensory attributes are major drawbacks which are encountered in the use of thermal processing methods. Hence, the objective of this study was to extend the shelf life of KCW using a combination of non-thermal technologies; ultrafiltration and ultraviolet (UV) sterilization retaining sensory and physicochemical properties. A pilot scale unit comprising of an ultrafiltration unit combined with a UV sterilizer was designed for this study. Fresh KCW was used as the control. Physicochemical properties; pH, acidity, percentage of reducing sugars, non-reducing sugars and total sugars were measured in the control and in ultrafiltered and UV sterilized KCW. On the 3rd, 7th and 14th day of storage, physicochemical parameters were evaluated and the total plate count was observed. Sensory evaluation was conducted and the most preferred sample for KCW was selected. Findings from the study revealed that, panelists mostly preferred fresh KCW. However, ultrafiltered and UV sterilized KCW was successful in retaining the unique taste of KCW which was almost similar to that of fresh KCW. In ultrafiltered and UV sterilized KCW, except for acidity, there was a change in the other tested parameters from the 3rd to the 14th day of storage. Non-thermally treated KCW was found to be microbiologically safe for consumption. It is concluded that ultrafiltered and UV sterilized KCW was successful in retaining the taste almost similar to that of KCW. Even though other tested parameters were altered, ultrafiltration and UV sterilization have been effective in extending the shelf life of KCW. However, an extension of shelf-life for two months is required for further validation.

Keywords: King coconut water, ultrafiltration, UV sterilization, shelf-life

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929/E2

Evaluation of bioactivities of extracts obtained from flowers of *Senna spectabilis*

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Tyrosinase enzyme is responsible for the synthesis of melanin in the skin. By inhibiting this enzyme, the rate of production of melanin can be decreased. Nowadays most women prefer to be fair skinned but adverse effects caused due to skin whitening agents have become a significant problem. Due to this reason, herbal skin whitening agents are becoming more popular in cosmeceutical industry. Researchers have found that, flowers of *Senna fistula* and *Senna auriculata* species show high anti tyrosinase activity. Hence, *Senna spectabilis* was chosen in this study and its total phenolic and flavonoid content, antioxidant activity and anti-tyrosinase activity were evaluated to find a potential skin whitening compound. The afore-mentioned bioactivities were selected to find out an existence of a correlation among them because these bioactivities are related to phenolics. The flower of *Senna spectabilis* was used in this study because of its high antioxidant activity. Sequential extraction was carried out into hexane, ethyl acetate and methanol, respectively. Water extraction was also carried out separately and extract was freeze dried. Phenolic content was determined using Folin-ciocalteu method whereas $AlCl_3$ colorimetric method was used to determine the total flavonoid content. Water extract showed a high phenolic (6.91 GAE g^{-1}) and flavonoid content (6.78 mg g^{-1}) compared to methanol extract. The antioxidant activity was evaluated by the 2, 2-dipheny-1-picrylhydrazil (DPPH) assay. Methanol extract showed a better antioxidant activity with the highest value (72.19 ±0.01%) for 4 mg/ml solution compared to water, hexane and ethyl acetate extracts. Methanolic extract showed a significant antioxidant activity compared to other extracts. The effect of skin whitening was evaluated using *in vitro* anti-tyrosinase assay. Unexpectedly, lipophilic extract (hexane) of *Senna spectabilis* displayed considerable anti-tyrosinase activity (40.13±0.03%) for high concentration (4 mg/ml) compared to hydrophilic extracts (methanol, ethyl acetate and water). Although there is no specific correlation between the four bioactivities, different extracts have shown significant results for different bioactivities. These preliminary studies provide new insights to further evaluate the correlation of different bioactivities in different extracts of *Senna spectabilis* plant.

Keywords: Antioxidant activity, cosmeceutical, *Senna spectabilis,* tyrosinase

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930/E2

Evaluation of the antibacterial and antiviral properties of *Bambusa vulgaris* young shoot extract

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The emergence of multi-drug resistant pathogens is one of the greatest threats to the efficacy of current therapeutics. Phytochemicals present in plants such as alkaloids, flavonoids, glycosides, tannins and triterpenoids have demonstrated promising potentials for the expansion of the range of modern therapeutics against viruses and microorganisms. The objective of the present study was to evaluate the antibacterial and antiviral activities of the fresh juice of *Bambusa vulgaris (*variety *vittata*) young shoots (FJBV) against a group of pathogenic bacteria and Dengue virus (DENV). In this study, the antibacterial activity of the bamboo shoot extract was assessed against Gram-positive and Gram-negative bacteria. According to the results obtained from MTT broth micro dilution assay, *Bacillus subtilis, Enterococcus faecalis, Pseudomonas aeruginosa, Escherichia coli, Klebsiella pneumoniae, Proteus vulgaris* and *Staphylococcus aureus* showed susceptibility to the fresh juice of bamboo shoot extract. Approximately 125 ml of FJBV was extracted from 400 g of a young bamboo shoot with an approximate height of 1.5 feet. Concentration of 50% (V/V) FJBV was able to kill approximately 90% of the *B. subtilis*, 75% of *E. faecalis* and *E. coli* and 50% of *S. aureus. Pseudomonas aeruginosa, K. pneumoniae* and *P. vulgaris* showed less susceptibility to 50% (V/V) FJBV. The antiviral activity was evaluated in Vero cells against DENV serotypes 1, 2, 3 and 4. MTT assay was performed to measure the cell viability and cytotoxicity of plant extract. The cell viability was significantly increased (>75% viable cells) in the presence of 50% (V/V) FJBV against DENV serotypes 1 and 4. Our results suggest that FJBV should be considered to develop novel antiviral and antibacterial therapeutics to support disease treatment and management.

Keywords: Bamboo shoot, Dengue virus (DENV), Vero cells, serotype

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931/E2

Comparison of major fatty acid groups in commercially available edible plant lipids in Sri Lanka

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Crude plant oils are processed industrially by several techniques such as partial hydrogenation, deodorizing, and refining for preparing different processed lipid products. In the food industry, the partial hydrogenation is practiced where a part of the unsaturated fatty acids (USFA) changes to saturated fatty acids (SFA) and *trans* fatty acids. During the processing, fatty acid (FA) composition can be changed. The determination of FA composition and changes in FA groups in processed plant lipids are important in relation to nutritional value. Under this study twenty-four processed plant lipid samples were analyzed. First, oil was extracted from selected edible plant lipid products; thereafter, oil samples were methylated and analyzed in triplicate using gas chromatography fitted with a flame ionization detector to determine the FA composition. Most processed plant oils contained more USFA than SFA. Total USFA ranged from 8.17% for virgin coconut oil to 85.84% for mustard oil. Total polyunsaturated fatty acid (PUFA) ranged from 1.14% for virgin coconut oil to 56.17% for sunflower oil and total monounsaturated fatty acid (MUFA) ranged from 7.03% for virgin coconut oil to 70.31% for olive oil. The highest content of SFA was found in virgin coconut oil (91.80%) and was lowest in sunflower oil (12.26%). In most hard/semi-solid edible lipids, SFA content was higher than USFA content. Total SFA ranged from 22.57% to 62.34%. Total USFA ranged from 37.37% to 77.42% and the prominent PUFA was, linoleic acid. The MUFA was high in a margarine brand (54.64%) which has enriched with MUFA. In conclusion, the FA groups change considerably among the processed edible plant lipids and due to the high content of PUFA, it is suggested that consumption of sunflower oil could be beneficial to health.

Keywords: Partially hydrogenated lipid, refined, fatty acid groups, plant lipids

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932/E2

Microencapsulation of orange peel oil and its qualitative antibacterial properties

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Essential oils (ESO) are natural compounds which demonstrate antibacterial properties that are beneficial for various industries. However, volatility and easy degradability limit their applications in the development of many products. For this purpose, a microencapsulation process, in which the active ESO as a core material is enveloped using a coat to give a small microcapsule, has been introduced. In pharmaceutical industry, target specificity, control releasing ability or the sustained release of drugs and easy administration can be achieved by microencapsulation techniques. Antibacterial activities are bacteriostatic or bactericidal. As far as ESO are concerned, the orange peel oil (OPO) is known to possess better antibacterial properties. In this study, coacervation phase separation technique was used to prepare microcapsules with OPO, under simple coacervation and complex coacervation. The microcapsules obtained from simple coacervation method were very small and difficult to recognize under optical microscope. Therefore, the most suitable method of preparing OPO microcapsules was the complex coacervation method based on the strength of optical microscopic images. Antibacterial activity of OPO and microcapsules loaded with OPO obtained from complex coacervation method were then tested with well diffusion assay against Gram-positive *Staphylococcus aureus* and gram-negative *Pseudomonas aeruginosa*. The presence of significant inhibition zones in agar plates against both bacteria indicated the antibacterial activity of OPO and developed OPO loaded microcapsules qualitatively. Furthermore, the antibacterial test results confirmed the encapsulation of OPO in the microcapsules. X-ray diffraction analysis confirmed that the used wall materials and prepared microcapsules are amorphous in nature. The delineated peak at 1645 cm^{-1} in the Fourier transform infrared spectrum of crushed microcapsules depicted complicated evidence for encapsulation of OPO or symmetrical stretching vibration of gum Arabic carboxylate groups.

Key Words: Antibacterial properties, coacervation, essential oils, microencapsulation, orange peel oil

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933/E2

Investigation of antioxidant activity of black seed oil loaded microcapsules

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Antioxidants possess the ability to scavenge free radicals allowing the body to control oxidative stress. Therefore, antioxidants can be considered as protective agents which play an important role in preventing diseases such as cancers where free radicals are known to be involved in the diseases causing process. Black seed oil is one of the most prominent traditional medicines with significant antioxidant activity. The microencapsulation process can preserve the antioxidant activity of black seed oil, control release property, and prevent degradation of the oil. The main objective of this research was to investigate the antioxidant activity of black seed oil loaded synthesized microcapsules by using 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay and Folin-Ciocalteu assay. First, black seed oil was microencapsulated through complex coacervation using the gelatin-sodium alginate system. A very small quantity (two drops) of lemongrass oil was used to mask the odour of black seed oil. Finally, the antioxidant activity of synthesized microcapsules was measured. According to DPPH assay, 65.5% of radical scavenging activity (% RSA) was observed for crushed microcapsules and 77.4% of RSA was observed in an equal amount of unencapsulated oil. According to Folin-Ciocalteu assay, 278.1 µg PGE/mg antioxidant capacity (AOC) was observed in synthesized, crushed microcapsules and 333.8 µg PGE/mg AOC was observed in an equal amount of unencapsulated oil. All assays were carried out in triplicate. These results provide evidence to conclude that the antioxidant activity of black seed oil was not significantly reduced due to the microencapsulation process. Here, ascorbic acid was used as the reference in DPPH (% RSA-39.4) and pyrogallol was used as the standard for Folin-Ciocalteu assay. Therefore, there is a potential of applying black seed oil loaded microcapsules as an antioxidant agent either directly on the skin or by using microcapsules embedded cotton gauzes or smart wristbands and can be developed further as an anticancer agent.

Keywords: Antioxidant, DPPH, Folin-ciocalteu, black seed oil, microcapules

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934/E2

Photoluminescence studies of functionalized lanthanide doped hydroxyapatite particles

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Luminescence is one of the most remarkable properties of lanthanide ions (Ln^{3+}). Ln^{3+} luminescence is highly utilized in a wide range of applications owing to the advantages they possess. Doping Ln^{3+} into inorganic material is one strategy to incorporate luminescence into non-luminescent inorganic materials. Hydroxyapatite (HAp) is one of the most important inorganic materials in bones and teeth. HAps are used in many applications including bioimaging, tissue engineering and water purification. Useful properties can be incorporated into HAp by fabricating HAp with desired dopants. Ln^{3+} have similar radii to Ca^{2+}; hence, Ln^{3+} can be doped into HAp to achieve the luminescence. Europium and terbium ions are most commonly used lanthanides in optical probes. Therefore, in this study, europium and terbium doped hydroxyapatite particles (EuTb-HAp) were investigated for their luminescence. Owing to LaPorte forbidden nature of *f-f* transitions, EuTb-HAp did not show prominent emission. Hence, EuTb-HAp were functionalized with dipicolinic acid (DPA) to increase luminescence using antenna effect. The primary goal of this research project is to synthesize HAp doped with Ln^{3+} and functionalized with DPA, which can be utilized as a luminescent probe. Well-crystallized HAp doped with both Eu^{3+} and Tb^{3+} have been successfully synthesized by coprecipitation method, maintaining the $[Eu^{3+}] = [Tb^{3+}]$ and ratios of Ln^{3+} to Ca^{2+} at 20 % and (Ca+ Ln)/ P at 1.67. Particles were functionalized *in situ* with DPA to achieve better luminescence. Synthesized EuTb-DPA-HAp were characterized by UV-absorbance and luminescence emission. Characterizations showed successful doping of both Eu^{3+} and Tb^{3+}, as well as the incorporation of DPA into HAp matrix. The addition of DPA into EuTb-HAp caused a great enhancement in luminescence emission when excited at 272 nm wavelength, which corresponds to the maximum absorbance wavelength of DPA. Synthesized EuTb-DPA-HAp showed characteristic Eu^{3+} and Tb^{3+} peaks at 490 nm, 545 nm, 590 nm and 620 nm. Tb3+ peaks were more prominent masking emission peaks from Eu3+ due to less energy transfer to Eu^{3+}. However, when the less intensed peaks at 589 nm and 620 nm are expanded, a clear splitting can be seen indicating emission peaks form both Tb and Eu. Finally, our study showed that the lanthanides can be easily doped to the HAp matrix and efficient transfer of energy from DPA to lanthanide ions take place within the HAp matrix.

Keywords: Lanthanide ions, hydroxyapatite, dipicolinic acid, EuTb-DPA-HAp, luminescence

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935/E2

DFT study on intermolecular interactions of MDI-BDO-PCL urethane molecules

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The packing arrangements of polyurethane chains in the crystalline and amorphous regions are responsible for several physiochemical and mechanical properties such as melting temperature, rigidity, abrasion resistance, and tensile strength. In this study, a model of (1,7)-Polyoxepan-2-one (PCL), 1,1'-Methylenebis(4-isocyanatobenzene) (MDI), and Butane-1,4-diol (BDO), (MDI-BDO-PCL) has been developed computationally, and it was used to study the packing arrangements and intermolecular interactions using DFT/B3LYP-6-31G(d). Out of the four possible intermolecular hydrogen bonding patterns for urethane chain, only the H-bond interactions between carbonyl oxygen (hard segment) and a hydrogen atom attached to the nitrogen (urethane linkage in the hard segment) were observed. The average H-bond distance is 2.04 Å. Therefore, hard segment crystallization was predicted due to the hard segment-hard segment H-bond interactions. In the crystallized region, hard segments are packed together, showing zig-zag orientation. The planer nature of the urethane group and benzene ring in the hard segment reduces steric hindrance and increases the crystallinity. The findings of this study have shed new light on the atomistic level understanding of the microstructure of the urethane matrix.

Keywords: Polyurethanes, hard segment, soft segment, hydrogen-bonding interactions

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