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Keynote Speaker's Profile

Professor Tilak Abeysinghe, PhD, MA, MSc, BA

- Senior Research Advisor (Visiting Professor), Asia Competitiveness Institute
- Former Professor of Economics, National University of Singapore
- Research Director, Gamani Corea Foundation, Colombo

Fields: *Econometrics, both theoretical and applied. Applied fields include Singapore Economy, welfare spending and fiscal sustainability, quality adjusted labour input and productivity, transmission of business cycles, health economics.*

Tilak Abeysinghe is currently the Research Director of the Gamani Corea Foundation, Colombo and Senior Research Adviser (visiting professor) in the Asia Competitiveness Institute, National University of Singapore (NUS). He was a Professor in the Department of Economics, NUS. After 31 years of service he retired from the Department in July 2019. At NUS, he served as the Director of the Singapore Centre for Applied and Policy Economics and Executive Committee member of the Department. He held other important administrative responsibilities such as Deputy/Acting Headship, Director of Economics Graduate Program and member of the Faculty Tenure and Promotion Committee. He was also a visiting professor at Kyoto University and Peradeniya University. His research interests lie in a range of theoretical and applied econometric topics that include the Singapore economy, housing affordability, stress and cancer and quantitative health research. He has published in various reputable international journals like Journal of Econometrics and NBER paper series. A major line of his research has been the econometric modelling of the Singapore economy, forecasting and policy analyses. Policy analyses based on these models have appeared in news media frequently. He coordinated the keenly awaited monthly newspaper column in The Straits Times, "Ask NUS economists". He is currently engaged in a number of research projects on the Sri Lankan economy. He has supervised a large number of PhD, Masters and Honours students. He obtained his PhD in Economics/Econometrics from the University of Manitoba and worked for the United States Agency for International Development (Colombo) before joining NUS in 1988.

Keynote Speech

It was science and technology that lifted the humankind above subsistence living. Just imagine how many were killed by famines and plagues without modern transport and healthcare developments. Covid-19 outbreak is unique because of its global spread. Nevertheless, scientific knowledge has kept the death toll so far well below the records of historical plagues. However, the social and economic despair caused by the pandemic at the global scale is likely to be unprecedented. Sri Lanka successfully managed the Covid-19 spread but the social and economic fallout is yet to be assessed. Economic fallout from disruptions to global value chain on Sri Lanka is unlikely to be substantial because of Sri Lanka's narrow global linkages. This may have come as a blessing in disguise during the pandemic because the economic shock of major hubs are not fully transmitted to the Sri Lankan economy. This, however, amounts to the old saying "a man sitting on the ground does not fall." In the long run strong global linkages are immensely helpful not only in lifting the economy off the ground but also in sustaining a higher altitude. This presentation draws attention to four key aspects:

1. Outlook for sectors of the Sri Lankan economy
2. Short-term relief and recovery
3. Labour productivity and long-term growth
4. Riding on the Asian century

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Biological Sciences

Abstract No: BS-01

Aloe vera gel and cinnamon essential oils-incorporated *Aloe vera* on stem-end rot control of mango (cv. Karthakolomban) using dip treatment

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Stem-end rot (SER) is a major post-harvest disease of mango worldwide. Naturally occurring biologically active compounds from plants are expected to be more suitable and less harmful than synthetic fungicides. Current research was carried out to investigate the applicability of *Aloe vera* gel and cinnamon bark oil and cinnamon leaf oil-incorporated *Aloe vera* gel in controlling SER and extending post-harvest shelf life of mango (cv. Karthakolomban). Dip treatments of *A. vera* gel and cinnamon bark oil (2.0 µL/mL) and cinnamon leaf oil (2.0 µL/mL) incorporated *A. vera* gel were carried out for 90-day old mango fruits and their pathological, physicochemical, sensory properties and percentage shriveling were evaluated after 10-day storage at 12-14 ℃. After the initial dip treatment trial, a scaling up experiment was conducted using the best treatments where treated and control mangoes were placed in ventilated corrugated fiberboard boxes instead of plastic trays to store mango at 12-14 ℃. Statistical analysis of the results was carried out using MINITAB 18 statistical software. Data with respect to physicochemical properties were analyzed using One-way ANOVA and Tukey's multiple comparison test. Kruskal Wallis non-parametric test was used to analyze data with respect to pathological, shriveling and sensory properties. Dip treatments of *Aloe vera* gel in combination with cinnamon leaf and bark oils reduced SER severity of mango to 3.0% in both trials once fruits were subjected to induce ripening. *A. vera* gel treatment reduced SER severity of mango to 6.0%. *A. vera* gel, cinnamon bark and leaf oil-incorporated *A. vera* gel treatments significantly reduced SER severity of mango in comparison to the negative control (distilled water) which showed SER severity of 19.0%. Physicochemical properties namely total soluble solids, titratable acidity, pH, firmness and weight loss of *A. vera* gel and gel plus oil treated mangoes were similar to the negative control fruits according to the statistical analysis. Percentage shriveling of mango subjected to *A. vera* gel treatments was reduced to 0-0.4% compared to the uncoated control fruits which indicated a shriveling of 1.6%. Sensory properties of mango did not demonstrate any drastic alteration between all treatments. Current ecofriendly treatment strategies could be introduced to horticulture industry to reduce post-harvest loss of mango in local trade, during transportation and exportation via air cargo within 10 days.

Keywords: *Aloe vera*, Dip treatment, Essential oils, Mango, Stem-end rot

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Abstract No: BS-02

Sugarcane bagasse as a potential bacterial carrier

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Immobilization of microorganisms into carrier materials is a promising tool in the formation of biofertilizers and biocontrol agents. Selection of an appropriate carrier material for cell immobilization is highly challenging since a carrier material should essentially facilitate cell immobilization, sufficient nutrition and a protective environment for the survival of immobilized cells. Further, there should not be a significant negative impact on ecological receptors of the receiving environment. Continuous supply of carrier materials at low cost is essential when scaling up laboratory made formulations into commercial products. Sugarcane bagasse (SCB) is a readily available industrial organic waste in Sri Lanka. However, it is underutilized as a carrier material in microorganism-based formations. Therefore, the objectives of the present study were to immobilize selected bacterial species in SCB and to estimate the viability of bacteria during storage in order to determine the potential of SCB as a bacterial carrier. The SCB matrix was prepared by grinding and sieving oven dried SCB to a fine powder. One portion of the fine powder was treated with 0.5 M NaOH while the other portion was kept untreated. *Bacillus cereus* at 1x 10^8 cell/mL optical density was used as the model bacterial inoculum. Four grams of both alkali-treated and untreated SCB matrices were inoculated with 50 mL of bacterial inoculum in 250 mL flasks. Immobilization of bacteria was facilitated by shaking at 150 rpm for 24 h. Bacteria-SCB matrices were collected by filtration and air dried for 1 h. Dried material was stored for 30 days at room temperature (approximately 30 °C) in sterilized screw-capped 250 mL flasks. Viability of bacteria in SCB matrices were compared with widely used sodium alginate bacterial carrier using the same model bacterial inoculum. Bacteria-sodium alginate homogenate was prepared at a final concentration of 2% (w/v) sodium alginate with 1x 10^8 cell/mL bacterial inoculum. Beads were prepared in 2.5% (w/v) $CaCl_2$ solution while stirring and washed with sterilized distilled water and air dried aseptically for 1 h. Beads were then stored for 30 days at room temperature in sterilized screw-capped 250 mL flasks. Viability of immobilized bacteria was determined by estimating colony forming units (CFU) per mL at different time intervals from 48 h to 30 days of storage. Results showed the presence of >3 x 10^8 CFU/mL at 10^{-6} which was the highest tested dilution until 14 days of storage for all three matrices. However, CFU of untreated SCB dropped up to 10 fold after 14 days at all dilutions whereas CFU of alkali-treated SCB and sodium alginate remained >3 x10^8 CFU/ mL at 10^{-6} for 30 days. Growth of immobilized bacteria in SCB carrier matrix with 3 x 10^8 CFU/mL at all dilutions confirms immobilization of tested bacteria in the SCB carrier matrix. Further, it confirms the viability of immobilized bacteria cells in the carrier material during storage at room temperature for 30 days. Scanning electron microscopic images showed attachment of bacteria on the surface of the SCB matrix. Therefore, we conclude the suitability of alkali treated SCB as a low-cost and locally available industrial waste as a carrier material for bacteria. Since *B. cereus* is a spore forming bacterium, during immobilization, cells may have survived as spores and germinated in the nutrient medium when cultured. Hence, further experiments with non-spore forming bacteria may support the evaluation of efficiency of cell multiplication in the alkali treated SCB matrix.

Keywords: Bacteria, Carrier material, Immobilization, SEM, Sugarcane bagasse

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Abstract No: BS-03

In vitro hardening of *Dendrobium* plantlets to enhance acclimatization

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Orchids are one of the most important cut flowers and ornamental plants in the floriculture industry with a high commercial and medicinal value. Successful establishment of *in vitro* derived orchid plants under *ex vitro* conditions is a challenge. When transferring from *in vitro* to *ex vitro* conditions, plantlets undergo an adaptation process due to factors relating to luminosity, transpiration, photosynthesis and nutrient absorption. This limits the cultivation of some species due to high plant mortality. Paclobutrazol (PBZ) has usually enhanced orchid acclimatization by contributing to fast adaptation and high survival rates upon the reduction of transpiration, plant height, leaf area, biomass and also due to the induction of root thickness and green coloration of leaves. Therefore, this study aimed to enhance the acclimatization of *in vitro* derived *Dendrobium* cultivars by *in vitro* hardening process with the use of PBZ in the Murashige and Skoog (MS) medium. After 10 months of *in vitro* culturing, *Dendrobium* plantlets were subcultured in different concentrations of PBZ supplemented MS media. The experiment was completely randomized with five treatments (PBZ concentrations: 0.025; 0.05; 0.075 and 0.1 mgL^{-1}, and the control with no PBZ) and five replications, with three plantlets per replication. A significant dropdown of plantlet height, leaf width, root length and an increment of root diameter was observed with the enhancement of PBZ concentration in the medium when compared to the control. The lowest plantlet height (3.07 ± 0.15^{c} cm) compared to the control (4.60 ± 0.20^{a} cm) was observed in 0.075 mgL^{-1} PBZ concentration. Meanwhile, the smallest leaf width (0.45 ± 0.04^{b} cm) compared to the control (1.23 ± 0.15^{a} cm), the lowest root length (1.00 ± 0.02^{c} cm) compared to the control (2.07 ± 0.21^{a} cm), the highest root diameter (1.00 ± 0.1^{a} cm) compared to the control (0.50 ± 0.11^{c} cm) were observed in 0.10 mgL^{-1} PBZ medium. Furthermore, after the acclimatization, the survival rate of plantlets in 0.10 mgL^{-1} PBZ concentration has increased up to 60% with a 47% of increment compared to the control showing the highest survival rate of plantlets. According to this result, MS medium supplemented with 0.10 mgL^{-1} PBZ could be used as an *in vitro* culture medium to enhance the acclimatization of *Dendrobium* plantlets.

Keywords: Acclimatization, Dendrobiums, Paclobutrazol (PBZ)

Abstract No: BS-04

First evidence of epiphytic marine algae *Acrochaete leptochaete* identified from Beruwala reef, Sri Lanka by DNA barcoding

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Several green microalgal species that grow as epiphytes and/or endophytes associated with seaweeds have been identified from different locations worldwide. The composition of epiphytic marine algae in a marine ecosystem is an important indicator of environmental alterations. However, there are no previous records on epiphytic marine microalgae in the Sri Lankan coast. Therefore, this study aimed at identifying epiphytic marine microalgae inhabiting marine macroalgae in the Barbarian reef, Beruwala, and provides the first evidence of an epiphytic micro chlorophyte colonized within the seaweed genera from all the three marine macroalgal divisions. Morphologically different macroalgal specimens were collected in September 2018 from the Barbarian reef, Beruwala and they were identified using macroscopic and microscopic characters within two days of sample collection. DNA was extracted from the algal thalli and the nuclear ribosomal DNA Internal Transcribed Spacer regions (nrDNA ITS1-5.8S-ITS2, 650 bp) were amplified by polymerase chain reaction (PCR) from the extracted DNA using a primer pair (ITS1 and ITS4) specific for micro chlorophytes. PCR products were unidirectionally sequenced by the Sanger sequencing method using the forward primer. Sequences were checked and edited using BIOEDIT software version 7.2.6 and aligned with the nucleotide database (blastn) in National Centre for Biotechnology Information (NCBI). According to the morphological characterization of the macroalgae, nine, three and seven genera belonged to the Divisions Chlorophyta, Phaeophyta and Rhodophyta, respectively. The nrDNA ITS1-5.8S-ITS2 sequences showed a 95-96% similarity to *Acrochaete leptochaete* (JN104107.1) for the macroalgae *Chaetomorpha* (Division Chlorophyta), *Padina* (Division Phaeophyta) and *Gracillaria* (Division Rhodophyta). According to the fact that 93% sequence similarity should be achieved with that of the Genbank sequences for the species level determination of algae using the nrDNA ITS1-5.8S-ITS2 sequence, it could be confirmed that *A. leptochaete* is inhabiting *Chaetomorpha* (*A. leptochaete* - accession MK910762.1), *Padina* (*A. leptochaete* - accession MK910764.1) and *Gracillaria* (*A. leptochaete* - accession MK910760.1). This provides evidence for the broad host range owned by *A. leptochaete* among seaweed genera.

Keywords: *Acrochaete leptochaete*, DNA barcoding, Epiphytic algae, nrDNA-ITS

Abstract No: BS-05

A preliminary study on selected metals in processed tea samples produced in different regions of Sri Lanka

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Sri Lanka is one of the oldest and most renowned tea exporters in the world. There are three major geographical zones (Up, Mid and Low country) and seven sub agro-ecological regions where tea is cultivated in Sri Lanka. The cultivation and processing have unique features in each region. Therefore, tea produced in specific regions in Sri Lanka acquires unique flavor characteristics and attracts higher prices in the international markets than tea produced in other countries. Often 'Ceylon tea' is blended with tea from other origins and sold as 'Pure Ceylon tea' to exploit this advantage. The objective of this study was to identify chemical parameters specific to the region of production to obtain geographical indications (GI) for tea produced in different regions of Sri Lanka. Generally, a combination of chemical parameters is used to establish GI. In this study, the focus was on the variation of selected metal contents in tea produced in different regions. The selected metals were Zn, Cu, Pb, Fe, Cr, Na, K and Ca. Tea samples from six agro-ecological regions were collected for the study. Microwave digestion was used as a rapid and efficient method for sample decomposition and the determination of metals was done by Flame Atomic Absorption Spectrometry and Flame Photometry. Results of the statistical analysis using one-way ANOVA indicated that there were significant differences in the mean levels of selected metals in tea among different regions of production. This may be due to the use of fertilizers which contain these metals and differences in soil metal composition in different regions. Machinery contamination may also have a minor contribution. Dendrogram obtained in cluster analysis shows that variation in mean values of metal contents can be clustered into three groups according to the similarity levels. One group is Dimbula and Uva. This might be of significance because they are highly sought-after teas of Sri Lankan origin. Results from the study indicated that variation of metal contents could be used as one parameter to distinguish highly sought-after tea of Dimbula and Uva regions from other regions after establishing the baseline levels for the regions.

Keywords: Agro-ecological regions, Atomic absorption spectrometry, Geographical indications, Metals, Processed Tea

Abstract No: BS-06

Unsaturated fatty acid compositions of selected pigmented and non-pigmented new improved rice varieties (*Oryza sativa* L.) of Sri Lanka

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Rice is the dietary staple for Sri Lankans and it contains monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs) beneficial to human health.There are thousands of rice varieties (RVs) in the country and widely cultivating and consuming varieties are the new improved rice varieties (NIRVs). Studies on fatty acid (FA) compositions of rice are extremely limited and to date there is no single study reported on FA compositions of NIRVs of Sri Lanka. Thus, this study evaluated the MUFA and PUFA compositions of a range of NIRVs of Sri Lanka. Eight Sri Lankan NIRVs including 03 pigmented (At 362, At 311 & Bw 272-6b) and 05 non-pigmented (Bw 367, At 307, At 308, At 309 & Bg 403) RVs were used in this study. Grain lengths of RVs were measured according to internationally accepted standard methods. Fat was extracted from whole grain rice flour by Soxhlet fat extraction method, followed by derivation to methyl esters and analyzed by Gas chromatography with flame ionization detection (GC-FID). Results showed that studied RVs were extra-long (At 311 & At 309), long (At 362 & At 308), medium (At 307 & Bg 403) and short (Bw 272-6b & Bw 367) grains. Total unsaturated FA, MUFA and PUFA contents of studied RVs were varied from 16.97 ± 0.07 to 24.87 ± 0.07, 9.50 ± 0.10 to 14.55 ± 0.01 and 7.47 ± 0.04 to 10.32 ± 0.07 mg/g of rice respectively and highest in Bw 272-6b. The MUFAs in tested RVs were palmitoleic, oleic and ecosenoic acids whereas oleic acid was the most predominant. Short grain red RV, Bw 272-6b had the highest (14.08 mg/g) content of oleic acid while long grain red RV, At 362 had the lowest (9.15 mg/g). Among the studied RVs, PUFAs present were linoleic, gamma linoleic, homogamma linoleic and docosadienoic acids while linoleic acid was the abundant FA. Linoleic acid was most abundant (9.91 mg/g) in Bw 272-6b while least abundant (7.23 mg/g) in At 362. The findings of this study confirm that MUFAs and PUFAs of studied RVs varied significantly ($p < 0.05$) among the grain sizes while it was insignificant ($p > 0.05$) between pigmented and non-pigmented RVs.

Keywords: Grain size, New improved Sri Lankan rice, Non-pigmented rice, Pigmented rice, Unsaturated fatty acids

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Abstract No: BS-07

Chemical profile of *Terminalia chebula* fruit collected from different regions of Sri Lanka and commercial samples from Sri Lanka and India

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Terminalia chebula is a valuable medicinal plant used in traditional medicine. The fruit of *T. chebula* contains a large number of biologically active chemical compounds. Demand for the herbal drugs is increasing every day and maintaining the quality of herbal drugs is very important. Therefore, the objective of this study is qualitative and quantitative comparison of the chemical profiles of *T. chebula* fruit (without seeds) of commercial samples and authentic samples. Authentic samples of *T. chebula* were analyzed to see the effect of climatic zone variation on chemical profile and physicochemical parameters. Authentic samples (SL_A) were collected from *T. chebula* plant itself from onsite visit, from Bibila, Buththala, Padhiyathalawa, Gampaha and Colombo and authenticated from the voucher specimen available at Herbarium, Link Natural Products (Pvt) Ltd (LNP). One composite sample was made according to sampling protocol, WHO 1998, from each region for analysis. Commercial samples are a mixture of fruits obtained from several suppliers from different areas. Commercial samples were obtained separately from three different batches of *T. chebula* commercial stocks from Sri Lanka (SL_C) and India (IN_C) at LNP. Powdered dried fruits were extracted with 70% aqueous methanol and concentrated using rotatory evaporator. Physicochemical parameters were determined according to WHO and European pharmacopoeia methods. Total tannin was determined using Folin-Denis assay. Crude *T. chebula* fruit extract was separated by thin layer chromatography (TLC) and high performance liquid chromatography (HPLC). Gallic acid content and gallic acid/ellagic acid ratio were calculated using the peak area of HPLC chromatograms. TLC and HPLC showed a large number of compounds in the crude extract of *T. chebula* fruit. Both showed similar profiles with variations in intensity among the samples. Physicochemical parameters (without water soluble extractive values), total tannin, gallic acid content, gallic acid/ellagic acid ratio are statistically different among SL_A samples ($P < 0.05$). Except physicochemical parameters, other parameters are statistically similar among SL_C and IN_C ($P<0.05$). Total tannin content (% w/w) of SL_A samples was; Padiyathalawa: 33.40 ± 0.17, Buththala: 43.39 ± 0.41, Gampaha: 41.13 ± 0.61, Bibila: 42.31 ± 0.23 and Colombo: 34.12 ± 0.01. Gallic acid content (% w/w) of SL_A samples was; Padiyathalawa: 0.49 ± 0.01, Buththala: 0.98 ± 0.01, Gampaha: 1.03 ± 0.02, Bibila: 0.83 ± 0.02 and Colombo: 1.86 ± 0.04. Gallic acid/ellagic acid ratio (% w/w) of SL_A samples; Padiyathalawa: 0.15 ± 0.0038, Buththala: 0.18 ± 0.0009, Gampaha: 0.16 ± 0.0003, Bibila: 0.16 ± 0.0041 and Colombo: 0.68 ± 0.0040. Total tannin content, gallic acid content and gallic acid/ellagic acid ratio vary in different batches of commercial samples. Mean of total tannin content (% w/w) of SL_C was 49.14 ± 6.09 and IN_C is 42.79 ± 0.76. Mean of gallic acid content (% w/w) of SL_C was 1.13 ± 0.28 and IN_C is 2.25 ± 0.69. Gallic acid/ellagic acid ratio (% w/w) of SL_C was 0.30 ± 0.07 and IN_C is 0.43 ± 0.05. Chemical composition and quality of *T. chebula*. dried fruit depend on the geographical location, maturity stage, growth condition and raw material processing condition.

Keywords: *T.chebula*, Gallic acid, HPLC, TLC

Abstract No: BS-08

Phytochemical screening and TLC profiles to identify adulteration of *Osbeckia octandra* (L.) (Heen bovitiya) with *Osbeckia aspera* and *Melastoma malabathricum*

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Osbeckia octandra (L.) (Heen bovitiya), which belongs to the family Melastomataceae is an endemic plant to Sri Lanka. This taxon contains different phytochemicals that have great importance in traditional therapeutic systems and widely used to treat jaundice, hepatitis and liver disorders. Lack of accurate identification and need of continuous supply of raw materials for medicinal preparations can be a cause for adulteration of *O. octandra*. Therefore, the present study was carried out to investigate phytochemical screening and TLC profiles of *O. octandra* with available adulteration materials of *Osbeckia aspera* and *Melastoma malabathricum*. Hexane, ethyl acetate, and ethanol leaf extracts were prepared using air dried leaf samples of *O. octandra*, *O. aspera* and *M. malabathricum.* The extracts were subjected to phytochemical screening of saponins, phenols, flavonoids and anthocyanins. These leaf extracts were separated using thin layer chromatography (TLC) technique under four solvent systems with different ratios of Hexane (HE): Ethyl acetate (EA); 9:1:17:3; 4:1 and 13:7 and three solvent systems with different ratios of Hexane: Ethyl acetate: Ethanol (ET); 18:1:1; 15:3:2 and 6:3:1 respectively. The spots were observed and retention factors (R_f) were calculated under visible light and ultra violet light (365 nm). According to the results of phytochemical screening, saponin was observed in hexane leaf extracts where phenols, flavonoids and anthocyanin were observed in ethyl acetate and ethanol extracts for all three species. TLC profiles have shown a range of R_f values of various phytochemicals in different solvent systems due to the presence of diverse groups of phytochemicals. *M. malabathricum* was clearly separated from *O. octandra* and *O. aspera* in TLC profile of ethanol extracts developed in solvent system of HE: EA; 13:7 under visible light. This TLC profile was observed under ultraviolet light and it has also revealed a clear difference between the phytochemical compositions of *O. octandra*, *O. aspera* and *M. malabathricum*. The cluster analysis of R_f values obtained from TLC profile has shown a close relationship between the phytochemical compositions of *O. octandra* and *O. aspera*. In conclusion, TLC profile obtained from ethanol leaf extracts subjected to solvent system of Hexane: Ethyl acetate; 13:7 can be used to identify adulteration of *O.octandra* with *O. aspera* and *M. malabathricum*.

Keywords: Adulteration materials, *Osbeckia octandra*, Phytochemicals

Abstract No: BS-09

Adulteration detection of *Cinnamomum verum* with BarHRM technology

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Sri Lanka is the premier exporter of the true cinnamon (*C. verum*) in the global market. However, Sri Lankan true cinnamon faces a major threat due to severe competition and adulteration from its substitute cassia (e.g. *C. aromaticum*). It costs one-third of the price of *C. verum* but it contains coumarin which is a hepatotoxin at substantial amounts (up to 5%) whereas true cinnamon has only trace amounts (about 0.004%). Therefore, it is paramount to detect adulteration of *C. verum* from its substitute to protect the reputation of true cinnamon. Chemical and morphological methods can detect the adulteration of *C. verum* but when it comes to admixtures and value-added products, morphological and chemical methods are not accurate. Hence, the objective of the research was to develop a molecular assay to detect adulteration in commercially available cinnamon products. In this study, DNA sequences of C. *verum* and *C. aromaticum* were extracted from the National Center for Biotechnology Information (NCBI) using the keyword "*Cinnamomum"* and selected barcode region *"rbcL".* Gene-specific novel markers were manually designed targeting the identified diagnostic SNP sites. Primer properties were analyzed using NetPrimer software and primers with the best qualities were selected. DNA extraction of cinnamon was done using CTAB method with slight modifications. Real-time PCR and melting curve analysis at 65 ºC to 95 ºC with a ramping rate of 0.05 ºC (Qiagen, Germany) was performed. The melting curve analysis and principal component analysis of the data demonstrated a clear distinction between the two species and results confirm that *rbcL* gene-specific primers can be used to distinguish *C. verum* from *C. aromaticum.* Further, this assay has a great potential to quantify adulterants in commercially available cinnamon samples and extremely valuable for an accurate and rapid adulteration detection of cinnamon value-added products in the global and local market.

Keywords: Adulteration, BarHRM, Cinnamon, Molecular detection

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Abstract No: BS-10

Optimization of bioethanol production from *Chlorella* sp. isolated from Sri Lankan fresh water habitats

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Bioethanol is an alternative energy source that can be used to replace fossil fuel. It is produced by the fermentation of various feedstock such as edible crops and lignocellulosic biomass that contain fermentable sugars. However, this production is challenging as these feedstocks contain high amounts of cellulose and lignin, which is difficult to digest during bioethanol production. To overcome these challenges researchers are now focusing on the use of microalgae as the feedstock. Effective carbon dioxide fixation, rapid growth, non-competition for arable land and potable water, potentially high carbohydrate and lipid accumulation along with less lignin content have made microalgae an ideal feedstock for bioethanol production. However, little or no evidence has been found on the production of bioethanol from microalgae in Sri Lanka. Therefore, experiments were carried out to produce bioethanol from microalgae found in freshwater habitats in Sri Lanka and to optimize bioethanol production. Microalgae were collected from selected natural ponds, identified and cultivated in 1.5 L culture bottles. Cultivation media (Bold's Basal medium, Bolds Basal medium + Compost extract and Modified R medium) and harvesting method (Centrifugation, gravity filtration, vacuum filtration, coagulation and flocculation) were optimized to obtain a high yield of microalgae biomass. Pre-treatment condition (Sulphuric acid concentration – 1%, 10%, 70% and reaction time - 30 minutes, 6 hours, 1 day) and fermentation time (2 days, 1 week, 2 weeks, 3 weeks) were optimized to release high amount of sugar and ethanol. Molisch's and Fehling's tests were used to detect released sugar. The dinitrosallicylic acid (DNS) method was used for the quantitative determination of released sugar. Ebulliometer and Gas Chromatography with Flame-Ionization Detector (GC-FID) were used for the characterization and quantitative determination of generated bioethanol. The isolated microalgal strain was identified as *Chlorella* sp. using identification keys for freshwater microalgae. *Chlorella* sp. grown in Modified-R-medium yielded the highest algal biomass of 1 g/L. Coagulation and flocculation method, which was selected as the best method to harvest microalgae yielded biomass of about 1 g/L. H_2SO_4 acid concentration of 70% which was the highest acid concentration used yielded the highest sugar concentration of 0.423 ± 0.01 g/L. The reaction time for acid hydrolysis was selected as 6 hours as it yielded the highest sugar concentration of 0.425 ± 0.008 g/L. The optimized results of fermentation time showed that two-week fermentation period yielded the maximum bioethanol of 0.554 ± 0.007 g/g of sugar. These values were further confirmed by GC-FID analysis which also gave a bioethanol content of 0.514 g/g of sugar. The results indicate that the *Chlorella* sp. inhabiting Sri Lankan freshwater habitats contain a considerable amount of fermentable sugars which can be used to produce bioethanol.

Keywords: Bioethanol, *Chlorella*, Fermentation, Microalgae, Pre-treatment

Abstract No: BS-11

Microfractionation-based approach to screen potential specialized anti-microbial metabolites of Sri Lankan marine sponges

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The discovery of bioactive specialized metabolites from marine invertebrates has increased significantly during the last two decades. Marine sponges (phylum Porifera) are the existing oldest metazoan group that host rich microbial communities, and are considered as potential sources of future drugs in pharmacological and biomedical industry as they produce an impressive array of anti-inflammatory, immunosuppressive, neurosuppressive, antitumor, antiviral, and antimicrobial compounds. Of the few studies that have been carried out on such products in Sri Lankan marine sponges, the discovery of bioactive peptides has been largely overlooked. Therefore, a study was carried out to screen potential specialized anti-microbial metabolites especially peptides and sterols in Sri Lankan marine sponges with the intention of large scale isolation of targeted bioactive molecules. Bioassay-guided micro fractionation is an efficient method for the rapid screening of a large number of samples using only a small amount of starting material. Aqueous extracts (60% methanol) and organic extracts (Dichloromethane: methanol 9:1) of 20 different sponge species collected in coastal waters in Sri Lanka were micro fractionated into 48 fractions in deep well plates (1 mL per well), using reversed-phase HPLC. A volume of 100 µL from each fraction was tested for antimicrobial activities and the wells with antimicrobial activity were analyzed by LC-MS coupled to a PDA detector to identify the molecular ions of the bioactive compounds. Of all the 40 extracts, 18 extracts produced by *Rhabdastrella globostellata, Aciculites* sp., *Rhabderemia* sp., *Erylus* sp, *Aulospongus* sp., *Manihinea* sp., *Agelas* sp., *Phakellia* sp., *Topsentia* sp., four species belonging to order Haplosclerida and one species belonging to order Suberitida showed bioactivity against *Staphylococcus aureus* (ATCC 25928). *Stylissa massa* showed bioactivity against *Escherichia coli* (ATCC 35218) while *Aulospongus* sp., showed bioactivity against *Candida albicans* (ATCC 90028). Sponge species were identified using their morphology, spicule arrangement and DNA barcoding. The 5' end of CO1 and 28S rRNA genes were sequenced for both forward and reverse direction. Sequences were compared using the BLASTn tool with the NCBI database in order to narrow down and identify the possible lowest taxonomic level. The wells that indicated bioactivity contained fractionated extract at $\leq$ 0.2 mg/mL concentration. Organic extracts of *Aciculites* sp., *Topsentia* sp. and the aqueous extract of *Erylus* sp. were the most active at $\leq$ 0.05 mg/mL. The targeted masses obtained from LC-MS will be isolated in large scale and the structural characterization of isolated specialized anti-microbial metabolites will be determined using LC-MS and NMR. Furthermore, these micro fractions will be subjected to lymphoma cell toxicity assay to identify potential anticancer compounds.

Keywords: Sri Lankan sponges, Specialized microbial metabolites, Antimicrobial activity

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Abstract No: BS-12

Indole Acetic acid production and pathogen growth control abilities of endophytic fungal assemblages associated with two newly improved *Oryza sativa* varieties of Sri Lanka

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Newly improved rice varieties, highly dependent on agrochemicals, have been introduced to meet the increasing food demand in Sri Lanka. Health and environmental problems caused by extensive use of agrochemicals in rice cultivation necessitate investigations on alternative, less harmful methods for maintaining high productivity and disease management. Endophytic fungi (EF) of many crops have been reported to have the ability to enhance plant growth through the synthesis of Indole Acetic Acid (IAA) and to possess mechanisms of fungal pathogen control. Therefore, the present study was carried out to assess the levels of IAA production by the endophytic fungi (EF) isolated from two rice varieties, At 362 and Bg 352 with a view to utilise the high producers of IAA as a means of increasing rice plant growth and productivity. Screening test for growth inhibition of two known rice pathogens, *Rhizoctonia solani* and *Bipolaris oryzae*, the causative agents of Sheath blight and Brown spot diseases respectively was carried out to test the possibility of using isolated EF for management of the two pathogens. Healthy plant samples of the selected rice varieties were collected during the Yala and Maha seasons (2019) from Anuradhapura, Kurunegala, Gampaha and Kalutara districts. Endophytic fungi present on leaves, stems and roots were isolated onto 2% Malt Extract Agar medium. Fungal isolates were identified based on morphological characters and ITS gene sequencing. A total of 235 EF isolates belonging to 26 genera were isolated from the two rice varieties. IAA production by these fungal isolates was evaluated using Salkowski's assay. The effect of the isolated EF on the growth of the two fungal pathogens was tested under *in-vitro* conditions using the dual culture assay. All experiments were conducted in triplicate and data were statistically analysed using one-way ANOVA and Tukey's pairwise comparisons. Amongst the tested isolates, *Curvularia* sp and *Aspergillus terreus* isolated from Bg 352 produced IAA at significantly high levels of 15.642 µg/mL and 15.117 µg/mL respectively ($P < 0.05$). Dual culture studies showed that *Sarocladium oryzae* and *Rhizopus microsporus* isolated from At 362 inhibited the colony growth of *R. solani* by 68.5% and 58.7% respectively whilst the growth inhibition of *B. oryzae* was 38.5% and 43.1% respectively. The preliminary tests of this study indicated that some of the EF associated with the two rice varieties have the ability to produce significantly high levels of the growth promoting phytohormone IAA whilst some others have the means to control the growth of two common rice pathogens and therefore have the potential to be used for increased productivity of rice as well as for the control of the two rice diseases after further testing.

Keywords: Endophytes, Rice, Growth-enhancement, Rice-pathogens, Bio-control

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Abstract No: BS-13

High-resolution melting traceability of black pepper adulteration with papaya seeds, chili and/or other potential plants

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Black pepper (*Piper nigrum* L.) is a valuable medicinal spice and one of the premier exports in Sri Lanka. The black pepper industry in Sri Lanka faces a major threat due to the adulteration of Ceylon pepper with inferior quality substitutes like papaya seeds and chili powder. Therefore, frequent testing of black pepper products is essential to retain the reputation of Ceylon pepper. Application of morphological and chemical methods have limitations in adulteration detection, especially for admixtures in powdery and processed forms. Available molecular techniques also have limitations of being expensive, time consuming and less reliable. The research was aimed at developing an assay based on DNA barcoding coupled High Resolution Melting Analysis (Bar-HRM) which is sequencing-free, reliable, yet faster and more economical than DNA barcoding to report the spice authentication results. DNA isolation from dried storage tissues is extremely difficult due to the presence of polysaccharides, polyphenols, proteins like compounds and due to the scarcity of DNA. A modified CTAB method was developed along with a phenol extraction to extract and amplify the required DNA regions from the dried processed admixture of black pepper and its major adulterants. Although the DNA quality of the product varies among different samples, the capability of PCR amplification from any material including powdered admixture affirms the validity of the tests being developed in adulterant detection. Two novel gene-specific primer pairs were designed targeting the assay development and both newly developed *rbc*L markers were successful in PCR amplification. Subsequently, a relatively novel, high throughput technique called Bar-HRM was applied to detect the black pepper adulteration. According to the results melting profiles of pure samples of black pepper, papaya and chili were clearly separated so that they can be differentiated by HRM analysis. HRM data were further examined using Principal Component Analysis (PCA) and the results showed that HRM analysis successfully differentiates three species, separating them into three different clusters. Then the optimized HRM conditions were applied to admixtures and HRM curves of the adulterated samples were clearly deviated from the pure samples. It could be concluded that developed technique is a very first HRM based high-throughput system to authenticate black pepper adulteration with papaya seeds and chili. Although as a proof of concept this technique was developed to detect papaya and chili adulteration, novel system has the potential to detect other black pepper adulterants as well.

Keywords: Admixture, Adulteration, Black pepper, HRM analysis, *rbc*L

Acknowledgment
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Abstract No: BS-14

Soil carbon sequestration capacity in paddy soils of Kurunegala district, Sri Lanka with respect to its agro climatic regions

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Paddy field ecosystems are considered as one of the major carbon pools as they store a significant amount of carbon under water-logged conditions. Hence, it is essential to understand the carbon storage capacity in paddy fields as this would help to identify the processes related to soil carbon sequestration potential in such ecosystems. However, the soil carbon content may vary with the prevailing climatic conditions of the site. Kurunegala is one of the districts in Sri Lanka with heavy paddy cultivation and also it experiences three different agro climatic conditions (Dry, Intermediate and Wet). This study aims to assess, how the soil carbon sequestration capacity in paddy soils would vary concerning three different agro climatic conditions in Kurunegala district. Adopting the conditional Latin hypercube sampling (cLHS) design, 200 soil samples were collected from two depths, surface soil layer (0 – 15 cm) and sub-surface soil layer (15 – 30 cm) so as to represent the agro climatic regions. Soil Moisture Content (MC), Soil pH and Electrical Conductivity (EC), Bulk Density (BD), Total Carbon (TC), Microbial Biomass Carbon (MBC), Labile Carbon (LC), Water-Soluble Carbon (WSC), Total Nitrogen (TN) were analyzed using standard protocols. Results showed that the total C and MBC contents were higher in the paddy soils collected from the wet zone climatic region and low soil pH (5.5-6.5) and anaerobic conditions prevailed could be contributing to this situation. Further, the Soil C stock (70.54 Mg ha-1) was higher in the wet zone climatic region compared to dry and intermediate climates. Increased TC content in paddy soils will cause to increase in the soil TN content too. Available P and NO_3^- contents in the paddy soil were higher in the Intermediate zone but the pH and the EC were higher in the soils from the dry zone. In conclusion, the paddy soils under the wet zone climatic conditions showed a higher carbon stock and a high potential to retain soil carbon than those in the other two agro climatic regions.

Keywords: Climate change, Anaerobic conditions, Microbial biomass carbon, Soil carbon stock, Total carbon.

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Abstract No: BS-15

The antagonistic effect between Abamectin degrading bacteria, *Staphylococcus nepalensis* and *Bacillus thuringiensis*

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Basic ecological concepts govern the composition and the functional relationships among microorganisms of a particular ecosystem of interest. Antagonism is one such functional relationship among bacteria. A bacterium that is antagonistic to another is capable of producing molecules with different structures, cellular targets, spatial range, and mode of action that are harmful to other organisms in the same niche. Even though the antagonism is beneficial to the survival of a bacterium when considering processes such as bioremediation having multiple bacteria capable of performing the same or cooperative objectives, this effect is detrimental. *Staphylococcus nepalensis* and *Bacillus thuringiensis* are two Abamectin degrading bacteria. To test whether there is an antagonistic interaction between *S. nepalensis* and *B. thuringiensis*, the growth compatibility assay was performed using salt yeast extract (MSYE) agar plates supplemented with Abamectin (25 mgL^{-1}). Parallel streak lines were made using previously isolated, Abamectin degrading, *S. nepalensis* and *B. thuringiensis* cultures and their identification was confirmed by biochemical tets. Plates were incubated for 72 hours at 37 °C. Growth inhibition zone encircling the *S. nepalensis* streak was observed after the incubation period. Results from this test were confirmed by measuring the Optical Density (OD) measurements at 600 nm, of MSYE broth cultures of *S. nepalensis*, *B. thuringiensis* and a combination of both. Inoculated broths were incubated in a shaker incubator (150 rpm, at 30 °C) for 72 hours, and growth was monitored by measuring OD at 24-hour intervals. OD measurements 72 hours after the inoculation (*S. nepalensis* - 0.19133, *B. thuringiensis* - 0.12500, Mixed culture - 0.12000) indicated the fact that the growth of pure cultures is higher, compared to that of the mixed culture of both organisms. Accordingly, the results of OD measurements demonstrated an antagonistic effect between *S. nepalensis* and *B. thuringiensis*. As claimed by the results of both tests it is not applicable to use them together to treat Abamectin-associated pollutions. They can still be successfully applied individually as pure cultures. However, both organisms should not be applied to the same site, at the same time, as it would be inimical towards their bioremediation capability.

Keywords: Antagonism, Pure culture, Mixed culture, Optical density, Bioremediation

Abstract No: BS-16

In vitro bioactivity of the *Ayurvedic* drug *Ramabana Rasa* in the Sri Lankan market

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Ramabana Rasa is an *Ayurvedic* drug which is commonly used to treat rheumatism and digestive problems. For its preparation, Hg (*Parada*) and S (*Ghandaka*) are triturated into nanoparticles of black HgS (*Kajjali*) and combined with various plant ingredients. Though previous studies have assessed the bioactivity of the different plant ingredients and the responsible phytochemicals separately, similar bioactive properties may not be present in the prepared drug. Lack of proper manufacturing practices in Sri Lanka may have caused significant variations in the composition and bioactivity of the drugs available in the market. The present research was carried out to investigate the *in vitro* bioactivity of the *Ayurvedic* drug *Ramabana Rasa* available in the market in Sri Lanka and evaluate the brand-to-brand and batch-to-batch variations. Drug samples of three different batches from three different manufacturers were purchased, powdered, shaken with methanol and water separately at 150 rpm. for 24 hours, vacuum filtered, concentrated and freeze dried. The methanol and aqueous extracts of the drugs were screened for antioxidant activity by the α,α-diphenyl-β-picrylhydrazyl (DPPH) free radical and 2,2′-azino-bis (3-ethylbenzothiazoline-6-sulfonic acid) (ABTS) cationic radical scavenging assays. Anti-inflammatory activity was determined by the human red blood cell membrane stabilization assay. Antibacterial activity was explored using the agar well diffusion method against *Escherichia coli*, *Staphylococcus aureus* and *Bacillus subtilis*. The IC_{50} values were statistically analyzed using one-way analysis of variance (ANOVA) and Fisher's comparison test. Both methanol and aqueous extracts exhibited antioxidant and anti-inflammatory activities in a dose dependent manner and the activities were found to be higher in the methanol extracts than the aqueous extracts except in a few samples at certain concentrations. The lowest IC_{50} reported for DPPH free radical scavenging activity was 67 ± 3 µg/ml for a methanol extract which was higher than the IC_{50} of the standard antioxidant 2,6-di-tert-butyl-p-cresol (BHT) (23 ± 2 µg/ml). The lowest IC_{50} reported for ABTS cationic radical scavenging activity was 24 ± 3 µg/ml for an aqueous extract where as BHT showed an IC_{50} of 14 ± 2 µg/ml. In the anti-inflammatory assay, the methanol extracts of several drug samples showed 50% inhibition at lower concentrations compared to the IC_{50} of the standard anti-inflammatory drug aspirin (164 ± 11 µg/ml). The lowest IC_{50} reported for the methanol extract was 124 ± 8 µg/ml suggesting high anti-inflammatory activity. No antibacterial activity was observed against the organisms tested. The results revealed that *Ramabana Rasa* drugs in the Sri Lankan market have good antioxidant activity and strong anti-inflammatory activity, while there are significant differences ($\alpha = 0.05$) in bioactivities between brands and batches of the same brand.

Keywords: Anti-inflammatory, Antioxidant, *Ayurveda*, *Kajjali*, *Rambana Rasa*

Abstract No: BS-17

Screening of endophytic *Hypoxylon* sp. for *in vitro* antimicrobial and antioxidant activity

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Genus *Hypoxylon* is the largest and most complex genus belonging to the family Hypoxylaceae in Xylariales, Division Ascomycota. In natural product development, *Hypoxylon* sp. are widely being studied in order to identify novel bioactive agents produced during their secondary metabolism. The objective of this study was to characterize and identify the bioactive properties of secondary metabolites of endophytic *Hypoxylon nicaraguense* isolated from Pilikuththuwa low land wet zone forest, Gampaha, Sri Lanka. During the study, secondary metabolites of *H. nicaraguense* were extracted by solid state fermentation using rice medium and liquid state fermentation using Malt Yeast Peptone Broth, followed by ethyl acetate extraction. Antibacterial activity of the crude extract was tested against *Erwinia* sp., while the antifungal activity was tested against *Fusarium oxysporum*, *Colletotrichum* sp., *Phomopsis* sp. and *Lasiodiplodia theobromae* by agar well diffusion method. Testing antioxidant activity was achieved using DPPH scavenging method. Preliminary screening of chemical compounds of crude extract was performed to identify the active compounds present in each crude extract. Antimicrobial activity test exhibited significant activity against the test pathogenic bacteria *Erwinia* sp. and test pathogenic fungi *Fusarium oxysporum* and *Phomopsis* sp. The crude extract was only slightly effective in controlling the growth of *Colletotrichum* sp. and ineffective in controlling the growth of *Lasiodiplodia theobromae*. Nevertheless, the highest concentration of crude extract of *H. nicaraguense* (10 mg/mL) showed higher antioxidant activity with IC_{50} value of 66.62%. Results of preliminary screening of chemical compounds confirmed that the crude extract consists of active compounds including carbohydrates, flavonoids, phenols, triterpenoids, steroids, glycosides, tannins and proteins. The current study discloses that *H. nicaraguense* is a promising source with antimicrobial and antioxidant properties which could benefit the agriculture related industries to improve commercial antibacterial and antifungal products.

Keywords: Antimicrobial, Antioxidant, Secondary Metabolites, Hypoxylaceae

Abstract No: BS-18

Evaluation of lipid parameters and their association with age, glycaemic parameters and anthropometric measurements of newly diagnosed patients with type 2 diabetes mellitus, Galle, Sri Lanka

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Serum lipid abnormalities in type 2 diabetic patients increase the risk of macrovascular diseases. Present investigation intended to assess the association of serum lipid parameters vs age, fasting plasma glucose (FPG) concentration, glycated haemoglobin (HbA_{1C}), body mass index (BMI) and waist circumference (WC) in newly diagnosed type 2 diabetic patients. 147 newly diagnosed type 2 diabetic patients were recruited to the study from Galle district, Sri Lanka. Age and anthropometric measurements were recorded. Biochemical parameters were estimated on collected fasting venous blood sample. Patients with known renal, liver, cardiac, respiratory, thyroid, psychiatric and any other chronic or acute diseases, and pregnant women were excluded from the study. Individuals who are using antilipidaemic drugs were also excluded. The correlation between lipid parameters vs age, FPG, HbA_{1C}, BMI, and WC was evaluated using linear correlation analysis. Binary logistic regression analysis was implemented to further evaluate the association between significantly correlated parameters and abnormal lipid parameters. A probability value of ≤ 0.05 was considered as statistically significant. The mean age, BMI, WC, FPG and HbA_{1C} of the study subjects were 48.48 ± 7.13 years, 25.16 ± 3.98 kgm^{-2}, 88.81±9.06 cm, 7.47±0.69 mmol/L, 6.41±0.64 % respectively. Mean lipid parameters for HDL-C, TG, TC, LDL-C and VLDL-C were 1.20 ± 0.37 mmol/L, 1.47 ± 0.45 mmol/L, 4.73 ± 0.84 mmol/L, 2.86 ± 0.89 mmol/L, 0.67 ± 0.20 mmol/L respectively. Age ($r = 0.195$ $p = 0.02$) and FPG ($r = 0.157$ $p = 0.04$) showed significant positive correlation with TC while BMI ($r = -0.170$ $p = 0.04$) and WC ($r = -0.197$ $p = 0.02$) showed significant negative correlation with HDL-C. The concentration of FPG also showed a significant positive correlation ($r = 0.197$ $p = 0.02$) with LDL-C. Regression analysis revealed that age (OR = 1.07, CI 1.01-1.13, p = 0.02) and FPG (OR = 1.63, CI 0.95-2.79, p = 0.05) were significantly associated with TC and LDL-C respectively. Significant correlations were observed between lipid parameters and age, BMI, WC and FPG in the study subjects. Increasing age and FPG levels of newly diagnosed type 2 diabetic patients are significantly associated with the lipid profile parameters of TC and LDL-C respectively. Hence, interventions in appropriate glycaemic control by healthy diets and lifestyle changes should be implemented to delay the progression of lipid abnormalities in newly diagnosed type 2 diabetic patients.

Keywords: Age, Body mass index, Lipid profile, Type 2 diabetes mellitus, Waist circumference

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Abstract No: BS-19

In vitro and *in vivo* antioxidant potential and phytochemical constituents of *Barleria prionitis* Linn. extracts

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Medicinal plants are natural sources of antioxidants. The use of antioxidants in the management of chronic diseases is an emerging therapeutic approach in the present era. Administration of several antioxidant compounds has demonstrated protective effects against nephrotoxicity induced by the anticancer drug; adriamycin in preclinical studies. *Barleria prionitis* Linn. (Family; Acanthaceae, common name: *Katukarandu*), is a medicinal plant with various therapeutic applications in kidney related diseases in Sri Lankan traditional medicine system. It is hypothesized that, nephroprotective effects of the plant is via its antioxidant potential. Herein, we aimed to assess the antioxidant potential of selected extracts of *B. prionitis* whole plant in adriamycin induced nephrotoxicity *in vivo,* to determine the total antioxidant activity *in vitro* and to identify the phytoconstituents in selected extracts. The hexane, ethyl acetate, butanol and aqueous extracts of *B. prionitis* were prepared by sequential Soxhlet extraction. Plant extracts were administered to adriamycin induced (5 mg/kg, ip) nephrotoxic Wistar rats (n = 6) at the human equivalent therapeutic dose (25 mg/kg, 80 mg/kg, 70 mg/kg, 120 mg/kg respectively), and standard drug fosinopril sodium (0.09 mg/kg) for 28 consecutive days as a daily single dose. The kidney tissues were excised from the sacrificed rats on the 28th day. The total antioxidant level and activity of glutathione reductase (EC 1.6.4.2) and glutathione peroxidase (EC 1.11.1.9) were estimated in the kidney homogenates of all experimental rats. Results were analyzed statistically by one-way ANOVA and Dunnett post hoc test and compared against the adriamycin induced nephrotoxic control group. The *in vitro* total antioxidant activity was determined by 2, 2'-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging assay. The qualitative screening of phytoconstituents was carried out for the presence of phenolic compounds, flavonoids, tannins, terpenoids, steroid glycosides, saponins, coumarins, and alkaloids using standard procedures. A significant increase in the total antioxidant concentration (62%, 71%, 59%, 58%) and in the activity of glutathione peroxidase (439%, 298%, 286%, 234%) was perceived following the treatment with hexane, ethyl acetate, butanol and aqueous extracts of *B. prionitis* respectively ($p < 0.05$). A significant increase in the concentration of glutathione reductase was noted only with the ethyl acetate (32.58 ± 2.55 U/L), butanol (27.66 ± 1.86 U/L) and with the aqueous (26.72 ± 1.57 U/L) extracts. No significant improvement in the activity of antioxidant enzymes was observed in fosinopril treated rats ($p > 0.05$). The *in vitro* total antioxidant capacity was deviated in the descending order of butanol (IC_{50}; 163.1 ± 2.1 µg/mL), aqueous (IC_{50}; 297.0 ± 2.3 µg/mL), ethyl acetate (IC_{50}; 775.6 ± 10.8 µg/mL), and hexane (IC_{50}; 961.7 ± 13.9 µg/mL) extracts of *B. prionitis* respectively. Phenolic compounds, flavonoids, tannins, steroid glycosides, terpenoids and saponins were present in the selected extracts at varying extents. The results revealed that selected extracts of *B. prionitis* improved the antioxidant enzyme levels in adriamycin induced nephrotoxicity in Wistar rats. Further, the selected plant extracts showed relatively high antioxidant activity *in vitro.* The phytoconstituents present in the *B. prionitis* extracts may attribute to its antioxidant potential.

Keywords: Adriamycin induced nephrotoxicity, Antioxidant activity, DPPH assay, Phytochemicals

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This work was supported by UGC block grant (RU/PG-R/16/14) and NSF research grant (RG/2016/HS-03)

Abstract No: BS-20

Optimization of DNA extraction protocol and DNA barcoding of *Hedyotis quinquinervia* in Sri Lanka

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Hedyotis quinquinervia, has been identified as a critically endangered possibly extinct (CR(PE)) endemic plant by the National Red List 2012 of Sri Lanka. However, in 2014 it was rediscovered from Thotupolakanda montane forests. It has a high potential as an ornamental plant due to compact, mosaic arrangement of curved shiny leaves with prominent veins. Thick leaf cuticle of this plant, hindered the extraction of good quality DNA for barcoding. Therefore, the aim of the present research was to establish an efficient DNA extraction protocol for *H. quinquinervia* in the absence of liquid N_2. *H. quinquinervia* leaves were stored at -80 ℃ or in silica gel for 48 hours prior to the DNA extraction. Three DNA extraction protocols were tested and agarose gel electrophoresis and spectroscopic method were used for the evaluation of quality and quantity of extracted DNA. All the extracted DNA samples were subjected to Polymerase Chain Reaction (PCR) for the amplification of nuclear rDNA-ITS region for barcoding. Out of three methods, classical CTAB protocol with 0.2% β-mercaptoethanol and 2% polyvinylpyrrolidone in CTAB buffer was successful, only after removing the cuticle of the adaxial surface of the leaf. The cuticle removal was achieved simply by using a clear tape and it was confirmed by staining the clear tape with safranin and observing it under the microscope. No DNA extraction was successful with the cuticle present on the leaves. PCR amplification was successful from the extracted DNA and rDNA-ITS sequences were obtained. A sequence of 435 bp, exhibited 98% query cover and 100% identity to *H. quinquinervia* of the NCBI database. Sequences were deposited in the GenBank under the accession numbers MT373692 and MT373691. It was also found that with the removal of cuticle, the amount of leaves required for good quality DNA extraction was five times less than that of the leaves with cuticle. Modified CTAB buffer and the cuticle removal from fresh leaves of *H. quinquinervia* were quick and easy modifications to obtain good quality DNA in the absence of liquid N_2. Cuticle removal method using clear tapes and the storage at -80 ℃ prior to DNA isolation could be recommended for identification of *H. quinquinervia* and other plant species with thick cuticle layers on the leaves.

Keywords: Cuticle, DNA extraction, DNA barcoding, *Hedyotis quinquinervia*, ITS-rDNA

Abstract No: BS-21

Deletion analysis of the *RB1* gene in retinoblastoma patients in Sri Lanka

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Retinoblastoma (RB), a tumour, affecting children aged less than 5 years has a prevalence of 1 in 20,000 with twenty cases/ year predicted in Sri Lanka. Unilateral RB (60%) presents on average at 24 months and bilateral RB (40%) presents around 15 months. A family history is reported in 10%. Many cases, diagnosed late, require enucleation. Genetic testing has not been available locally, but may enable better targeting of screening for patients and their siblings and reduce the need for enucleation in affected cases. Mutations of *RB1* gene lead to inactivation of pRB (retinoblastoma protein) and loss of its function. Different mutations of *RB1* gene include nonsense (37%), frameshift (20%), splice site (21%), missense (5%), deletions/ duplications of one or several exons or even the entire gene (15%) and mutations in the promoter region (1%). Hypermethylation of the promoter region is also found in the tumours of some retinoblastoma cases. About 5-15% of retinoblastoma patients have microscopic or submicroscopic deletions, which includes the entire or substantial parts (one or several exons) of the *RB1* gene. The objective of this study was to identify the presence of germline copy number variations of the *RB1* gene or any of its exons in retinoblastoma patients. Primers were designed for the 27 exons and promoter region of the target gene (*RB1*) and a control gene (Cystic fibrosis transmembrane conductance regulator - *CFTR*) to compare the copy number of both genes using gene ratio analysis copy enumeration PCR (GRACE-PCR). The peak height of the melting curve was analysed for calculation of the ratio. The ratio of the peak height of the melting curve of the target (*RB1*) to the control gene (*CFTR)* was calculated for patients and normal individuals separately. A ratio of patient to normal of 1 indicates the patient is deletion negative. A ratio of 0.5 indicates a deletion and a ratio of 1.5 indicates a duplication. Seven exons (exons 3, 4, 5, 6, 8, 9 and 10) of 32 patients and 3 more exons (exons 11, 12 and 16) of 16 patients who have no germline mutation identified from targeted amplicon sequencing, were tested. One case had a deletion for all 10 exons, while one case each had deletions of exon 11 and exon 12. In conclusion, three RB cases out of 32 patients (9%) have a deletion of one or several exons which is similar to world wide data and further testing is ongoing. Genetic testing helps to determine the recurrence risk and to target intensive screening to at risk family members. This can contribute to balance the resource limited healthcare services of developing countries.

Key words: Germline, Mutation, Large deletion, *RB1*, Retinoblastoma

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Ethical clearance was obtained from the ethical committee of Lady Ridgeway hospital, Colombo.

Abstract No: BS-22

In vitro control of *Lasiodiplodia* sp. isolated from black banded disease-infected mango (*Mangifera indica* L.) trees in Sri Lanka

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Mango (*Mangifera indica* L.) is indigenous to the Indian subcontinent and extensively grown in Sri Lanka. Black banded disease, which has been reported to reduce the vigor and productivity of mango trees in India, has not been adequately studied in Sri Lanka. The objective of this study was to isolate fungi associated with black banded disease and to determine the effectiveness of selected fungicides and botanicals to control them. This is the first study to isolate and identify the fungi associated with black banded disease in Sri Lanka. Mango twigs of 15 black banded disease-infected trees (willard and karthakolomban cultivars) were collected from different locations in Kuliyapitiya, Anuradhapura, Panadura and Kurunegala regions, and the associated fungi were isolated onto PDA under aseptic conditions. Resultant fungal colonies from all samples had similar characteristics and were identified to genus level using its morphological characteristics and its pathogenicity was confirmed according to Koch's postulates. Growth inhibition of the resultant fungus was tested *in vitro* by poison plate method with hot water and cold water leaf extracts of five plant species; *Lantana camara, Azadirachta indica, Mirabilis jalapa* and *Polyalthia longifolia* at 20% (w/v) concentration, which have been reported to exhibit antifungal effects. Contact fungicides Captan, Thiram, Mancozeb and Propineb at 100 ppm, 250 ppm, 500 ppm and 750 ppm concentrations incorporated into potato dextrose agar were also tested *in vitro* for growth inhibition of the isolated fungus at room temperature (30 °C). Black colony and pycnidia forming fungus with cylindrical, septate hyphae was isolated from all infected samples. It was observed to produce immature, hyaline conidia, later turning brown with a septum in the middle. It was identified as *Lasiodiplodia* sp., and its pathogenicity was confirmed by the development of black mycelial mass on black colored lesions at the site of re-inoculation, similar to the black banded disease. This is contradictory to previous studies in India, where the causative agent has been reported to be *Peziotrichum corticolum* (*Rhinocladium corticolum*). Neither hot nor cold water extractions of any of the five plant species showed successful growth inhibition of *Lasiodiplodia* sp. after 5 days of incubation. Less solubility of active compounds in water or comparatively low concentration used might have been the reasons for the lack of control of fast-growing *Lasiodiplodia.* Fungicides Captan and Thiram at 500 ppm and 750 ppm concentrations were most effective in controlling *Lasiodiplodia* sp. *in vitro*, with more than 80% inhibition, while Propineb exhibited the least inhibition of the pathogen with less than 10% pathogen inhibition even at 750 ppm, after 7 days of incubation. Thus, the inhibitory effects of Captan and Thiram against the causative pathogen *in vivo* have to be further evaluated in order to confirm their efficacy in controlling black banded disease in the field.

Keywords: Black banded disease, Fungicides, *Lasiodiplodia* sp., Mango

Abstract No: BS-23

Pollen morphometrics of family Magnoliaceae and Commelinid clade

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Basal angiosperms are classified into ANITA grade and Magnoliid clade according to the APG IV (2016) classification system. Many taxonomists have considered that some traits of the Family Magnoliaceae are independently derived (synapomorphies) from remaining Magnoliids. Commelinid clade is considered paraphyletic to the other monocots and including four orders; Arecales, Poales, Commelinales and Zingiberales. Pollen characters are potentially informative in higher-level systematics for floral evolution. Various pollen morphological features such as symmetry, shape, apertural pattern and exine configuration are considered as conservative features for the taxonomic assessments of the plants. The objective of the present investigation was to determine the phylogenetic relationships of family Magnoliaceae and Commelinid clade by studying the available species in Sri Lanka using their pollen morphometrics. *Licuala grandis, Loxococcus rupicola, Fimbristylis miliacea, Cyperus melanospermus, Monochoria vaginalis, Commelina diffusa, Heliconia rostrata* and *Alpinia purpurata* were selected as plant taxa belongs to the Commelinid clade, while *Michelia champaca* and *Michelia nilagirica* were selected from the family Magnoliaceae for the present study. The mature flowers of selected species were collected during the period of April 2019 to August 2019. Healthy anthers were separated from fresh flowers/florets. Pollens were subjected to acetolysis treatment (Acetic anhydride: conc. H_2SO_4; 9:1 ratio) and treated pollens were stained with Safranin (5%). Stained pollens were observed under Phase Contrast Microscope (10 x 40) and microphotographs of the pollen grains were prepared. Pollen characters were analyzed using the PAST (PAleontological STatistics) software package to interpret phylogenetic relationships. Cladogram has shown close phylogenetic relationships with family Magnoliaceae and family Arecaceae among the Commelinid clade. The studied species were aligned with the family Magnoliaceae and Commelinid clade of APG system IV (2016) with respect to their pollen morphometrics.

Keywords: APG IV system, Cladogram, Commelinids, Family Magnoliaceae, Pollen morphometrics

Abstract No: BS-24

Investigation of antihyperglycaemic activity of hexane extract of polyherbal mixture in streptozotocin induced diabetic rats

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A homemade Ayurvedic remedy made of cloves of *Allium sativum*, leaves of *Murraya koenigii*, seeds of *Piper nigrum* and dried fruit rinds of *Garcinia quaesita* is considered as an antidiabetic polyherbal mixture. This polyherbal mixture has been used for the treatment of diabetes mellitus and dyslipidaemia in Sri Lankan traditional medicine. The *in-vitro* antioxidant and *in-vivo* acute antihyperglycaemic screening of hexane, ethyl acetate and methanol extracts of the above polyherbal mixture were studied and the hexane extract showed a significant antioxidant and dose dependent antihyperglycaemic activity when compared with the two extracts. Hence, the present study was aimed to further investigate the effect of administration of the hexane extract of polyherbal mixture at the optimum effective therapeutic dose for 30 days on serum glycaemic parameters in streptozotocin induced diabetic rats. Diabetes was induced in male Wistar rats by injecting with streptozotocin at the single dose of 65 $mgkg^{-1}$. Group one and two considered as the healthy untreated control, diabetic untreated control rats and received standard animal food and distilled water daily for 30 days (n = 6 /group). Group three and four were diabetic rats and were treated with the hexane extract (25 $mgkg^{-1}$) and glibenclamide (positive control - 0.5 $mgkg^{-1}$) daily for 30 days respectively (n = 6 /group). Body weight of treated and control group rats were measured on 1^{st}, 7^{th}, 14^{th}, 21^{st} and 28^{th} day of the experiment. On the 30^{th} day, all experimental rats were euthanized and blood was collected by cardiac puncture. The antihyperglycaemic activity was evaluated by determining the changes of fasting serum glucose concentration in each group using oral glucose tolerance test on 1^{st}, 7^{th}, 14^{th}, 21^{st} and 28^{th} day and analyzed through total oral glucose tolerance curve (TAUC) values. Further, the percentage of glycated haemoglobin (HbA_{1C}) and fasting serum glucose concentration were determined as glycaemic parameters in each group. The body weight was increased in healthy untreated control group and treated groups while the diabetic untreated control group showed a 10% reduction of body weight during the intervention period, indicating the treatment led to control loss of body weight. The oral administration of hexane extract and glibenclamde, lowered the TAUC values by 21% and 35% respectively and these values were statistically significant compared with TAUC value of diabetic untreated group ($p < 0.05$) on the 28^{th} day of experiment. There was a statistically significant reduction in the HbA_{1C} (27%, 33%) and the fasting serum glucose concentration (23%, 33%) in hexane extract and glibenclamide treated diabetic rats when compared to streptozotocin induced untreated diabetic rats ($p < 0.05$). The findings of the current study revealed that the hexane extract of the polyherbal mixture is a potential source to develop antidiabetic agent/s and further investigations are warranted to study the cellular antidiabetic mechanisms.

Keywords: Antidiabetic, Hexane extract, Glycated haeamoglobin, TAUC

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Abstract No: BS-25

Potential of *Trichoderma harzianum* and *Trichoderma virens* in controlling *Meloidogyne incognita* on *Basella alba*

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Meloidogyne incognita, the root knot nematodes are a widely spread group of plant pathogens that affect a variety of economically important plants. Even though chemical nematicides are used to control the nematodes at present, these nematicides pose a huge threat to the environment. Taking this fact into account usage of nematophagous fungi has gained popularity as a more ecofriendly approach to control nematodes. *Trichoderma* spp. has a great ability to control nematodes by using trapping mechanisms and by secreting nematicidal metabolites. The present study focuses on the potential of using *Trichoderma harzianum* and *T. virens* in controlling *Meloidogyne incognita*. Three weeks old healthy nematode free *Basella alba* L. (Indian spinach) seedlings were subjected to five different treatments; Soil, Soil+ Nematodes, Soil + Nematodes + Nematicides, Soil + Nematodes + *T. harzianum* and Soil + Nematodes + *T. virens*. Six replicate samples were considered for each treatment. The plants were maintained in a homogenous environment. Some below ground direct growth parameters including number of galls, length, fresh weight and the dry weight of the tap root were measured at one month intervals up to three months. As *Meloidogyne incognita* develop disease symptoms mainly in the root system of *Basella alba* plants the above ground indirect systems were not considered in the present study. The data collected were analyzed using MINITAB version 18 statistical software. At the end of the second sampling time, the plants grown on soil treated with nematodes alone had a significantly higher number of galls (72 ± 6.97) compared to those treated with nematodes + *T. harzianum* (7 ± 0.516) ,nematodes + *T. virens* (8 ± 0.211) and nematodes and nematicides (32 ± 6.98) . However a significant difference was not observed in the length of the tap root. This may be because length of the tap root is not directly affected by the *Meloidogyne incognita* infection. At the end of the third sampling time, the fresh weight (14.42 g ± 1.29) and the dry weight (10.67 g ± 0.29) of the roots of plants infected with nematodes, were significantly higher than the fresh weight(3.83 g ± 0.55) and dry weight(2.34 g ± 0.51) of the roots of plants grown in soil. This study clearly indicates that both T. *harzianum* and *T. virens* have a great potential to be used as biocontrol agents of the root knot nematode *Meloidogyne incognita* in *Basella alba* L. This present study can be further improved by investigating the mechanisms employed by *Trichoderma harzianum* and *Trichoderma virens* in controlling *Meloidogyne incognita*.

Keywords: *Basella alba*, Bio control, *Meloidogyne incognita, Trichoderma harzianum, Trichoderma virens*

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Abstract No: BS-26

Novel protocols for biomass harvesting, lipid extraction, and biodiesel synthesis from Microalgae, *Chlorella* sp.

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At present, there is a huge interest in utilizing microalgae fatty compounds as a source of energy for the production of biodiesel. The small size and thick-walls of microalgae have made it difficult to harvest from cultures and extract produced lipids. For the same reason, most of the published protocols in the literature, still give unsatisfying results. Therefore, a study was carried out to develop novel protocols for harvesting biomass and extraction of lipids for the efficient synthesis of biodiesel. *Chlorella* sp. was cultivated in commercial-grade Albert's solution for mass production of microalgae. The ECF (Electrocoagulation and Flocculation) technique was used for harvesting biomass. A novel Aluminium and hybrid (Aluminium-Carbon) electrode systems were also employed and optimized for harvesting microalgae. Two systems were evaluated by two-factor factorial ANOVA design to determine the significance of variation due to the electrode system and distance between electrodes. Harvested microalgae were dewatered and dried. A newly developed sand crushing-heating method was adopted to extract lipids from the microalgal biomass. Factorial analysis of variance was used to determine the significance of variation due to sand to sample ratio and amount of solvent in the extraction procedure. To synthesize biodiesel, extracted lipids were trans-esterified by a novel, stoppered bottle-mixing method and optimized a by trial and error method. The resulting fatty acid methyl esters (Biodiesel) were subjected to *GC-MS* to analyse the fatty acid profile. Out of the methods tested, the pure Aluminium electrode system was recognized as the best ECF technique for harvesting microalgae after statistical analysis. According to the data analysis, the optimum distance between two electrodes was 3.0 mm and harvested 4.0 liters of culture within 5.75 ($\pm$ 0.7) minutes. There was sufficient evidence of interaction effect between the electrode system and distance between electrodes at $\alpha = 0.05$. The newly developed sand crushing-heating method was employed to extract lipids from microalgae with a low amount of impurities compared to conventional chemical extraction methods such as the Floch method (Chloroform-Methanol, 1:2 v/v) and its modifications. There was sufficient evidence of interaction effect between sand to sample ratio and Hexane volume using 0.05 of significance level. The optimum sand to sample ratio was found to be as 2:1 and the optimum volume of Hexane was found as 15.00 mL per 1.00 g of sample. Results indicated that the stoppered bottle mixing method could convert crude, extracted algal oil (172 ± 10 mg/g) into biodiesel efficiently ($\approx$ 95%). According to the fatty acid profile, oleic acid (38.64%), linoleic acid (36.58%), palmitic acid (11.28%), and stearic acid (5.53%) were observed as major fatty acid components present in lipids of *Chlorella* sp. This study highlights the advantages of developed novel protocols, both in terms of efficiency and purity.

Keywords: Microalgae, Biofuel, Transesterification, Electrodes

Acknowledgment
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Abstract No: BS-27

Effect of *Trichoderma virens* on vegetative and reproductive growth of *Capsicum annuum* cv. MI2 (green chilli)

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Plant Growth Promoting Fungi (PGPF) facilitate a favorable interaction with plants in the rhizosphere through several biological processes. PGPF play a significant role in phyto-stimulation, phytoremediation and biofertilization. The use of PGPF as a biofertilizer has steadily increased in sustainable agriculture to reduce the use of chemical fertilizers. The objective of the present study is to investigate the effect of *Trichoderma virens* on vegetative and reproductive growth of *Capsicum annuum* cv. MI2 (green chilli). The trials were conducted in a greenhouse in the botanical garden, University of Kelaniya. Six weeks-old seedlings of *C. annuum* cv. MI2 were transplanted in solarized potting medium prepared by mixing topsoil and compost (3:1), filled into grow bags. Four treatments (10^3, 10^5, 10^7 conidia/ mL) including control (treated with Urea, Triple superphostphate and Muriate of Potash) were carried out along with five replications. Potting medium was inoculated with the conidial suspensions at the time of transplanting, followed by four inoculations until the time of uprooting. At the completion of 10 weeks after transplanting, the plants were uprooted, measured and represented as a percentage increment compared to the control; for the vegetative (shoot height, number of leaves, leaf area, average leaf length, girth of tap root, total leaf chlorophyll, fresh and dry weights of shoot and root mass) and reproductive parameters (number of buds, flowers and pods) of *C. annuum* cv. MI2. The plants treated with 10^7 conidia of *T. virens* per mL showed a significant increase in growth parameters of shoot height (18.55%), leaf number (79.78%), fresh weight of shoot (122.4%), fresh weight of root (14.17 %) and a significant increase in reproductive parameters of, number of buds (18.18%), and number of pods (143.75%) compared to the control was observed. Moreover, the plants treated with 10^5 conidia of *T. virens* per mL showed a significant enhancement in the growth parameters, leaf area (17.63%), total chlorophyll content (8.87%) and dry weight of root (54.16%) compared to the control. Present study clearly indicated that *C. annuum* cv. MI2 show better vegetative, as well as reproductive growth performance, when treated with conidial suspensions of *T. virens*. Therefore, *T. virens* can be suggested as a potential biofertilizer for *C. annuum* cv. MI2.

Keywords: Biofertilizer, *Capsicum annuum*, PGPF, *Trichoderma virens*.

Abstract No: BS-28

Optimization of production of extracellular amylases by *Aspergillus niger* by solid state fermentation of microbial digestion of ground nut shell substrate

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Amylase has found its applications in a range of industries including food, brewing, distilling, textile, paper and pharmaceuticals and in the bioconversion of solid waste. Amylase has been reported to be produced by plants, animals and microorganisms, although microbial amylase production has been reported to be the most effective. In the current work, amylase was produced by *Aspergillus niger* under solid state fermentation using ground nut shell as the carbon source. Initially, conditions were optimized to improve the microbial digestion of ground nut shell. For that, digestion was carried out using a mixed culture of *Saccharomyces cerevisae* and *Peniciliiunm* sp., with and without a mineral salt solution, varying pH (4 to 7), the incubation period (1-7 days), amount of carbon source (2.00 to 6.00g), moisture content (10.00 to 30.00mL), with surfactants (between 20 and 80) and addition of nitrogen sources [$(NH_4)_2SO_4$, NH_4NO_3, NH_4Cl, $NaNO_3$ and $(NH_4)_3PO_4$]. Results revealed that maximum digestion can be achieved with optimized conditions, on the 4th day of incubation in 4.00 mL of mineral salt solution (pH 5) with 4.00 g of carbon source, between 80 (0.05%) and NH_4NO_3 (0.50 g). The digestion of ground nut shells was more effective in optimized conditions as there was significant growth of *S. cerevisae* and *Peniciliiunm* sp. Minerals that are required for microbial growth was provided by mineral salt solution. Surfactants increase the secretion of the enzymes by increasing the cell membrane permeability. As *Penicillium* sp. grows at pH 3 - 4.5 and *S. cerevisiae*, an acidophilic organism, grows better under acidic conditions (pH 4 to 6), the medium pH was in between pH 4 to 7. Digestion of ground nut shells was measured using DNS assay. After digesting the ground nut shells by *S. cerevisae* and *Peniciliiunm* sp. under optimized conditions the samples were inoculated with *A. niger* in the presence of organic N sources (peptone, glycine, urea and yeast extract). Statistical analysis was done by calculating mean enzyme activity. The maximum enzyme activity was obtained on the 5th day with yeast extract (0.50 g). The average enzyme activity was 31.35 U/mL, obtained on the 5th day with yeast extract (0.50 g). The enzyme activity was measured using amylase assay. There is a good potential of producing amylase by *A. niger* under solid state fermentation using ground nut shell as the substrate after digesting with *S. cerevisiae* and *Penicillium* sp.

Keywords: *Aspergillus niger*, *Saccharomyces cerevisae* Amylase, Ground nut shells, Solid state fermentation

Abstract No: BS-29

Exploration of antioxidant activity and photoprotective potential of methanolic extract of *Ananas comosus* (Pineapple) peel

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Pineapple (*Ananas comosus*) is known to rich in phytochemicals with antioxidant and antimicrobial activities. As less research has been conducted to investigate the bioactivity of its peels, the present study aimed to evaluate the antioxidant activity and photo-protective property of methanolic extract of pineapple peel to investigate its potential to be used as a natural source of cosmeceutical sunscreen agents. Pineapples at full ripeness stage were purchased and the chemical constituents of dried and powdered pineapple peels (20.00 g) extracted into methanol by Soxhlet extraction were sequentially partitioned into hexane, dichloromethane and aqueous methanol (50%). The antioxidant activity of each fraction was determined by α-diphenyl- β-picrylhydrazyl (DPPH) free radical assay. Total phenolic content (TPC) and total flavonoid content (TFC) of methanolic extract and its fractions were assessed by Folin-Ciocalteu and aluminium chloride colorimetric assays respectively. The photo-protective potential of the fractions was evaluated by determining the Sun Protection Factor (SPF) of each fraction using the Mansur equation. All the tests were conducted in triplicates. The aqueous methanol fraction showed the highest DPPH free radical scavenging activity with IC_{50} value of 85.704 ± 0.09 µg/mL and the highest TPC of 41.780 ± 0.223 mg Gallic acid equivalent /g dry weight of plant material. Dichloromethane fraction was rich in flavonoids with TFC of 31.372 ± 0.996 mg Catechin equivalent/g dry weight of pineapple peel. All the fractions of methanolic extract of pineapple peel exhibited UV-B absorption and among them, dichloromethane fraction showed significantly high photo protective properties with an SPF of 29.74 ± 0.03 at 1 mg/mL while the SPF of the reference photo-protective agent, benzophenone was 13.75 ± 0.01 at 1 mg/mL. Aqueous methanol was found to be the most photo-stable after irradiation with direct solar radiation for 21 days. The results suggest that the extract of peels of pineapple could be incorporated into sunscreen formulation as a source rich in phytochemicals with potential antioxidant and photo-protective properties.

Keywords: Antioxidant, Photo-protective, Phytochemicals, Sunscreen

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Abstract No: BS-30

Anti-diabetic activity of cinnamon (*Cinnamomum zeylanicum*) loaded nano-particles

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Ceylon cinnamon (*Cinnamomum zeylanicum*) is one of the cinnamon species that shows relatively high anti-diabetic activity. "*Sri Vijaya*" cinnamon variety (CCSV) is an accession of *C. zeylanicum* and, it has been identified as a good source of anti-diabetic compounds. The aqueous extract of the quills of CCSV is rich with anti-diabetic compounds. Mainly there are two methods that are used to prepare the aqueous extract. One method is "pressured water extraction" and the other is "decoction". According to the previously conducted researches, the aqueous extract which is prepared using "pressured water extraction" is more active than the other. Higher stability and the easiness of storage and transportation make powdered drugs and nutraceuticals preferred over liquids. However, most of the powdering techniques such as freeze drying and spray drying decrease the activity of the aqueous extracts. The objective of the present study was to synthesize a powdered nutraceutical from the pressured water extract of the quills of CCSV while conserving the anti-diabetic properties. In this study, cinnamon loaded nano-particles were synthesized using bovine serum albumin (BSA) as the base and citric acid as the cross-linking agent. Since nano-particles are extremely small in size, their surface area is higher. Because of that their reactivity is also higher compared with the other powdered form of drugs and nutraceuticals. α-amylase inhibitory activity and the α-glucosidase inhibitory activity of nano-particles were determined using dinitrosallicylic acid assay and para nitrophenyl glucopyranoside assay respectively and the corresponding IC_{50} values were calculated using Graphpad prism software in order to assess the anti-diabetic properties. The inhibitory activity and IC_{50} values of the aqueous cinnamon extract and the positive control acarbose were determined using the same enzyme assays and they were compared with the values obtained for nano-particles. The obtained data were statistically analysed by one-way analysis of variance (ANOVA) using SPSS software package. The IC_{50} values of nano-particles, aqueous cinnamon extract and acarbose on α-amylase were 117.60 ± 1.73 µg/mL, 131.27 ± 1.64 µg/mL and 140.37 ± 1.17 µg/mL respectively. The IC_{50} values of the same compounds on α-glucosidase were 119.25 ± 0.07 µg/mL, 141.25 ± 0.21 µg/mL and 224.45 ± 0.21 µg/mL respectively. IC_{50} values obtained for nano-particles showed statistically significant difference compared to others. In conclusion, cinnamon loaded nano-particles showed higher inhibitory activity on α-amylase and α-glucosidase than the aqueous extract and acarbose.

Keywords: Ceylon cinnamon, Diabetes, Nano-particles, Nutraceuticals

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Abstract No: BS-31

Morpho-molecular characterization of *Lasiodiplodia* and *Diaporthe* species infecting *Solanum melongena* L. (brinjal) in Gampaha district

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Solanum melongena L. (brinjal) is a vegetable belonging to the family *Solanaceae* and a popular commodity among consumers. Brinjal plants are infected by numerous fungal pathogens causing a wide range of diseases such as anthracnose by *Colletotrichum* sp., stem and leaf lesions by *Phomopsis vexans* (anamorph of *Diaporthe*), and early blight by *Alternaria solani* which significantly reduce the yield. The objective of this study was to isolate and identify the fungal pathogens associated with leaves of *S. melongena* in the Gampaha district. Necrotic or prematurely wilted leaves of *S. melongena* were collected and associated fungi were isolated onto PDA medium. Pathogenicity was confirmed by wounded and non-wounded inoculation of a seven-day old isolate onto healthy *S. melongena* leaves and the confirmed fungal pathogens were identified using their morphological, cultural characteristics and analysis of the internal transcribed spacer region (ITS1-5.8S-ITS2). Fifteen fungal isolates were isolated from necrotic leaves of *S. melongena*. Three fungal isolates (Isolates H32A, H32B and U11) were identified to be pathogenic on leaves of *S. melongena* based on the pathogenicity test. A necrotic leaf spot was initiated at the site of inoculation with isolates H32A and H32B in both wounded and non-wounded inoculations, which later developed into wilting and premature falling of the leaf. Leaf blight was observed with non-wounded inoculation of isolate U11. Morphological characters of isolates H32A and H32B were similar, with fluffy, blackish-grey, septate mycelia and dark brown oval shape spores with a septum in the middle. Both had similar growth rates of 2.25 cm/day. They were morphologically identified as *Lasiodiplodia* sp. Yellowish grey color pigmentation was observed in the isolate U11 which produced aseptate hyphae but could not be identified by its morphological characteristics. The nucleotide sequence of ITS region confirmed the morphological identification of isolates H32A (MT990527) and H32B (MT990528) as *Lasiodiplodia theobromae* with 99.81% sequence similarity to *L. theobromae* (IRNKB244) at NCBI database. Further, isolate U11 (MT990529) showed 99.82% sequence similarity with *Diaporthe eugeniae* (ASHM304) at NCBI database. *L. theobromae* is reported to cause fruit rot in brinjal, while *Diaporthe* sp. has caused stem and leaf lesions. *L. theobromae and D. eugeniae* were confirmed to be pathogenic on *S. melongena* L. (brinjal) plants in the Gampaha district and further studies will be conducted to develop an environmentally friendly strategy to manage above mentioned diseases.

Keywords: *Diaporthe, Lasiodiplodia, Solanum melongena*

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Abstract No: BS-32

Therapeutic potential of *Cinnamomum zeylanicum* Blum aqueous bark extract on doxorubicin induced cardiotoxicity in Wistar rats

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The effectiveness of doxorubicin as an anti-cancer agent is hampered by its' life-threatening cardiotoxicity induced by oxidative-stress. As *Cinnamomum zeylanicum* Blum has proven antioxidant activity, the objective of this study was to find out the therapeutic potential of aqueous *Cinnamomum* bark extract against cardiotoxicity induced by doxorubicin in Wistar rats. Sample size of the study group was determined and an equal number of male and female Wistar rats were randomly selected into five groups. Group 1: normal-control (distilled water for 14 days, normal saline (10 mL/kg) on 11th day); group 2: plant control (2.0 g/kg of freeze dried plant extract for 14 days, normal saline (10 mL/kg); group 3: doxorubicin control (distilled water for 14 days, doxorubicin (18 mg/kg) on 11th day); group 4: freeze dried plant extract (2.0 g/kg) for 14 days, doxorubicin (18 mg/kg) on 11th day; group 5: distilled water for 14 days, dexrazoxane (180 mg/kg) 0.5 h before doxorubicin (18 mg/kg). Animals were sacrificed on the 15th day, blood was drawn for biochemical analysis and heart tissues were collected for estimation of antioxidant parameters and histological assessment of tissue damage. A significant ($p < 0.05$) elevation in cardiac biomarkers including cardiac troponin I, AST, LDH and NT-proBNP activity were observed in doxorubicin-control group compared to the normal-control. Pretreatment with *Cinnamomum* bark extract in the doxorubicin treated rats showed a significant reduction ($p < 0.05$) in above cardiac biomarkers compared to the doxorubicin-control. A significant reduction ($p < 0.05$) in reduced glutathione, glutathione peroxidase and glutathione reductase was observed in the doxorubicin control group (Group 3) compared to the normal-control. Total antioxidant capacity as well as superoxide dismutase and catalase activity were markedly reduced ($p < 0.05$) in the doxorubicin control group. However, pretreatment with *Cinnamomum* extract was capable of significantly increasing ($p < 0.05$) all of the above antioxidant parameters compared to the rat group which was treated with doxorubicin alone. A significant increase ($p < 0.05$) in malondialdehyde concentration, which measures the lipid peroxidation and myeloperoxidase activity, which measures the extent of inflammation was observed in the doxorubicin-control compared to the normal-control. The plant-treated group showed a significant decrease ($p < 0.05$) in malondialdehyde concentration and myeloperoxidase activity compared to the doxorubicin-control. Histological assessment of tissue damage was scored according to a scale developed by the authors and doxorubicin-treated group showed a significant damage to the myocardium showing the highest score among the five groups. Plant-treated group showed only a minor degree of damage and showed a significant reduction in the score compared to the doxorubicin control. In conclusion, *C. zeylanicum* Blum bark extract has the potential to significantly reduce doxorubicin induced cardiotoxicity in Wistar rats.

Keywords:
Cardioprotectivity, Cardiotoxicity, *Cinnamomum zeylanicum* bark extract, Doxorubicin, Oxidative-stress

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Abstract No: BS-33

Diversity of Firmicutes in selected hot water springs of Sri Lanka by 16S metagenomic sequencing

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Thermophiles have the ability to survive in environments with very high temperatures. Hot springs provide unique natural environments for these thermophilic microorganisms. In recent years, hot water springs and thermophilic microorganisms have gained attention due to their industrial and biotechnological importance. Among the thermophilic bacteria, a large number of metabolites can be found in the phylum Firmicutes. Different species of Firmicutes show various ecological optima. Even though Sri Lanka harbors many hot springs, majority of them are not yet explored and require comprehensive studies to unravel the inhabitant microbial diversity, specially the phylum Firmicutes. This study was focused into uncovering the resident thermophilic Firmicutes which could be unculturable and their diversity in four major hot springs namely, Mahapelessa, Wahawa, Maha Oya and Nelumwewa using 16S rRNA metagenomic sequencing. Water samples were collected from the four hot springs in which the surface temperature ranged from 44.2 to 53.8 °C. Further, a water sample from a natural spring located in Digana (26.9 °C) was used as the control. Genomic DNA was extracted from the water samples using modified Boom's method and was subjected to 16S rRNA metagenomic sequencing (16S V3-V4 region) using Illumina platform. The results were analyzed using GAIA: Metagenomics data analysis software to identify Firmicute bacteria (Operational taxonomic units/ OTU) and to determine their relative abundance. OTU analysis was carried out with a cut-off similarity value at 97%. The relative abundance of Firmicutes in each spring is as follows: Mahapelessa (23.7%), Wahawa (0.8%), Maha Oya (0.9%), Nelumwewa (5.8%) and Digana natural spring (4.2%). The class Clostridia and Bacilli were the most abundant classes observed in hot springs. A total of twenty-one species were affiliated with the phylum Firmicutes, among which 18 species were only detected in hot water springs while the rest of the three species (*Clostridium* sp., *Flintibacter butyricus* and *Oscillibacter* sp.) were only detected in the natural spring. Nine different bacterial species were unique to Mahapelessa hot spring including; *Bacillus licheniformis* and *Bacillus thuringiensis* belonging to class Bacilli, *Caldanaerocella colombiensis, Desulfotomaculum reducens, Geosporobacter* sp., *Geosporobacter subterraneus, Pelotomaculum isophthalicicum, Salimesophilobacter vulgaris* and *Tepidibacter* sp. belonging to the class Clostridia. The two bacterial species; *Carboxydocella manganica* and *Faecalibacterium prausnitzii* were only recorded from Maha Oya while *Clostridium islandicum* was reported from Maha Oya and Nelumwewa hot springs. *Bacillus pumilus* and *Sporacetigenium mesophilum* were present in Mahapelessa and Wahawa hot springs. *Anaerosolibacter carboniphilus* was found in both Mahapelessa and Nelumwewa while *Anaerobacterium chartisolvens* was detected in all hot water springs except Wahawa. *Bacillus* sp. and *Paenibacillus* sp. were common in all the hot water springs. When compared to the natural spring, the four hot water springs showed high bacterial species diversity (85%). Results from this study confirm the uniqueness of bacterial species belonging to phylum Firmicutes in hot water springs than in the natural springs. More comprehensive studies on these Firmucutes are needed to identify their potential to be used in industrial and biotechnological applications.

Keywords: Hot springs, 16S metagenomics, Firmicutes

Abstract No: BS-34

Synthesis of C-11 and C-12 oxidized derivatives of3β-[(α-L-arabinopyranosyl)oxy]olean-12-en-28-oic acid and evaluation of their cytotoxic activity in human non-small cell lung cancer (NCI-H292) cells using Sulforhodamine B assay

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The most common cancer, lung cancer is the foremost reason for cancer deaths in both males and females throughout the world. The two major categories of lung cancer which propagate differently are Non-small cell lung cancer (NSCLC) and Small cell lung cancer (SCLC). Among those NSCLCs are the most prevalent lung cancers, contributing 80% of all lung cancers. Natural products represent the bedrock of drug discovery, providing novel scaffold structures that serve as a starting point for developing novel therapeutic agents. A number of new drugs with improved therapeutic potential have been obtained from natural sources, by functional group modifications or by the synthesis of new compounds, following lead natural compounds as models. The recurrence of cancer due to the drug resistance and undesirable side effects which have limited the use of anticancer drugs, have increased the demand for novel alternative therapeutics with enhanced pharmacological activity and fewer side effects. Hence, the synthesis of natural product derived compound libraries in the discovery of novel drugs is still a key aspect of cancer therapy. 3β-[(α-L-arabinopyranosyl)oxy]olean-12-en-28-oic acid (APOA) is a triterpenoid saponin with the oleanolic acid aglycone linked to arabinopyranose sugar moiety and can be easily isolated from endemic plant extracts of genus *Schumacheria*. This compound exerts potent cytotoxic and apoptotic potential in human NSCLC cells (NCI-H292) with an IC_{50} value of 5.977 μgmL^{-1} while exhibiting a comparable toxicity value (IC_{50} = 5.702 μgmL^{-1}) against normal lung (MRC-5) cells. The objective of this study was to synthesize oxidized structural analogues at C-11 and C-12 positions of the APOA and to evaluate their cytotoxic effect. Sulforhodamine B (SRB) assay is used to evaluate *in-vitro* cytotoxic efficacy of the synthesized analogues on NCI-H292 cells and MRC-5 cells. The methylene group at the C-11 and methine group at C-12 of the ethyl ester of acetylated APOA (Ee-Ac-APOA) was oxidized to afford respective ketones and followed by deacetylation of the afforded analogues resulted in the oxidized analogues with free sugar hydroxyls (Ee-APOA). Chemical structures of the synthesized analogues were confirmed with spectroscopic data and comparative cytotoxic effects of the synthesized analogues were assessed using SRB assay against APOA. GraphPad Prism 7.00 software was used for statistical analysis and the results indicated that the oxidized analogues of Ee-APOA exhibit higher cytotoxicity against NCI-H292 cells than the oxidized derivatives of Ee-Ac-APOA while exhibiting comparable toxicity values against normal lung (MRC-5) cells. However, the α, β-unsaturated derivative of Ee-Ac-APOA exhibited potent cytotoxic activity against NCI-H292 cells while being less toxic to normal MRC-5 cells compared to the parental saponin indicating better activity. These empirical data suggest that the oxidized compounds at C-11 and C-12 of APOA could be a lead to develop promising new anticancer agents.

Keywords: Non-small cell lung cancers, *Schumacheria*, Structural analogues, Oxidized derivatives, Sulforhodamine B assay.

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Abstract No: BS-35

Farmers' knowledge, perception, and practices on agrochemical usage in upper Uma Oya and Kumbukkan Oya watersheds in Sri Lanka

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Pesticides are widely used to reduce pre- and post-harvest losses in cultivations due to the pest infestations. A semi-structured questionnaire survey and key informant interviews were carried out to compare the patterns of pesticide usage, perception and knowledge of farmers in one of the main vegetables growing areas of upper Uma Oya and main field crop cultivated areas of upper Kumbukkan Oya watershed in Sri Lanka. The primary data were collected covering two main seasons (*Yala and Maha* of 2019/2020) in Uma Oya (n = 61) and Kumbukkan Oya (n = 65) watersheds. The cultivated major crops in Uma Oya watershed area are potato, bean, tomato and cabbage whereas rice, cowpea, and maize are grown in Kumbukkan Oya watershed. According to the results, active ingredients of 26 insecticides, 21 fungicides, 17 herbicides were used by farmers for their cultivations in both sampling areas. The most frequently used pesticides were insecticides (51.2%) followed by fungicides (45.8%) and herbicides (3.0%) in Uma Oya watershed while in Kumbukkan Oya watershed herbicides usage (44.4%) was followed by insecticides (36.0%) and fungicides (19.6%). More than 50% of farmers in Uma Oya watershed mainly used five insecticides namely Abamectin, Carbosulfan, Chlorantraniliprole 20% + Thiamethoxam 20%, Profenofos, three fungicides of Chlorothalonil, Mancozeb, Propineb and only three types of herbicides. More than 80% of the farmers in the Kumbukkan Oya watershed used to utilize herbicides of MCPA 600 g/l and MCPA 400 g/l as major pesticides. Most of these active ingredients used in this study were belong to the World Health Organization hazard classification class "U" which is unlikely to present an acute hazard. Highly used insecticides Abamectin, Carbosulfan, Profenofos MCPA 600 g/l and MCPA belongs to WHO hazard class II (moderately hazardous) chemicals while fungicide Chlorothalonil belongs to hazard class III (slightly hazardous) chemicals. There is no significant difference observed in mixing ($\chi 2 = 2.567$, $\alpha = 0.05$) and selecting the pesticides ($\chi 2 = 0.403$, $\alpha = 0.05$) in both regions. Nearly 67.5% of the respondents applied a mixture of different chemicals because they believe such mixtures save their time (20.6%) and unsure about the pesticide strength of controlling pests and diseases (34.2%). Farmers selected pesticides mainly based on the information provided by the pesticide retail shop owners or dealers (72.2%). Meanwhile, only 7.1% of farmers seek advice from agricultural instructors/extension officers on pest management decisions. Only 31.0% of respondents had training on the correct use of pesticides and such training were conducted by private sector organizations involved in pesticide marketing. Most of the farmers washed their pesticide sprayers in their field (62%) while 23% washed in the irrigation canal and 13% washed in nearby waterways. Eight percent of farmers carelessly disposed of the pesticide leftovers and containers in the open fields. The findings indicated pesticide application in the study areas represents a potential risk for the environment and farmers.

Keywords: *Environment pollution, Farmers' perceptions, Kumbukkan Oya watershed, Pesticides, Uma Oya Watershed*

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Abstract No: BS-36

Spatial and temporal variations of ground water quality in Kalpitiya peninsula

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Intensive agricultural practices in Kalpitiya have caused excessive usage of fertilizers. The sandy regosol soil and the over irrigation due to the presence of semi-arid climatic conditions in the area have led to nutrient leaching conditions in Kalpitiya. Since 1990s, the groundwater aquifers in Kalpitiya remain contaminated with higher levels of nitrate due to intensive agricultural practices and the current status of groundwater pollution remains poorly studied. Therefore, this study was conducted to evaluate the current status of groundwater pollution in Kalpitiya, with special emphasis on spatial and seasonal variations. Groundwater samples of 50 wells (potable and agricultural) located in five sentinel sites, namely Nawakkadu, Narakkalli, Thalavila, Kandakuli and Kalpitiya town were collected at monthly intervals from November 2018 to March 2020. In addition, the existing land use practices surrounding the respective wells were also recorded. Selected water quality parameters, namely pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), salinity, nitrate and phosphate concentrations were analyzed using standard methods. The General Linear Model (GLM) followed by Tukey's pairwise comparison was used for statistical analysis. Significant spatial variations ($p<0.05$) were observed among the study areas for all the water quality parameters, except for pH and phosphate concentration. The highest conductivity (1.96 ± 0.13 mS/cm), nitrate (59.27 ± 5.38 mg/L), salinity (0.95 ± 0.05%) and TDS (870.88 ± 50.78 mg/L) levels were recorded from groundwater samples collected from Nawakkadu. Meanwhile, Thalavila area denoted the lowest values. The highest pH and phosphate levels and the lowest conductivity, nitrate, salinity and TDS levels in groundwater were detected during the second inter monsoon period, followed by the North-East monsoon. The impact of seasonal variations in rainfall on ground water quality remained significant ($p < 0.05$) at 95% level of confidence. EC, nitrate, phosphate and TDS levels in groundwater samples of Nawakkadu, Narakkalli, and Kalpitiya town areas remained above the permissible levels for potable water quality given by the Central Environmental Authority (CEA). Therefore, adequate treatment of groundwater is recommended prior to use for drinking purposes.

Keywords: Groundwater pollution, Nitrate, Kalpitiya, Agriculture

Acknowledgment
This work was supported by the AHEAD DOR project and the Land based Water Pollution Project of Arthacharya Foundation.

Physical Sciences

Abstract No: PS-01

Identification of factors and classifying the accident severity in Colombo-Katunayake expressway, Sri Lanka using multinomial logistic regression

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Accidents are one of the main social problems in the World, which cause damages or injuries unintentionally and unexpectedly. This is a major issue affecting not only in developing countries like Sri Lanka but also in developed countries. Sri Lanka's expressway system was launched in 2011 and currently has three major expressways: Southern Expressway, Colombo-Katunayake Expressway and Outer-Circle Expressway. After the construction of expressways, many people opted for expressways based on time, traffic, ease of driving, etc., rather than ordinary roads. The number of accidents on expressways has been on the rise in recent years compared to the past. At present, the accident rate on the Colombo-Katunayake Expressway, which connects the Sri Lankan capital, Colombo with Bandaranaike International Airport, Katunayake and Negombo, is high compared to the other two expressways, but no research has been done to date regarding this. Therefore, the objective of the study was to identify the factors contributing to accidents on the Colombo-Katunayake Expressway and to develop an appropriate regression model to classify the severity of the accidents. In this study, 704 total accident cases of Colombo-Katunayake expressway were considered during the period from 2013 to 2019. Initially, Pearson Chi-square, Logistic regression and Kruskal–Wallis H tests were used to identify the association between the multinomial response variable (accident severity) and eleven predictor variables identified based on the literature. Finally, from selected predictor variables, seven variables: time category, driver's age category, vehicle type, reason for the accident, number of vehicles involved, cause for accident and rainfall were identified as influencing variables to accident severity under 5% level of significance. Since this is not a time series data, 80% of the data were selected in various ways for model building and the remaining 20% were used to test the performance of the built models. Considering significant variables identified above, Multinomial Logistic Regression (MLR) was trained using the stepwise enter method with different data selections criteria. The Random under-sampling technique was used to overcome the class imbalance problem that persists in the data set considered in the study and after selecting the best model, the adequacy of the model was examined and classified the severity of accidents in Colombo-Katunayake Expressway. The final MLR model predicts accident severity with an overall accuracy of 64.3% and rainfall, cause for accident and time category (it is a categorical variable that divides 24 hours into four equal parts) have been identified as the most influential factors affecting accidents on the Colombo-Katunayake Expressway. Furthermore, the final model depicts, with rainy weather, high speed, sleepiness, technical faults and reckless driving increased the likelihood of an accident on the Colombo-Katunayake Expressway, and [0-6] and [12-18] hours were identified as dangerous time categories. The final model developed by this study can be used to implement safety improvements against traffic accidents in expressways of Sri Lanka. As a future study, machine learning techniques can be employed to identify better models with higher classification accuracy.

Keywords: Classification, Class imbalance problem, Expressway, Random under-sampling, Road accident

Abstract No: PS-02

Use of Google Earth Engine to monitor surface water: A case study in water tanks located in the dry zone of Sri Lanka

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Water is a valuable and limited resource that needs to be managed properly. The amount of surface water changes over time due to a variety of reasons including rainfall, temperature, wind patterns and agricultural usage. Large scale surface water level monitoring is one of the most labour-intensive tasks in managing water resources. Satellite based remote sensing is a commonly used technique in such scenarios, where earth orbiting satellites are used to monitor the changes on the earth's surface using different types of sensors. A large amount of remote sensed data sets has been made available by different agencies. However, analysis of such data sets requires specialized computing systems with large storage, memory and processing power. With the public release of Landsat data in 2008, Google archived all the data sets and linked them to a cloud computing engine named, Google Earth Engine (GEE) providing a free and open source platform which handles all low-level data handling, allowing users to manipulate the data set at a much higher level. In the present study, GEE was used to evaluate the feasibility of surface water monitoring in water tanks located in the dry zone of Sri Lanka from January 2017 to December 2019. Sentinel-1 (S1), Synthetic-Aperture Radar (SAR) data and Sentinel-2 (S2) Multi-spectral Instruments were used to identify the surface water body coverage area. Normalized water index (NDWI) was calculated based on the B3 and B8 bands of S2 images. Due to significant local cloud coverage within the region of interest, most of the available data points had to be discarded. It was noted that NDWI based water level estimation was not suitable for analyzing temporal dynamics. S1-SAR Ground Range Detected (GRD) data was processed by segmenting the area using a K-means clustering algorithm. Image dilation and erosion operations were used to reduce the effect of speckle noise. The water level was estimated for the considered time period based on individually segmented images. Ground data was obtained, which corresponds to the satellite passes that were published online by the Department of Irrigation, Sri Lanka. The estimated water surface area for Kaudulla, Senanayaka Samudraya and Lunugamwehera tanks showed a good linear relationship against the reported water volume with coefficient of determinants of 0.73, 0.94 and 0.67 respectively. SAR-GRD measures backscatter and it depends on the surface flatness. Therefore, water quality or cloud cover has no effect on the detected water surface area estimation. Hence, SAR-GRD image-based classification is better suited to detect short time scale changes in water level in selected tanks even under uncooperative weather.

Keywords: Google Earth Engine, GEE, Sentinel-1, SAR-GRD, Surface water

Abstract No: PS-03

Enhancement of photovoltaic performance of Cu_2O homojunction by introducing a ZnO buffer layer

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Cuprous oxide (Cu_2O) is a semiconductor material having the capability of producing a theoretical conversion efficiency of 20% which is acceptable for solar energy applications. In this investigation, we have explored the possibility of improving open circuit voltage (V_{oc}) of Cu_2O homojunctions by introducing a ZnO buffer layer in between n- and p-Cu_2O layers. The thin buffer layer may be able to develop an additional potential drop across the interface improving V_{oc} without hindering short-circuit current density (J_{sc}). In this investigation, n-Cu_2O thin films were electrodeposited on Ti substrates at -200 mV vs Ag/AgCl for 30 minutes in an acetate bath. Samples were then annealed at 175 ^oC for 30 min in air. ZnO thin film was deposited on Ti/n-Cu_2O film by employing Successive Ionic Layer Adsorption Reaction (SILAR) technique using 0.1 M $Zn(NH_3)_4^{2+}$ aqueous solution. Resulted samples were annealed at 175 ^oC for 10 minutes. p-Cu_2O thin film was electrodeposited on Ti/n-Cu_2O/ZnO electrode at -450 mV vs. Ag/AgCl for 45 minutes in a lactate bath. Surface of p-Cu_2O was exposed to ammonium sulphide vapor in order to prepare an ultra-thin Cu_2S layer. Finally, 2x2 mm^2 Au spots were sputtered on the coper sulphide layer. A set of Ti/n-Cu_2O/ZnO/p-Cu_2O/Au devices having different thicknesses of ZnO layers was prepared by changing the number of successive adsorption cycles and characterized them by using dark and light current voltage measurements. Dark and light current voltage characteristics revealed that the device fabricated using 3 cycled ZnO layer produces the best photoactive performance. Without the buffer layer, the device produced V_{oc} of 384 mV and J_{sc} of 8.1 $mAcm^{-2}$, under AM 1.5 illumination. With the ZnO buffer layer the device V_{oc} improved up to 416 mV and J_{sc} up to 9.1 $mAcm^{-2}$. Our results revealed the possibility of improving both V_{oc} and J_{sc} of the Cu_2O homojunction by introducing a ZnO buffer layer.

Keywords: Buffer Layer, Cu_2O, Electrodeposition**,** Homojunction, ZnO

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Abstract No: PS-04

An investigation of the variation of shear strength of soil with its moisture content

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The mechanical behavior of soil is highly dependent on its shear strength. Cohesion and internal friction angle and effective stress of soil are important factors of soil shear strength. The key objective of this study was to establish a relation between the shear strength of unsaturated soil and its moisture content. In the current study, different types of soil such as red gravel soil, mud from a paddy field, sand, soil from rubber cultivation, home garden soil and soil from an ant-hill type in Sri Lanka were used as the raw material. Before the shear strength measurement, the selected soil sample should be well dried and free from impurities. The apparatus set up was designed to measure the limiting friction force of the soil sample with the varying moisture content while maintaining a constant density in all the raw soil samples. In the present study, limiting friction force acts as the shear force of the particular soil sample. Shear stress was calculated by dividing the shear force by the contact surface area of the soil. According to soil mechanics, shear strength is the magnitude of shear stress that soil can sustain. The obtained results reveal that the moisture content has a great influence on the shear strength. The shear strength started to increase gradually relative to the increasing water content. At a specific point, the shear strength reached a peak level, beyond which it started to decrease gradually with the increase of water content. The characteristic curves of shear strength against the moisture content displayed some changing aspects according to the soil type. According to the results, the maximum shear strength was observed in the soil from the rubber cultivation and the minimum was observed in the sand sample. The maximum shear strength of the soil varied in the range $(2.421 \pm 0.006 - 8.500 \pm 0.266) \times 10^2\ \mathrm{Nm}^{-2}$. The highest value of the optimum moisture content was observed in red gravel soil while lower values of the optimum moisture contents were observed in soil from an ant-hill, mud from a paddy field, and sand. The optimum moisture content of the soil varied in the range (7-30) g. High soil moisture content is the main cause of landslides. The results of the present study can be used to get an idea about the specific moisture content which could cause a landslide. In this study, a direct comparison of maximum shear strengths of six different soil types in Sri Lanka was made and the relevant results could be useful in making predictions about the landslides that occur due to heavy rain. However, geotechnical engineers have to consider factors like geological composition, surface drainage, groundwater content, in addition the shear strength of soils in assessing the stability of hill-type lands.

Keywords: Moisture content, Shear strength, Soil

Abstract No: PS-05

Effect of film thickness on characteristic properties of thermally evaporated cadmium sulphide thin films

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Cadmium sulphide (CdS) thin films are regarded as one of the most promising materials for heterojunction solar cells. Due to its wide bandgap (~ 2.42 eV), CdS thin films have been used as the window material together with several semiconductors such as InP, CdTe, Cu_2S, and $CuInSe_2$. For the future development of photonic devices based on above materials comprehensive studies on CdS window layer throughout all aspects such as deposition technique, temperature, duration, and post-heat treatments, etc. are highly required. In this study, CdS thin films were deposited on the cleaned FTO glass substrates using vacuum thermal evaporation technique by varying the deposition duration to have different layer thicknesses. The temperature of the substrates and the chamber pressure were maintained at 175 °C and 2×10^{-5} torr respectively. The deposition was carried out using CdS powder (*Sigma-Aldrich*, 99.995%) containing in an alumina boat. Deposited samples were then annealed in vacuum (pressure 3×10^{-5} torr) at 300 °C for 30 minutes. The bandgap and optical transmittance of the deposited thin films were studied using UV-Visible spectrophotometry. The surface topology analysis of the deposited thin films was carried out using Atomic Force Microscopy (AFM). A photoelectrochemical cell of (CdS/0.1 mol L^{-1} $Na_2S_2O_3$/Pt) was used to investigate electrical properties such as short circuit current (J_{SC}), open circuit voltage (V_{OC}), carrier concentration, and majority carrier type of the semiconductor with the aid of I-V measurements and Mott–Schottky measurements. The structural and crystal properties such as preferred orientation, phase distribution, crystallite size, microstrain, and lattice parameters were studied by employing the grazing incident X-ray diffraction. The calculations were done using the profile fit, Rietveld refinement, and Pawley refinement techniques. All the results revealed that there exists a correlation between the film thickness and the above-considered properties of the CdS thin film. The highest bandgap of 2.43 eV and optimum J_{SC} and V_{OC} of 113 μA/cm^3 and 341 mV respectively were observed for the photoelectrochemical cell made by 210 nm thick CdS thin film.

Keywords: Cadmium sulphide, Film thickness, GIXRD, Thermal evaporation

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Abstract No: PS-06

Effect of thermal annealing of CBD-CdS on the electrical properties of CBD-CdS/ED-CdTe solar cell

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Thermal annealing is one of the key steps to enhance the optoelectronic properties of the CdS/CdTe solar cells. In this study, the effects of annealing temperature and annealing time of chemical bath deposited (CBD) CdS on the electrical properties of CBD-CdS/electrodeposited (ED) CdTe solar cells were investigated. CBD-CdS layers were prepared using pre-optimized deposition conditions (90 ℃, 55 min) on fluorine doped tin oxide (FTO) glass substrates utilizing a bath consisted of 0.033 mol/L $Cd(CH_3COO)_2$, 0.667 mol/L $CS(NH_2)_2$ as cadmium and sulfur precursors, respectively and therein, 1 mol/L $CH_3CO_2NH_4$ and 0.735 mol/L NH_4OH were used for pH adjustment. Thereafter, a set of CBD-CdS samples prepared was annealed at different temperatures (350, 375 and 400 ℃) by varying the annealing time (10, 20, 30, and 40 min). Consequently, CdTe thin films were electrodeposited on annealed CBD-CdS substrates using an ED-bath consisted of 1.0 mol/L $CdSO_4$ and 1.0 mmol/L TeO_2 at pH of 2.3, temperature of 65 ℃, and potential of -650 mV against a saturated calomel electrode. The prepared glass/FTO/CBD-CdS/ED-CdTe samples were air annealed (400 ℃, 20 min) and Cu/Au back contacts were deposited using thermal evaporation technique.

The electrical properties of the CBD-CdS samples were investigated by photo-electrochemical cell (PEC) study at the CBD-CdS/electrolyte junction. As per the PEC analysis, CBD-CdS sample annealed at 375 ℃, 30 min has shown the highest short circuit current density (J_{sc}) of 21.5 μA/cm^2, while the sample annealed at 400 ℃, 10 min shown the highest open circuit voltage (V_{oc}) of 499 mV. The electrical properties of the CBD-CdS/ED-CdTe/Cu/Au devices were investigated under AM 1.5 light source and therein, CBD-CdS sample annealed at 375 ℃, 30 min scored the highest J_{sc} (14.12 mA/cm^2) and the one annealed at 400 ℃, 10 min displayed the highest V_{oc} (616 mV). Also, the device annealed at 375 ℃, 30 min showed the lowest series resistance (205 Ω) while the one annealed at 400 ℃, 10 min demonstrated the highest shunt resistance (1401 Ω). Accordingly, the 375 ℃, 30 min and 400 ℃, 10 min were found to be the effective conditions for annealing CBD-CdS that can result in materials with better electrical properties for CBD-CdS/ED-CdTe/Cu/Au device fabrication.

Keywords: Chemical bath deposition, Electrodeposition, Thermal annealing, CdS/CdTe solar cell

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Abstract No: PS-07

Time series models to forecast number of registered cars in Sri Lanka

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Even though Sri Lanka is a developing country, the automobile industry of Sri Lanka displays rapid growth recently. The Department of Motor Traffic reports indicates that the number of vehicle registrations has been steadily increasing. Therefore, the analysis of car registrations is crucial for the economic development and legislation process of Sri Lanka. This study aims to predict the total number of registered cars and to predict the number of registered cars by categories i.e. brand new, reconditioned and locally manufactured. Time series analysis enables forecasting the number of registered cars based on the past car registration patterns and comparing them with current trends. This study uses the number of registered reconditioned, brand-new, and local cars from January 2008 to December 2018 and attempts to create better forecasts using Box-Jenkins time series models and Holt's double exponential smoothing technique. Furthermore, this study plan to test if one level, the bottom-up approach of hierarchical forecasting (number of total registered cars as the sum of registered reconditioned, brand-new and local cars) outperforms forecasting number of registered total cars as a whole. Firstly, 90% of the data was considered as the training set for the analysis, and the remaining 10% of the data was considered as the testing set. To accurately model the high volatility of data, generalized autoregressive conditional heteroscedasticity (GARCH) and exponential generalized autoregressive conditional heteroscedasticity (EGARCH) models were used. The Moving Average (MA)(1)+GARCH(1,1) model was fitted to predict reconditioned car registration data. The Autoregressive Integrated Moving Average (ARIMA)(4,1,7)+EARCH(1,1) model was fitted to brand-new car registration data. The ARIMA(1,1,7)+GARCH(1,1) model was fitted to analyze local car registrations over time. Finally, MA(1)+ autoregressive conditional heteroscedasticity (ARCH)(1) model was fitted to extrapolate total car registration data. The mean absolute percentage error (MAPE) was used as the accuracy measure since it does not depend on the scale. Hence, the model which gives the minimum MAPE was selected to forecast the number of registered cars. The fitted models indicate satisfactory forecast results, which are 13% in MAPE for reconditioned car registrations using Holt's double exponential technique, 18% in MAPE for brand new car registrations using ARIMA(4,1,7) + EGARCH(1,1) hybrid model, and 19% in MAPE for local car registrations using Holt's double exponential technique. The total number of car registration is predicted using the one level hierarchical forecasting technique with 13% in MAPE. Concerning the findings, the number of registered cars highly fluctuated over the period. Besides, ARIMA is not adequate to capture the volatility, and the hierarchical forecasting technique is better to forecast total car registration data other than forecast it as a whole. This study predicted the number of registered cars considering different car categories and comparing time series models with smoothing techniques. Moreover, novel methods such as EGARCH and hierarchical approach were used to make more accurate predictions. This study's major limitation is irregular variations due to the influence of external factors that could be addressed in future research.

Keywords: ARCH, GARCH, Time series forecasting model, Hierarchical forecasting, Holt's double exponential smoothing

Abstract No: PS-08

Reduction of experimental error in coconut research by choosing proper data analysis techniques

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Accurate data analysis techniques are essential in field experiments to correctly understand the influence of independent variables on the dependent variable/s. This study compares different statistical techniques used in analyzing longitudinal data (nut yield data collected in multiple years) of a coconut field experiment. Longitudinal studies are necessary for coconut research due to its perennial nature. However, these experiments often have high variability due to the heterogeneity nature of coconut palms, where individual palms display inconsistent temporal behaviour. High variation among the individuals in similarly treated plots makes treatment mean sensitive to those fluctuations ultimately masking the true treatment effect. Even careful planning of the experiment cannot ensure the total elimination of this component. The study highlights the ways in which how this unaccountable variability should be handled to obtain a precise research output. There are many types of statistical techniques used in analyzing data from different experimental designs to achieve optimal research outcomes. This study compares different statistical techniques applied to a randomized complete block design (RCBD), the most frequently used experimental design in coconut research, using a long term coconut fertilizer study. The example illustrates the appropriate types of analyses to meet the precise analysis output by evaluating the model residuals and the Coefficient of Variations (CV). CV, the ratio of the standard deviation to the mean (total average of the design), is a measure of relative variability. In particular ANOVA, Mean Square Error of ANOVA can be used as the standard deviation of the design because Standard Error (SE) of a statistic (usually an estimate of a parameter) represents the standard deviation of its sampling distribution. In this study, Repeated Measures Analysis of Variance (RMANOVA) was used as the classical method. Improved methods used were Linear mixed model and Multivariate Analysis of Variance(MANOVA) with two principal components (representing ≥ 78% variation of the data) as dependent variables. Adequacy of all methods was accepted after checking normality with the Shapiro-Wilk test, homogeneity of variance with Levene's test, and independence of residuals with the Box-Pierce test. CV resulted from RMANOVA applied on RCBD was 39.2%, while it was 16.51% from the Liner mixed model. The lowest CV (10.04%) resulted from MANOVA with two principal components indicates that it can be more efficiently used to analyze long term experiments of coconuts. The consistency of the results should be studied further with a few more similar kinds of data sets. In addition to the above statistical analysis techniques, Bayesian inference methods will be studied for further improvements in the results.

Keywords: Coefficient of Variance, Mean Square Error, Randomized Complete Block Design, Repeated Measures Analysis of Variance

Abstract No: PS-09

Time series analysis and forecasting of sector-wise electricity production and consumption in Sri Lanka

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Electricity is one of the main power sources all over the world. Electricity can be defined as Sri Lanka's' primary breath since disparities of electricity mainly impact on country's socio and economic well-being. Therefore, it is essential to understand the electricity consumption patterns and the future capacity of electricity production for decision-making purposes. One of the study's key objectives is to estimate the appropriate model for defining and forecasting the sector-specific electricity production in Sri Lanka using an efficient and reiterative methodology based on the univariate and multivariate time series modelling approach. The other objective is to define the interrelationships between the production and consumption sectors individually. The electricity production in Sri Lanka has a national grid-primarily powered by hydropower, thermal heat, and wind power. The demand for electricity in Sri Lanka mainly depends on the activities of domestic, industrial, commercial sectors, and religious purposes. The proposed methodology was successfully applied to the monthly data related to the sector-wise electricity production and consumption (Units in GWh) in Sri Lanka over the past eighteen years from the year 2000 to 2018. Electricity production sectors were modelled by using both univariate and multivariate time series applications. Electricity consumption was modelled by using a multivariate time series approach. In the univariate approach, the Autoregressive Integrated Moving Average (0,1,4)(ARIMA(0,1,4)) model was proposed for the hydroelectricity production with Mean Absolute Percentage Error(MAPE) 17.59%, ARIMA(0,1,3)(0,0,2)(12)+ GARCH(1,1) model was fitted for the Thermal heat sector with MAPE 11.98% and the ARIMA(2,0,0)(1,1,1) model was fitted for the wind power sector with 17% of MAPE. According to these univariate analysis results, it can be concluded that there are seasonal patterns in thermal heat and wind power electricity production sectors. In this study, the existence of the correlation and cointegration of variables considered under the sectors of electricity production and consumption lead to consider a Vector Error Correction Model (VECM). The multivariate analysis shows evidence of the existence of the short term and long-term relationship between electricity production and consumption sectors separately.

Keywords: Electricity production, Electricity consumption, Univariate & Multivariate Time Series

Abstract No: PS-10

Implementation of a wireless distributed node-based system for monitoring, controlling and data logging of a Parabolic Trough Concentrator

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Solar thermal energy harnessing through a Parabolic Trough Concentrator (PTC) type plant is the most efficient and cheapest technique in the field of renewable energy harnessing. Near real time performance monitoring and frequent maintenance of such plants should be done in order to maintain a consistent thermal output from the system. Typically, the temperature of a well-focused Heat Collecting Element (HCE) of a PTC exceeds 300 ℃ during peak operation. It is necessary to have an unmanned data acquisition system due to physical limitations in accessing the HCE and measuring the HCE temperatures. This also reduces the downtime and increases the efficiency of the monitoring and management process. The objective of this study was to develop a wireless distributed node-based controlling and monitoring system to monitor the status of a medium scale PTC, based on Wi-Fi enabled IoT devices. The system was designed as distributed nodes and a custom firmware was developed in order to handle data transmission using Message Queuing Telemetry Transport (MQTT). For long-term storage and redundancy, the collected data was uploaded to a cloud storage. Automated error and status reporting features were also implemented. The system was built using five low power wireless nodes. The temperature node was specially designed to measure the temperature profile across the focal plane to optimize the performance of the PTC. Twenty K-type calibrated thermocouples were used as the sensor. The trough angle was also measured using a MPU 6050 accelerometer. The tracking node was developed to use the current trough angle to move the trough according to the calculated solar angle using the Sun Position Algorithm developed by the National Renewable Energy Laboratory, USA. Ambient temperature, relative humidity and solar irradiance measurement were logged along with the temperature measurements. The average response time of the temperature, weather and trough-angle nodes were observed to be 7.10s, 150ms and 30ms respectively. The slow response of the temperature monitoring node was due to the switching of 20 thermocouples. The average power consumption of a node was found to be 0.42 W during the data transmission and 0.14 W when the system is idling. This system can be upscaled and adapted to similar data acquisition tasks involving spatially distributed applications.

Keywords: IoT, Wireless, Energy harnessing, Node-based, Control systems

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Abstract No: PS-11

Performance investigation of Perovskite/CIGS tandem solar cell using numerical modelling and simulation

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In the modern world, multi-billion projects are going on researching photovoltaic (PV) devices. Considering the global energy demand the contribution of solar power is still negligible. Therefore, researchers are working on finding new solutions to enhance the performances of these PV devices. With the approach of the multi junctional PV devices, researchers identified a clear path to reach Shockley & Queisser's detailed balanced limit. This research was focused on modelling a tandem cell structure with perovskite and CIGS materials to obtain the best efficient device with enhanced performance. Therefore, a two-terminal tandem structure was modelled computationally. The SCAPS-1D (one-dimensional solar cell capacitance simulator) software was used for the modelling and simulations. The top cell configuration was modelled with SnO2, PCBM, CH3NH3PbI3 and PEDOT: PSS materials and the bottom cell with ZnO, CdS and CIGS materials. The higher energy bandgap materials were used in the top cell to absorb the high energies from the AM1.5G spectrum. The energies penetrating through the top cell are absorbed by the bottom cell. Therefore, low energy bandgap materials were used for the bottom cell absorber. In the simulation procedure, a SCAPS script was used to analyze partial absorptions of the top cell. Additionally, a homojunction was created at the bottom cell CdS/CIGS interface according to previous studies. This process created an SDL (surface defect layer). The defect densities of the two interfaces; CdS/SDL and SDL/CIGS were altered to analyze the possible outcomes. According to the results, 30.946% efficiency was observed for the tandem device with 1.816 V open-circuit voltage and 20.863 mA/cm2 short circuit current. According to the defect density alteration of the interfaces, the defects at the SDL/CIGS interface showed high influence compared to CdS/SDL. With the results of JV characteristic curves and quantum efficiency curves, the current matching condition and the peak efficiency have appeared at the same condition. Therefore, the results adhere to the basic operation of the tandem configuration. By concerning the interface defect densities, it can be concluded that the changing defect densities at SDL/CIGS interface change the direction of the carriers, which causes the efficiency decrement. In numerical modelling, many assumptions were used, and the fabrication of the model is recommended to observe the practical situation.

Keywords: CIGS, Optimization, Perovskite, SDL, SCAPS, Tandem

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Abstract No: PS-12

A numerical simulation of the effect of the surface defect layer (SDL) properties on 3D/2D perovskite solar cell performance

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Organic-inorganic hybrid perovskites have become one of the promising solar cell materials in photovoltaic because of their low cost and excellent performance. In this study, we have modelled a hybrid organic-inorganic perovskite thin-film solar cell having p-i-n structure, with intrinsic layers of 3D methylammonium lead iodide ($CH_3NH_3PbI_3$) (MAPI) and 2D monolayers of $CH_3NH_3PbI_3$. The 2D layer is mainly used to improve the stability of the 3D $CH_3NH_3PbI_3$ layer. The p-type layer is an organic hole transporting material (HTM) called Poly (3,4-ethylenedioxythiophene) polystyrene sulfonate (PEDOT:PSS). The material fullerene derivative (6,6)-phenyl-C61-butyric acid methyl ester (PCBM) is used as an organic electron transporting material (ETM) and this is the n-type layer. This numerical simulation study of a 3D/2D hybrid perovskite solar cell model has been carried out by using Solar Cell Capacitance Simulator (SCAPS-1D). In this study, we have intentionally included the surface defect layer (SDL), which is p-type, in between 3D-MAPI and 2D-MAPI layers to improve the performance of the 3D/2D perovskite-based thin-film solar cell model. The effect of the surface defect layer (SDL) is analyzed by changing the thickness, bandgap, and neutral defect density. According to the simulation results, the optimum thickness of SDL is in the range of 160-170 nm with the optimum SDL bandgap of 1.4 eV, has shown higher power conversion efficiency of the cell model. The neutral defect density of the SDL has been changed to identify the effect on the power conversion efficiency of the solar cell. We have also identified that the neutral defect density of the SDL should be kept less than 10^{13} cm^{-3} to get better performance. According to the results, we have observed the improvement of the solar cell efficiency of the cell structure, p-PEDOT:PSS/i-3D-MAPI/p-SDL/i-2D-MAPI/n-PCBM/Ag, with the efficiency of 21.41%, open-circuit voltage (V_{OC}) of 1.1034 V, short-circuit current density (J_{SC}) of 25.59 mA/cm^2, and fill factor (FF) of 75.80%. This 3D/2D perovskite solar cell structure with SDL has shown good power conversion efficiency than that of the cell model that does not contain SDL, which is 19.65%. We have numerically simulated that the SDL can improve the efficiency and the performance of the cell model.

Keywords: Defect density, Perovskite-based solar cell, Power conversion efficiency, Surface defect layer (SDL), Thin-films

Acknowledgment
This work was supported by the Ministry of Science Technology and Research under the research grant MSTR/TRD/AGR/03/02/15.

Abstract No: PS-13

Prime labeling of scorpion graphs

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The concept of prime labeling was introduced by Roger Entringer. Around 1980, he conjectured that all trees have prime labeling which has not been proved yet. In 2011, The Entringer's conjecture for trees of sufficiently large order was proved by Haxell, Pikhurko, and Taraz. A graph $G = (V(G), E(G))$ with $|V(G)|$ vertices is said to have prime labeling, if there exists a bijection mapping $f: V(G) \to \{1,2,3, \dots, |V(G)|\}$ such that for each edge $e = uv$ in $E(G)$, $f(u)$ and $f(v)$ are relatively prime, where $V(G)$ and $E(G)$ are the vertex set and the edge set of G respectively. Two integers are said to be relatively prime, if their greatest common divisor is 1. Graph G which admits prime labeling is called a prime graph. Much work has been done on various types of prime labeling problems including the shape of some insects and small animals, such as caterpillar, spider, cockroach, snake, etc. In the present work, we focus on prime labeling of a special type of a simple undirected finite graph called scorpion graph, denoted by $S_{(2p,2q,r)}$. Scorpion graph gets its name from its shape, which resembles a scorpion, having $2p + 2q + r$ vertices ($p \geq 1, q \geq 2, r \geq 2$) which are placed in head, body, and tail respectively. If P_n denotes the path on n vertices, then the Cartesian product $P_n \times P_m$, where $n \geq m$, is called a grid graph. If $m = 2$, then the graph is called a ladder graph. To prove that the scorpion graphs have prime labeling, we used two results that have already been proved for ladder graphs. Those results are: if $n + 1$ is prime, then $P_n \times P_2$ has a prime labeling and if $2n + 1$ is prime, then $P_n \times P_2$ has a consecutive cyclic prime labeling with the value 1 assigned to the vertex v_1. In our work, we prove Scorpion graph is prime when $n + 1$ and $2n + 1$ are prime. As a future work, we are planning to generalize results for scorpion graphs with walking legs.

Keywords: Ladder graph, Prime labeling, Prime graphs, Scorpion graph

Abstract No: PS-14

Comparison of the properties of CZTS semiconductor films grown by sequential and single step electrodeposition techniques

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Cu_2ZnSnS_4 (CZTS) is a promising semiconductor material suitable for application in low-cost and environmentally friendly thin film solar cells due to its superior optoelectronics properties. It is a perfect absorber material due to its high absorption coefficient ($>10^{-4}$ cm^{-1}) and direct optical bandgap (1.4-1.5 eV). Among the CZTS preparation techniques, electrodeposition is an attractive technique because of its simplicity, low cost and easy process controlling capability. In this investigation, a comparative study on CZTS films grown by two different techniques, namely, sequential electrodeposition and single step electrodeposition, has been carried out. Electrodeposition of Cu, Sn and Zn stack layers followed by sulphurisation with H_2S is one of CZTS growth techniques. In this study, growth parameters of sequentially electrodeposited CZTS were optimized to obtain best photoactive CZTS thin films. Electrodeposition parameters of Cu, Sn and Zn have been obtained using voltammograms. Cu thin film was electrodeposited on Mo substrate at –0.89 V vs Ag/AgCl in an electrochemical cell containing 0.4 M $CuSO_4$, 3 M lactic acid and NaOH at pH 11. Deposition of Sn thin film on Mo/Cu electrodes was carried out at -1.2 V vs Ag/AgCl in an electrochemical cell containing 0.055 M, 2.25 M NaOH and 8 ml of sorbitol. Zn thin film was electrodeposited on Mo/Cu/Sn at -1.2 V vs Ag/AgCl in an electrochemical cell containing 0.2 M $ZnSO_4$. In order to grow CZTS, Mo/Cu/Sn/Zn thin films were annealed at 550 ^oC for 60 min in H_2S. In the single step electrodeposition, CZTS thin films on Mo substrate were potentiostatically electrodeposited at -1.05 V vs Ag/AgCl for 40 min in a three electrode electrochemical cell containing 0.02 M copper (II) sulfate pentahydrate ($CuSO_4 \cdot 5H_2O$), 0.01 M zinc sulfate heptahydrate ($ZnSO_4 \cdot 7H_2O$), 0.02 M tin sulfate ($SnSO_4$) and 0.02 M sodium thiosulfate ($Na_2S_2O_3$) at room temperature. 0.2 M tri-sodium citrate ($C_6H_5Na_3O_7$) was used as the complexing agent and tartaric acid ($C_4H_6O_6$) was used as the pH control solution. The pH of the bath was maintained at 5. The Ag/AgCl and platinum electrodes were used as the reference and the counter electrodes respectively. Then samples prepared were annealed at 550 ^oC for 30 min in H_2S. CZTS films grown by two techniques were characterized using X-ray diffraction, reflectance, dark and light I-V, spectral response and C-V measurements in a PEC containing 0.1 M sodium acetate. Reflectance measurements reveal that the band gap energy of the films is 1.45 eV and I-V and spectral response measurements reveal that CZTS thin films were photoactive and p-type. The results obtained revealed that high quality photoactive CZTS can be prepared using both techniques. However, I-V and spectral response characteristics revealed that photoactive properties of CZTS thin films prepared by single step electrodeposition technique are superior in comparison to sequentially electrodeposited thin films.

Keywords: Cu_2ZnSnS_4, Cu/Sn/Zn metal stack layers**,** I-V characteristics, Single step electrodeposition

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Abstract No: PS-15

Fabrication of inverted polymer based organic solar cells on stainless steel substrate

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In the past years, polymer based organic solar cells (OSCs) have become a widely researched topic as a potential candidate for producing clean and renewable energy due to their lightweight, high mechanical flexibility, and large-area processability. As an alternative for the conventional device structure, in this study, OSC devices with an inverted structure were fabricated and characterized under the top illumination. Regioregular poly (3-hexylthiophene) (P3HT) and phenyl-C61-butyric acid methyl ester (PCBM) were used as the electron donor and electron acceptor material respectively for the device fabrication with structure of SS/P3HT:PCBM/PEDOT:PSS/Au. On pre-cleaned stainless steel (SS) substrates, bulk heterojunction polymer blend was spin coated from chlorobenzene solution (20 mg/mL) with a 1:1 weight ratio of P3HT: PCBM and then it was thermally annealed. As a hole-transport-layer (HTL), a thin film of poly (3,4-ethylenedioxythiophene) polystyrene sulfonate (PEDOT:PSS) doped with ethylene glycol (10 wt.%) was blade coated on the active layer and the stack was annealed at 120ºC for 10 minutes. As the top contact of the device, gold (Au) was sputter coated. Performances of the fabricated OSC devices were optimized by varying several discrete parameters including the spin rate of the active layer formation, annealing temperature and the annealing time of the active layer. The optimum conditions for the device fabrication with the best performance were at the spin rate of 3000 rev./min for the active layer formation whereas optimum annealing temperature and annealing time were 160ºC and 60 minutes, respectively. The best device produced had an open-circuit voltage (V_{oc}) of 238 mV and a short-circuit current density (J_{sc}) of 4.36 $mAcm^{-2}$. A maximum power conversion efficiency (PCE) of 0.02% with a fill factor (FF) of 23.16% was obtained under 1 sun illumination (AM 1.5G, 1000 Wm^{-2}). The spectral response measurements of the fabricated cell indicate that it absorbs photons with energy higher than 1.77 eV to generate electron-hole pairs. It is planned to fabricate a thin film of Zinc Oxide (ZnO) as a potential electron transport layer (ETL) on SS substrate to improve the FF and PCE of the device.

Keywords: Inverted structure, Organic solar cells, P3HT:PCBM, Stainless steel substrate, Top illumination

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Abstract No: PS-16

Effects of ZnO on inverted P3HT:PCBM bulk heterojunction solar cells

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Low cost, low environmental impact, ease of mass production and many more promising attributes of Organic Solar Cells (OSCs) have inspired researchers to investigate OCSs for increasing their performance and stability in a constant phase. Moreover, in the recent years, OSCs with inverted structures have gained more attention compared to the conventional configuration of the device.

In this study, Indium Tin Oxide (ITO) -free inverted OSC devices were fabricated on polished Stainless Steel (SS) substrates with top illumination in order to have the device structure of SS/ZnO/P3HT:PCBM/PEDOT:PSS/Au. A thin film of Zinc Oxide (ZnO) layer was deposited on SS substrates from a solution of Zinc Acetate Dihydrate ($ZnC_4H_6O_4 \cdot 2H_2O$) using spin coating technique. The active layer was spin-coated from a bulk heterojunction polymer blend of regioregular Poly(3-hexylthiophene) (P3HT) and Phenyl-C61-butyric acid methyl ester (PCBM) on the prepared ZnO layer. On the top of the active layer, Ethylene glycol doped poly(3,4-ethylenedioxythiophene) polystyrene sulfonate (PEDOT:PSS) was blade coated as the hole transport layer. Then the stack was annealed before Gold (Au) was sputter coated to make the top contact.

The device performance was optimized by varying a number of parameters including the concentration of $ZnC_4H_6O_4 \cdot 2H_2O$ solution, thickness of the ZnO layer, annealing temperature, annealing time, composition of the polymer blend and dopant material of PEDOT:PSS dispersion. Open circuit voltage (V_{oc}) and short circuit current (J_{sc}) of the devices increased after applying ZnO layer. The thermal annealing improved the fill factor (FF) of the devices. Spectral response measurements reveal that photon energies higher than 1.77 eV are absorbed by the device and photogenerated electron-hole pairs are produced. The best OSC device exhibited V_{oc} of 440 mV with the J_{sc} of 6.2 mA/cm^2, fill factor (FF) of 30% and maximum power conversion efficiency of 0.05%.

Keywords: Inverted structure, Organic solar cells, P3HT:PCBM, Stainless steel substrate, Spin coating

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Abstract No: PS-17

Feasibility of classifying brainwave data extracted from commercially available EEG headset using deep learning techniques

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Electroencephalography (EEG) is the process of observing the electrical activity of the brain. In recent years there has been an increase in the availability of low-cost EEG headsets in the consumer market. This study was conducted using such a device, the Emotiv Insight 5-channel EEG headset. The objective of this study is to visually stimulate the brain and successfully identify the stimulus by classifying the EEG data using deep neural network techniques. Since the used EEG headset only contains 5 electrodes, it is quite difficult to classify the signals without employing learning-based algorithms. By nature, the human brain unlikely to stay idle for a long period. Due to that, the collection of EEG recordings must be done carefully without contaminating the data. To achieve this the proposed method of data collection is done through the help of a Graphical User Interface (GUI) which was programmed using the Python language. The GUI automates the tasks of recording, saving, and managing the EEG data. First, the subject was placed in front of a screen, in a quiet environment and the EEG headset was put on. After the recording begins, the GUI randomly chooses an image from an image-set which was provided beforehand and display it on the screen for 2 seconds while recording the EEG data in the background. After 30 seconds, the recording stops automatically, and the captured data is saved with the necessary information. The above periods were chosen specifically to limit the stress of watching a sequence of images for a long time period. The subject was informed about what types of image classes are shown and instructed to "identify" the class of the image. For the following analysis, 200 recordings of 30-second records from one subject were used. They were recorded using images of "Cats" and "Dogs". The initial results of this study were obtained by employing two data classification methods. The first analysis is done with a 1-Dimensional Convolutional Neural Network (1D-CNN) and it achieved an accuracy of 52%. The second method employed a spectrogram based 2-Dimensional Convolutional Neural Network (2D-CNN) with an accuracy of 54%.

Keywords: Deep learning, EEG, Image classification

Abstract No: PS-18

Vector Autoregressive (VAR) model for forecasting water level in Attanagalu Oya

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Flood is one of the major natural hazards in the world. Sri Lanka also undergoes flooding incidents every year. Both natural and human-induced activities such as precipitation, unplanned infrastructures, water drainage, lack of vegetation cause floods. High precipitation is one of the main reasons for flooding. Generally, most flood incidents occur in monsoon periods and inter monsoon periods. Attanagalu Oya, one of the tributaries of Kelani river and downstream of Kelani river cause to flood in the Gampaha district, Sri Lanka. According to the literature, the water level in Attanagalu Oya has not been studied using the multivariate time series approach. Therefore, this study aims to develop a Vector Auto Regressive (VAR) model to forecast the water level in Attanagalu Oya. The fitted model might be useful to identify the flood incidents that occur due to overflowing Attanagalu Oya. The model is fitted for daily water level and rainfall data for ten years. Water level data at the Dunamale gauging station of Attanagalu Oya and rainfall data at the Henarathgoda station were obtained from the Irrigation Department and Meteorological Department respectively. The analysis was carried out using R statistical software. Missing and unusual values of rainfall data were cleaned using the average values. Cross-correlations were calculated to identify lags of the rainfall data that might be useful to predict the water level. Results indicated the significant correlations at lags 1,2 and 3 as expected in this context as it takes 1-2 days to raise the water level after rain. The best VAR model must be chosen by selecting the optimal autoregressive order which is selected based on the minimum Akaike's Information Criterion (AIC). The lowest AIC score was achieved at the order of 8. Hence, VAR (8) model was selected as the best model. Results indicated that the rainy season occurred in southwest monsoon (May-September) and second inter monsoon (October-November) periods. The water level is also increased in those periods. According to the observed values of 2019 significant increase in water level could be seen from mid-September to November and the beginning of December. Forecasted results also showed an increase in water level in those periods. Also, the model accuracy was examined using mean absolute percentage error (MAPE) and root mean squared error (RMSE). Accuracy test results showed that the MAPE and RMSE values for forecasted rainfall are 2.907063 and 16.13093 and the water levels are 0.7730767 and 0.9059733 respectively. Hence, those values indicated that the model is adequate for forecasting. Findings of this study are vital to Agricultural Department to plan their cropping calendar, and urban council to plan various development and construction activities and warn the community in Attanagalu Oya basin for staying alert in the periods in which the water level is increased. Besides, this study is continued to improve the accuracy of the existing VAR model and to advance the existing model by considering other factors such as temperature and humidity.

Keywords: Attanagalu Oya, Flood, Multivariate time series, Rainfall, Water level

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Abstract No: PS-19

Influence of ZnS buffer layer on CdS/CdTe based solar cells

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Among thin film materials, cadmium sulfide (CdS) is the best suited window material as a heterojunction partner in cadmium telluride (CdTe) based solar cells due to its wide and direct band gap. In order to enhance the solar cell efficiency, a buffer layer such as zinc sulfide (ZnS) having a relatively wider band gap can be introduced into the conventional CdS/CdTe heterojunction solar cell by reducing the thickness of CdS thin layer. ZnS/CdS is an alternative to the conventional CdS window layer since it admits and transmits the maximum amount of photons to the junction to increase the short circuit current density (J_{sc}) and the efficiency of the solar cell. The electrodeposition of ZnS on fluorine doped SnO_2 glass (FTO) has been previously reported and this work focuses on the electrodeposition of intrinsic CdS layers on both FTO substrate and FTO/ZnS substrate, using a three electrode cell. The electrolyte used was consisted of 0.01 mol/L $Na_2S_2O_3$ and 0.1 mol/L $CdCl_2$ at pH of 1.7 at 55 °C and the deposition potential was varied between -0.68 to -0.72 V. The samples prepared were annealed at 400 °C for 15 minutes. Both thin film structures, FTO/CdS and FTO/ZnS/CdS were analyzed by the UV-Visible spectrophotometry and photoelectrochemical (PEC) cell performance to investigate the optical absorbance and its electrical properties. The optical absorption of the samples was fallen within 2.30-2.46 eV that agree with the typical band gap energy of CdS. Among the two structures, FTO/ZnS/CdS shows lower optical absorbance in 300-900 nm region, which has been recognized as a characteristic feature for a window layer in a solar cell. For the PEC cells, made with FTO/CdS, the J_{sc} and $J_{sc}\times V_{oc}$ values were between (18.0-1.60) $\times 10^{-6}$ A cm^{-2} and (5.94-0.38) $\times 10^{-6}$ AVcm^{-2} respectively, while for the cells made with FTO/ZnS/CdS, these values were (14.8-2.50) $\times 10^{-6}$ A cm^{-2} and (6.66-0.90) $\times 10^{-6}$ AVcm^{-2}. Although the J_{sc} of the FTO/ZnS/CdS based cell was relatively low, the product of $J_{sc}\times V_{oc}$ was high due to its high V_{oc}. The ZnS buffer layer facilitated the electrodeposition of well adhered, compact and pinhole free CdS window layer compared to the deposition of CdS on bare FTO. Hence, the implanting of a ZnS buffer layer on CdS/CdTe based solar cell can enhance the optoelectronic properties of the final solar cell device.

Keywords: Electrodeposition, CdS, ZnS, Buffer layer, PEC study

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Abstract No: PS-20

Voltage and wire standards for domestic DC distribution systems

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Home micro-grid concepts have gained interest in the modern world due to the increased distributed generations with renewable energy sources. The present "DC-AC-DC" route from distributed generations to DC loads via inverters may not be rational from the viewpoint of system simplicity and energy efficiency. Considering the increasing prevalence of DC home appliances, establishing reasonable DC distribution standards for domestic buildings is significant. In this study, the Wattage of household electric appliances and the time duration they are being used were collected. The monthly power consumption of each appliance category was calculated. According to the results, the average monthly electricity demand of a Sri Lankan family is 111 kWh. Only eight equipment categories consume nearly 90% of domestic power. Those are refrigerators (22%), lights (16%), fans (16%), rice cookers (14%), TV (8%), irons (7%), washing machines (4%) and water pumps (3%). When considering the average maximum power demand, the most commonly available appliances have less than 1 kW maximum power demand. By considering the power requirements, to minimize the loss, and keep the system's safety at the maximum level, the midpoint grounding system with main wires at +60 VDC and -60 VDC is proposed. Using this topology, 120 V line to line potential difference can be archived with keeping the ground to line voltage within safety extra-low voltage limit as proposed by the European telecom standards. Following the IEE wiring standards, three commonly available wire sizes ($2.5\,mm^2$, $4\,mm^2$, $6\,mm^2$) were selected to analyze the suitability for the system's sub circuits. Voltage drop, power loss, short circuit current, and insulation resistance were considered to select the maximum allowable current for each wire size in a sub-circuit. Since the wire length for a sub-circuit of a domestic distribution system is usually less than 10 m, the voltage drops and the power losses are too small and negligible. The insulation resistance of each wire was tested against high voltages. All the wires show infinite resistance (more than 1 $T\Omega$) up to 2500 V. The most critical factor in wire selection is the short circuit current. According to the results, for a high power sub-circuit that require power up to 2400 W, wire size of 6 mm^2 can be used with 20 A circuit breaker. For sub circuits with power requirement less than 1800 W, 4 mm^2 wires can be used with a 15 A circuit breaker. And for low power sub-circuits, 2.5 mm^2 wire can be used with 10 A circuit breaker to supply power up to 1200 W. Further studies must be carried out to determine the power/voltage losses and increase the whole distribution system's efficiency under these conditions.

Keywords: Electricity, Micro grid, Wire, Voltage level

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Abstract No: PS-21

Design and characterization of a parametric speaker using Pulse Width Modulation method

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This study focuses on designing and characterization of a parametric speaker. It is used to convert sound waves that spread out in all directions emitted from a sound source into a narrow sound beam to reduce noise pollution. The designed parametric speaker consisted of a parametric acoustic array. The operation of the device is based on nonlinear acoustic characteristics of sound in air. An ultrasound wave that can be modulated by any audio signal is radiated from a transducer array into the air. As a result, an audio signal is produced by the self-demodulation effect of the modulated sound in the air due to the nonlinearity of the air. Typical parametric speakers use different amplitude modulation methods to produce the parametric acoustic array. There is a high cost to produce parametric speakers using those methods. In this work, a method is proposed to produce the parametric acoustic array using the pulse width modulation method (PWM). PWM techniques were used for modulating the input signal. Mainly TL494 IC was used to realize the modulate system. In that process, input audible sound waves were converted to digital high frequency sound (ultrasound) waves which contains information of the audible sound. The proposed design consists of an array of ultrasound transducers each with 8 mm radius that produces ultrasound wave of 40 kHz frequency as the carrier frequency and a class D power amplifier to amplify the sound level of the modulated output sound. The operation of the proposed parametric speaker was tested by changing the carrier frequency and audio signal and measuring the sound pressure level of the parametric speaker for the different distances. It is identified that this method will be a suitable and cost effective method to produce the parametric speaker. Further the directness of the parametric sound beam depends on the carrier frequency and slightly on the input signal. Hence, the parametric sound beam can be more narrowed by using the (30 kHz – 80 kHz) high-frequency range ultrasound emitters and carrier frequencies for the parametric speaker array. It is concluded that the pulse width modulation method based parametric array used for this research is cost effective method and has a great potential to be further developed for designing commercial scale parametric speakers.

Keywords: Nonlinear acoustic characteristics, Parametric Speaker, Pulse Width Modulation

Abstract No: PS-22

A simple solvothermal approach to synthesize Zn-doped TiO_2 nanomaterials for dye sensitized solar cells

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Dye sensitized solar cells (DSSC) are considered one of the most promising organic solar cells. It is found as an alternative to traditional silicon based solar cells due to low-cost, ease of fabrication, ability to work under low light conditions and environmentally friendly nature. In DSSCs, titanium dioxide (TiO_2) is commonly used as a promising wide bandgap semiconductor photoanode and the light harvesting properties of the photoanode is a crucial factor that determines the overall efficiency of DSSCs. Doping could be used to improve the light harvesting properties of the photoanode by tuning the bandgap of the semiconductor. TiO_2 photoanodes doped with elements such as alkali-earth metals, transition metals, rare-earth elements and non-metals are found to improve the power conversion efficiency (PCE) of DSSCs. Among these elements, transition metal doped TiO_2 photoanodes perform efficiently by suppressing the relaxation and recombination of charge carriers and improving the absorption of light in the visible region. This work reports the possibility of enhancing the PCE of DSSCs by employing Zn-doped TiO_2 photoanodes since Zn is one of the promising n-type transition metals and Zn-doped TiO_2 improves the photocurrent in DSSCs. Zn-doped TiO_2 nanomaterials were synthesized, using varied amounts of Zn precursors, by a facile solvothermal method using a reaction bottle instead of an autoclave and characterized by X-ray diffraction and UV-Visible spectroscopy. The X-ray diffraction studies confirmed the presence of anatase phase of TiO_2 in the synthesized nanomaterials is unaffected by Zn-doping. The UV-Visible spectra of Zn-doped TiO_2 showed a red shift which could be attributed to the reduced bandgap resulted by Zn doping. Subsequently, the DSSCs were fabricated by doctor-blade method with an effective area of 0.25 cm^2 utilizing N719 dye, I^-/ I_3^- redox couple and Pt electrode as the sensitizer, electrolyte and counter electrode respectively. Then, performances of the fabricated devices were investigated. Significant enhancement in PCE was observed with 1.0 mol% Zn-doped TiO_2 based DSSC tested under simulated irradiation of intensity 100 mW/cm^2 with AM 1.5 filter, which was 35 % greater than that of the control device fabricated with un-doped TiO_2 photoanode. These improvements are attributed to the reduced band gap energy and the enhanced photocurrent due to Zn doping on TiO_2.

Keywords: DSSCs, Doped TiO_2, Solvothermal method, Zinc, PCE

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Abstract No: PS-23

Computational investigation of anti-Alzheimer effects of Asiatic acid present in *Centella asiatica* (Gotukola) and its derivatives

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Centella asiatica (Gotukola) is a commonly used medicinal plant that has a wide range of beneficial effects such as antioxidant effects, anti-Alzheimer's disease effects, anti-inflammatory effects, anti-fertility effects, anti-tumor effect and antimicrobial effects. Asiatic acid, pentacyclic triterpenoid is one of the secondary metabolites present in *Centella asiatica* extract that has all the above pharmacological properties. In this study, the Anti- Alzheimer biological activities of Asiatic acid and its derivatives were mainly focused. Alzheimer's disease (AD) is a neurodegenerative disease. It results in loss of cognitive activity and memory and creates impairments in signaling among brain cells. Main proteins involved in Alzheimer's disease are Human amyloid precursor protein (1AAP), Acetylcholine esterase (4PDE), Tau protein (2MZ7), Alzheimer's beta-A (1IYT) and Alzheimer's beta-A fibrils (2BEG). In this study, twenty derivatives of Asiatic acid were considered to investigate the anti-Alzheimer activity and one of cholinesterase inhibitor; Donepezil which is commonly used as a clinical drug in Alzheimer was considered as a reference compound. Initially, energy minimized structures of Asiatic acid and its derivatives were obtained using molecular mechanical calculations. Docking studies were carried out for the reference compound, Asiatic acid and suggested derivatives with Alzheimer's disease related proteins. They were docked using Autodock4.0 to obtain their interactions with target proteins and to determine the amino acid residues in binding pockets. The binding affinities of derivatives with proteins were compared with the binding affinity of parent molecule, Asiatic acid and also with the binding affinity of the reference compound, Donepezil respectively. According to the results, several Asiatic acid derivatives have a higher binding affinity with acetylcholine esterase enzyme and some derivatives showed the high affinity with other proteins. The reasons for their highest binding affinities and further details were obtained by using molecular dynamics (MD) simulations. The parent molecule and several derivatives that have the highest affinity with each protein were then further analyzed using MD simulations. MD simulations were carried out on protein-ligand complexes for 50 ns using CHARMM36 force field. The trajectories obtained from MD simulations were used to calculate the radius of gyration (Rg), root mean square deviation (RMSD), root mean square fluctuation (RMSF), solvent accessible surface areas (SASA), and hydrogen bonding (HB). According to the Rg and RMSD results, the studied protein-ligand complexes were stable throughout simulation time. A significant number of hydrogen bonds were observed between the derivates and protein residues. Further, RMSF and HB results of derivatives were compared with the results of Asiatic acid, in order to investigate the higher binding affinities of the derivatives. The MD analysis results along with docking results indicated that the Asiatic acid derivatives with higher binding affinities according to docking studies have the potential to act as promising anti-Alzheimer agents.

Keywords: Asiatic acid, Alzheimer, Derivatives, Docking, MD

Abstract No: PS-24

Factors associated with possessing the knowledge of HIV/AIDS - A case study based on ever married women in the reproductive age in Sri Lanka

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Human Immunodeficiency Virus (HIV) is not a notifiable condition in Sri Lanka. Moreover, HIV case reporting represents only a fraction of HIV infected people in the country as many infected persons may perhaps not be aware of their HIV status. Therefore, having a good level of knowledge about HIV largely contribute to preventing HIV prevalence in the country. In this study, we aim to identify the factors that are associated with possessing the knowledge of HIV/AIDS spread among ever married women in the reproductive age (15-49) in Sri Lanka. This will be particularly useful for authorities who organize awareness programs to identify various socio-economic as well as geographic subgroups who are lacking knowledge of HIV/AIDS spread. We used secondary data from the 2016 Sri Lanka Demographic and Health Survey that was conducted by the Department of Census and Statistics in Sri Lanka. Separate Binary logistic methods were utilized as methods of model building for six response variables which represent the answers to the following statements: people can get HIV from mosquito bites, a healthy-looking person can be infected with HIV, children infected with HIV should not be allowed to study in the same school with healthy children, someone can get HIV by sharing food with an HIV infected person, someone can reduce the risk of getting HIV by having sex with one uninfected partner, and someone can reduce the risk of getting HIV by using a condom every time they have sex. Respondents' province, highest education qualification, frequency of watching television, frequency of reading newspapers, frequency of listening to the radio, religion, age group, and wealth index were found to have a significant effect on possessing the knowledge of HIV/AIDS spread among ever married women in reproductive age in Sri Lanka. Respondent's answers regarding the knowledge about the HIV/AIDS based on the above factors are likely to be correlated and this correlation was not considered in the analysis. For future study, we recommend the application of a generalized linear mixed model approach for the analysis.

Keywords: Binary logistic models, Awareness of HIV, HIV/AIDS

Abstract No: PS-25

Non-Newtonian fluid flow in a long-distance pipe with circular cross section

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In many chemical and process industries, the fluid should pump through pipes over long distances from a storage to various processing plants. The substantial frictional pressure loss both in the pipeline and in the individual units is a common problem in these applications. Therefore, it is often necessary to calculate the pressure gradient, selection of optimum pipe diameter, and the flow rate. In this work, we develop a mathematical model for the description of the laminar, steady and incompressible fully developed flow of a Non-Newtonian polymer fluid in a circular tube of constant radius. The fluid flow has been studied using the Giesekus fluid model and the radial stress equations. Navier Stokes equations have been used as the governing equations and Giesekus constitutive relation has been used to model the stress tensor. No-slip boundary conditions at the outer wall and non-singularity conditions at the centre have been used to close the system. Non-dimensionalized coupled problem has been solved analytically for the velocity field and volumetric flow rate for optimal flow parameters, namely, the Giesekus parameter, Deborah number and pressure gradient. The maximum constant pressure gradient has been calculated and the behavior of the velocity profiles and the corresponding flow rate of the fluid flow has been computed. The simulation results indicate that for fixed Giesekus parameter and Deborah number, an increase of the ratio of relaxation time of the viscoelastic fluid and the shear viscosity increases the velocity. Furthermore, for a fixed ratio of relaxation time and the shear viscosity and fixed Deborah number, a decrease of the Giesekus parameter increases the velocity. Also, it can be concluded that the negative pressure gradient with the maximum value of the Deborah number provides the maximum velocity field and the maximum fluid flow rate.

Keywords: Deborah Number, Fully developed pipe flow, Giesekus fluid, Non-Newtonian fluid, Pressure gradient

Abstract No: PS-26

Activation of wood biochar and red brick using natural coconut vinegar

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Number of studies have been carried out to determine the efficiency of strong oxidizers in activating natural raw materials used in low cost water purification processes. However, rural communities find it difficult to acquire most of such chemicals. Therefore, this study was aimed to determine the ability of natural coconut vinegar, which is a common domestic acidic solution, in activating abundantly available potential water purifying materials to reduce calcium (Ca^{2+}) ions from water, further reducing the water hardness. In this study mature barks of Glyricidia (*Glyricidia sepium*), Gadumba (*Trema orientalis*) and Ipil Ipil (*Leucaena leucocephala*) were collected and air dried. These were carbonized (400-450 °C) in a closed vessel (2 hours) to produce biochar. Both biochar and brick particles in the range of 2.0-5.6 mm were selected for the analysis. For the activation these samples were soaked in natural coconut vinegar (biochar/brick: vinegar, 1:2 V/V) for 24 hours and completely dried in an oven (120 °C) for 3 hours. Laboratory scale glass columns (2 cm in diameter) were used to calculate Ca^{2+} adsorption and retaining capacities. Filtrates were analyzed for Ca^{2+} using flame photometer. Ca^{2+} adsorption and retaining capacities of each material were calculated per unit bulk volume of the material. Each test was duplicated, and the average was recorded. Untreated red brick and biochar of Glyricidia, Gadumba, Ipil Ipil showed Ca^{2+} adsorption capacities of 0.44, 0.30, 0.31, 0.27 mg cm^{-3} and retaining capacities of 0.19, 0.01, 0.02, 0.02 mg cm^{-3} respectively. Activated red brick and biochar of Glyricidia, Gadumba and Ipil Ipil showed Ca^{2+} adsorption capacities of 0.76, 0.58, 0.68 and 0.63 mg cm^{-3} and retaining capacities of 0.25, 0.20, 0.23 and 0.15 mg cm^{-3} respectively. Increase in Ca^{2+} adsorption and retaining capacities were observed in all the materials tested after activation with vinegar. Further studies are continued to use the vinegar activated natural materials in a low-cost domestic drinking water purification process.

Keywords: Adsorption, Biochar, Calcium, Vinegar

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Abstract No: PS-27

Women's autonomy in household purchasing decision making in Sri Lanka

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This study aims to identify factors associated with decision making autonomy regarding household purchases of women in Sri Lanka. The modern world places high importance on equality of all aspects. Gender equality has been foremost among this. Sri Lanka has already accomplished an outstanding milestone in female empowerment by producing the world's first female Prime Minister. Female decision-making autonomy has been an interesting subject of research in this area. The level of autonomy exerted by women depends not only on their personal characteristics but also influenced by traditions. This research studies the factors that affect autonomy regarding purchasing decisions of a household, namely major household purchases and daily household purchases. The data used for this research was obtained from the Sri Lanka Demographic and Health Survey 2016, conducted by the Department of Census and Statistics of Sri Lanka. First, the important predictors were identified using the chi-square test of association and then the significant predictors were included in the baseline category logit model. Using the Wald test, significant predictors in the baseline category logit model were identified. The goodness of fit of the model was tested using the Hosmer Lemeshow test. The results of the study indicate that for major household purchases, age, being resided in the urban sector, wealth status, number of children, being employed (specifically in the high skilled occupation group) and the age gap between the partners affect positively while education and husbands being employed in the low and high skilled occupation groups affect negatively to women's autonomy in major household purchases decision making. It could be seen that for daily household purchasing, age, is residing in the urban sector, education, wealth status, number of children and employability affect positively to women's autonomy while husbands being employed in high skilled occupation groups and age gap between the partners have a negative impact. Certain significant factors showed variations in results. However, most importantly, this study reveals that couples in Sri Lanka tend to make decisions jointly in most of the cases, as opposed to one person being autonomous. It can be advised to conduct a more improved study by including more extensive variables on the subject area, as it could not be done in this study due to the use of a secondary data source.

Keywords: Baseline category logit model, Gender, Women's autonomy

Abstract No: PS-28

Computational investigation of anti-Alzheimer properties of novel Curcumin derivatives

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Curcumin, a naturally- occurring principal curcuminoid of turmeric has been used as a remedy in many Asian countries for the past century. Curcumin has shown remarkable results for the effect of various medical conditions such as cancers, liver diseases, heart diseases, osteoarthritis, and also diabetes. In this study, we discuss the effect of Curcumin and its newly synthesized derivatives as potential anti-Alzheimer compounds. Alzheimer's disease (AD) is a chronic, neurodegenerative disease that can cause dementia that could affect memory, thinking, and behavior. Due to its anti-oxidant, anti-inflammatory, and lipophilic action, Curcumin can improve the cognitive functions in Alzheimer's disease patients. There are satisfactory proofs for the effect of Curcumin on Alzheimer's disease such as decreased Beta-amyloid plaques (the main concern regarding AD) and delayed degradation of neurons. The main proteins that are associated with Alzheimer's disease and highly focused on this article are Amyloid Precursor protein (1AAP), Alzheimer's Beta – A (1IYT), Alzheimer's Beta A fibrils (2BEG), Acetylcholine esterase (4PQE), and Tau protein (2MZ7). In this computational investigation, energy-optimized structures of selected eight derivatives of Curcumin and parent compound, Curcumin were obtained using DFT calculations. To secure a better understanding of binding interactions of the above-mentioned proteins with our selected derivatives and parent compound as ligands, docking studies were performed. To check the validation of docking results, Donepezil, a clinical drug that is currently used for the AD was used as a reference molecule and docking studies were performed. Among the newly synthesized derivatives, which were suggested as potential anti-Alzheimer agents, two derivatives have shown promising results with higher binding affinities for each protein, according to docking studies. The derivatives that showed the highest binding affinities were selected along with the parent compound, Curcumin for each protein for Molecular Dynamics (MD) simulations. MD simulations were performed on protein-ligand complexes for 50 ns using CHARMM36 force field. The mean radius of gyration (Rg), root mean square deviation (RMSD), root mean square fluctuation (RMSF) and solvent accessible surface areas of the binding pockets were calculated and hydrogen bond analysis (HBA) was also performed. Rg and RMSD results indicated the stability of the protein-ligand complex throughout the simulation time. HBA results showed that ligand has significant number of hydrogen bonds with the ligand. RMSF and HBA results of derivatives were compared with the results of Curcumin, in order to explain the higher binding affinities of the derivatives. The MD analysis results along with docking results reveal that the two derivatives with higher binding affinities according to docking studies have the potential to act as promising anti-Alzheimer agents.

Keywords: Alzheimer, Curcumin, Derivatives, Docking, MD

Abstract No: PS-29

Fabrication of reduced graphene oxide – nano iron (rGO-nZVI) anode for electrocoagulation treatment to regulate excess fluoride in water

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Due to excess fluoride in drinking water, over millions of people are being affected globally with dental and bone problems. The World Health Organization (WHO) guidelines specify 1.5 mg /L fluoride in drinking water as the maximum permissible contaminant limit (MCL). However, in dry climatic zones and tropical countries, the water consumption is high, therefore in a lower fluoride value than WHO MCL may suitable for the dry zone of Sri Lanka. The situation aggravates further in dry zone (Sri Lanka) as the fluoride in groundwater sometimes exceeds 5 mg/L. Presently water treatment methods based on adsorption, co-precipitation, membrane technology and ion exchange are used to mitigate enriched fluoride water with limited success. Briefly, both adsorption and co-precipitation generate excess sludge. The reverse osmosis methods remove ions in treated water than required. Most of the electrocoagulation (EC) methods used aluminum scarifying anode, which may pause additional threat of leaching neuro-toxic free Al^{3+} into the treated water stream. Therefore, we developed a novel anode composites using nano Fe and reduced graphene oxide (rGO) to be used in EC cells to regulate excess fluoride. rGO was synthesized by the modified Hummers method at ambient temperature. Natural green tea leaves polyphenols were used to reduce Fe^{2+}/ Fe^{3+} into metallic Fe. The widely used $NaBH_4$ method was also used to produce metallic Fe. The resulted composites are designated as polyphenol derived reduced graphene oxide-nano Fe (rGO–nZVI-P), and $NaBH_4$ derived reduced graphene oxide-nano Fe (rGO–nZVI-B). Before their application, conventional and spectroscopic methods extensively characterized rGO-nZVI composites. 2D Raman bands appeared at 2715 cm^{-1} for rGO-nZVI-P confirm the presence of multilayer structure while the bands at 2680 cm^{-1} for rGO-nZVI-B confirm the presence of the single-layer structure of graphene. XRD diffraction peaks confirm the presence of BCC, α-phase Fe (0) in the core of both nZVI particles. Our results suggest that 1 mg/L fluoride in water can be removed within 1 hr. to 75 µg/L and 3 µg/L respectively using rGO-nZVI-P and rGO-nZVI-B composites with minimal waste generation. Following pseudo-second-order kinetics, at pH 5.6, both composite materials adsorbed over 90 % of 1 mg/L fluoride within 1 hr. The rGO-nZVI-P based EC has the potential to treat fluoride-rich waters efficiently.

Keywords: Fluoride, Groundwater, Reduced graphene oxide, World Health Organization

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Abstract No: PS-30

Calibration of the rolling angle of a Quadrant Photo Detector mounted in the image plane of a dark-field passive LIDAR system

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Passive Light Detection and Ranging (LIDAR) has successfully been used for observing insects and their activities. It was reported that such techniques are more efficient compared to traditional approaches. Quadrant Photo Detectors (QPDs) are widely used at the image plane with the use of a modified eye-piece to detect both wing-beats and heading angles of insects. In these systems, knowing the exact orientation of the QPD in the image plane is an imperative task. This study was carried out to propose a method to calibrate the rolling angle of a QPD mounted in the image plane of a Newtonian telescope in a dark-field passive LIDAR system using a Hamamatsu S4349 Silicon QPD. Each segment of the QPD was connected to a data acquisition card through four Trans-impedance amplifiers and programmable gain amplifiers. A white coloured inverted pendulum oscillated across the Field of View (FOV) of the QPD at a known distance was used for calibration. Intensities registered at the individual segments of the QPD were recorded at a rate of 10 kHz while the pendulum swept the FOV. Thirty-six of such measurements were obtained by changing the rolling angles by 10-degree at a time. The four filtered and normalized signals were used to calculate the activation times (full width at 10%) and four unique sinusoidal functions were fitted to the whole range of angles. These coefficients can be used to estimate the rolling angle of the QPD using a test oscillation. It was found that the accuracy of the estimate was ± 6.04 degrees. A ray tracing-based simulation was conducted to simulate this activity and findings from the activity agrees with the theoretical simulation results. It was noted that the highest performance can be obtained when the pendulum oscillates in a plane normal to the optical axis.

Keywords: LIDAR, QPD, Rolling angle calibration, Heading angle, Entomological LIDAR.

Abstract No: PS-31

Wild bootstrapping rank-based procedure: Multiple testing on multivariate data

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Multivariate data occur in many scientific applications, for example in agriculture, biology, clinical studies in medicine, or in social sciences. They are apparent if two or more possibly correlated response variables are measured on the same experimental unit. Besides, in a study design, the experimental units might be stratified into several treatment groups. Such a design is called a multivariate factorial design and should allow comparisons across different treatment groups. In statistical practice, the evaluation of a multivariate factorial design does not only include the question of whether there is a treatment effect between the groups in any of the responses but, if such a treatment effect is observed, between which groups and under which responses those differences exist. That is, testing only the global null hypothesis (all treatment groups have the same effect across all responses) is not of interest but in particular, multiple comparisons between the treatment groups are also of practical importance. To date, the available nonparametric methods of multivariate analysis are used to test hypotheses formulated in terms of the distribution functions of the data and thus, assume identical covariance matrices across the groups. Moreover, they cannot provide adjusted *p*-values and compatible simultaneous confidence intervals (SCIs) for the multiple tests. In the present work, rank-based tests that overcome the existing gaps have been derived to test hypotheses formulated in terms of purely nonparametric treatment effects. Thus, the new approaches can be used for testing the global null hypothesis as well as for performing multiple comparisons and for the computation of compatible SCIs. Due to the complexity of multivariate factorial designs and usually apparent small sample sizes in statistical practice, small sample size approximations of the test statistics are of particular importance. Therefore, a modern resampling method, namely, a wild bootstrap approach has been introduced. It can be seen from the resampling algorithm that the resampling version of the test statistic does not require the estimation of the correlation matrix of the test statistics. Also, the critical values from the resampling distribution are used in the construction of rank-based multiple contrast tests and SCIs. The asymptotic validity of the wild bootstrap approach has been derived and its behavior was analyzed in an extensive simulation study where different data distributions with different covariance structures and sample sizes were considered. The simulation results show that the wild bootstrap method tends to be more robust, controls the multiple type-I error rate quite accurately, and has comparable power compared to rank-based MANOVA-type tests in all the investigated scenarios. Furthermore, a real data example illustrates the application of the proposed tests.

Keywords: Multivariate data, Rank statistics, Multiple comparisons, Simultaneous confidence intervals, Wild bootstrap approach

Abstract No: PS-32

Finding co-rotation resonance in spiral galaxies using localized observable features

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The co-rotation resonance of a spiral galaxy represents a stable region within the galactic structure where the velocity of the disk material and the spiral arm global pattern speeds concur with each other. The cardinal objectives of studying these regions include but are not limited to; checking the validity of theoretical predictions, getting a better understanding about the disk material distribution process and to study the evolution process of galaxies. Often these regions are attributed to galactic scale habitable zones; hence the study is undoubtedly a worthy pursuit. The co-rotation resonance region creates a radius of localized observable features that can be used to locate and study them. The current study focusses on using multiple methods such as spiral arm overlays by measuring pitch angles, arm-inter-arm contrast plots, 2D-fast Fourier transformation plots and 3-D surface intensity plots. Ten nearby galaxies were observed in 3.6 μm, 8 μm and B-band based on the availability and the clarity of image data. It is important to emphasize that the different wavelengths were selected based on their unique characteristic abilities to trace different structural components of the galaxy. B-band usually depicts the newly formed young stars while the 3.6 μm images are sensitive to the old stellar population. 8 μm images denote the gas and dust lanes; hence they are usually ascribed with the location of the underlying density waves. As the initial phase, we create composite images using the different wavelengths and de-project them to a face-on orientation. The standard, Image Reduction and Analysis Facility (IRAF) ellipse fitting tasks are used in the de-projection process while considering the available published de-projection parameters in the NASA/IPAC Extragalactic Database (NED). The arm-inter-arm contrast plots require an additional symmetry enhancement process to better visualize the underlying symmetry. The most probable locations for the co-rotation radii were identified using each method and were compared against previous studies found in the literature. Most of the results are compatible, while there are a few galaxies with notable deviations. Considering each galaxy and the results obtained through each method, the largest sample standard deviation of s = 1.5 kpc is recorded for NGC 1566, while the smallest, s = 0.31 kpc is recorded for NGC 5194. NGC 3031 shows the largest deviation when comparing our results with the values found in the literature. To better understand the deviations, further analysis is required using larger sample sizes and more wavelengths.

Keywords: Co-rotation radius, Resonance locations, Spiral galaxies

Abstract No: PS-33

Fabrication and characterization of environmentally friendly packaging materials using banana agricultural waste

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Polythene and plastic usage has been increased rapidly all over the world during recent decades because of their unique properties such as low electrical and thermal conductivity, low density, resistance to most solvents, strong and tough nature, and low cost. However, the waste plastics cause serious environmental pollution due to their low biodegradability. To reduce the aforementioned pollution, eco-friendly alternative products are essential. Use of banana fiber has been investigated in producing alternative eco-friendly materials by many research groups. The main objective of this work is to investigate the thermal conductivity of banana fiber composite made from agricultural waste. Wood ash, which is a natural bonding material, was used to modify the bonding and coherence between the banana fibers in the pulp, whereas chemical treatment was used in other studies reported. To prepare the pulp, a known amount of chopped banana pseudo stems and wood ash were boiled together with adequate amounts of water. Ten such specimens were made using 100 g of banana pseudo stem by varying the wood ash in 10 g multiples (100 banana stems: 10n wood ash; where n=1 to 10). Each pulp was poured into molds of dimensions $30 \times 12 \times 1\ cm^3$ and kept in a moderate environment to make a dry sheet. The dried sheet specimens formed were smooth, flexible and of low weight. The thermal conductivity of the specimens was measured by *Lee's disc* method. The thermal conductivity was observed to be increased gradually with temperature (75 to 132 ºC) and with increasing the amount of wood ash (10 to 100g) in the composite. The density of each specimen was calculated, and it was observed that the thermal conductivity of the sample in the above-mentioned temperature range was minimum in samples containing 40 g and 50 g of wood ash. The minimum thermal conductivity observed was 0.05 W/mK at 75.3 ºC. The results of this study show that banana fiber composite can be a replacement for Polystyrene packaging material because of their low thermal conductivity and low density.

Keywords: Banana fiber, Lee's disc method, Thermal conductivity, Wood ash

Abstract No: PS-34

Mathematical model for kinematics of basketball free-throw shooting

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Basketball shooting is a basic and essential practice for a basketball player. Points are scored in a game of basketball, by throwing the ball over a hoop. This can be done by Free throws and field goals. A free throw is a special shot granted when a player is fouled while shooting a basket. Any player of the opposition team who is on the court at that time can be awarded a free throw. Hence, all the members of a team should be competent in scoring baskets. The angle and the velocity of the ball are important mathematical parameters in scoring goals. If the players are aware of the correct angle and velocity for a successful free throw then players can practice accordingly and aim perfect shots. Hence a model for the players to know their perfect successful angles would be helpful. Therefore, the main purpose of this research is to obtain a model to calculate the best releasing angle and the releasing velocity for the free throw shots. The air resistance is considered as zero, magnus effect is negligible and having zero spin of the ball were the assumptions in developing the model. Equations of motions for horizontal and vertical directions of the velocity was used and simplified them. An expression was developed for minimum angles by examining the descends of the ball to the hoop. Tables were constructed for the release angles and velocity for various heights using MATLAB(R2018a) to plot the graphs to find the feasible regions for the angles and velocity. Finally, the minimum angle for the longest shot was calculated. A physical model was developed to find the releasing angles with their release velocities. Basketball players could use the free throw shot using the best angles developed in the current study. Measuring velocity is not practical in basketball games, hence the players can practice with the best angle for a free throw and manage their velocities with the angle according to the velocities given in the table. Based on the tables, an increase in height of the player including the height to the releasing point will decrease the releasing angle and releasing velocity. The derivation of the model for optimal angle a quadratic equation was solved to develop the model. Therefore, there were ranges of releasing angles for some releasing velocities. The effect of air resistance was small for the motion of the basketball shot was observed.

Keywords: Basketball free throws, Minimum angle, Releasing angle, Releasing velocity

Abstract No: PS-35

Investigation of a best fitting mathematical model for the frequency of occurrence of *Trichoderma harzianum* in Hakgala Montane Forest in Sri Lanka

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Trichoderma is a genus commonly found in the soils of all climatic zones. All most all the species of *Trichoderma* can produce antimicrobial antibiotics and are good competitors of fungal pathogens, which promote plant growth, enhance stress resistance and induce disease resistance in plants. Interactions between plants and *Trichoderma* are ecologically important. Moreover, this genus is economically much important because *Trichoderma* has been used as a biofertilizer and bio pesticide. In the present study, the attention is given to *Trichoderma* species: *Trichoderma harzianum*. The aim of this study was to detect a proper mathematical model to investigate the frequency of occurrence of fungus; *Trichoderma harzianum* in Hakgala Montane Forest in Sri Lanka at any period of time. Data for the frequency of occurrence of *Trichoderma harzianum* were collected at once in three months intervals from the decomposing leaf litter of Hakgala Montane Forest in a previous study. Significance of the data was checked using the ANOVA test. Data were tested with five mathematical models (Exponential, Logistic, Gompertz, Brody, Von Bertalanffy) and parameters estimated using the nonlinear least square method in R Studio software. The models were tested for goodness of fit using the adjusted coefficient of determination (R^2), Akaike's information criterion (AIC) and Bayesian information criterion (BIC). The logistic model provided the best fit of the data due to the highest value of R^2, lower values of AIC and BIC than other models. The developed logistic model revealed 0.549% for the growth rate of *Trichoderma harzianum* in Hakgala Montane Forest. Since the Hakgala Montane Forest is an undisturbed natural ecosystem with its equilibrium stage this proposed model can be used to investigate the frequency of *Trichoderma harzianum* at any time period even for future predictions.

Keywords: ANOVA, Coefficient of determination, Frequency of occurrence, Logistic model, *Trichoderma harzianum*

Abstract No: PS-36

Multivariate time series models for temperature data in Nuwara Eliya, Sri Lanka

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Sri Lanka is located north of the equator. Hence, its climate is regarded as a tropical climate and the average mean temperature in Sri Lanka is 27.0 °C (81 °F). However, the temperature in some parts of the island deviates from the typical temperature pattern. Especially the cities in the central parts of Sri Lanka are situated far above the sea level, and hence temperature in these regions is low and experience seasonal behaviour. Nuwara Eliya district is one of the tourism hotspots of Sri Lanka, which is located in the central province. The lowest annual regional temperature in Sri Lanka is recorded in weather stations at Nuwara Eliya, which is about 15.0 °C (59 °F). Nuwara Eliya district is long known for its high-quality agricultural products including tea, vegetables, and fruits. The behaviour of temperature heavily influences these two industries (tourism and agriculture). Therefore, it is very significant to analyze the temperature in Nuwara Eliya. Thus, in this study, we expect to analyze the monthly atmospheric temperature of Nuwara Eliya. For that, monthly maximum, and minimum temperature series in Nuwara Eliya from 1997 to 2018 were collected from the Department of Meteorology, Sri Lanka. This study focused on seeking the joint behaviour of monthly maximum and minimum temperature series while analyzing the correlation structure of both series. Using regression analysis, the seasonal components and trend components of both series were estimated. However, according to the trend analysis, both series did not experience a significant trend during the considered time period. Then, using the whitening technique, a significant cross-correlation between the seasonally adjusted two series was investigated. A VAR (Vector Autoregression) model was fitted to represent the joint behaviour of the two deseasonalized temperature series. VAR (3) model was selected as the best multivariate model for the two series. In addition, the forecasting accuracy using the multivariate model was assessed. The resulted mean absolute percentage error values (MAPE) are 6.29% and 2.43% for minimum and maximum series respectively. These MAPE values confirm that the model can be utilized for better predictions with higher accuracy.

Keywords: Cross correlation, Prewhitening, Time Series

Abstract No: PS-37

A method of obtaining a solution of $a^{px+qy} \equiv b \pmod{m}$ when m is prime and a is a primitive root modulo m

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The congruence relation modulo a positive integer identifies two integers if and only if their difference is divisible by that positive integer. The modern theory of congruences was developed by Gauss at the beginning of the 19th century. Several formulations are established in solving congruences of various types. In this study, we introduce a method in solving congruences of the form $a^{px+qy} \equiv b \pmod{m}$ for a prime number m and integers $a, b, p,$ and q. Since we do not have a standard generalized method of obtaining a solution for the aforementioned congruence type, some restricted forms of it were studied. In this work, we especially focus on the congruences of prime modulus m and a is a primitive root modulo m: If $\gcd(a, n) = 1$ and $\varphi(n)$ is the order of a modulo n, then a is called a *primitive root* of the integer n. Here $\varphi(n)$ is the Euler's Phi function (totient function) of n, that counts the number of integers less than or equal to n which are relatively prime to n. In or method, first, a solution system for $a^{px+qy} \equiv 1 \pmod{m}$ is obtained. That solution system is used with a transformation to obtain a solution of the congruence $a^{px+qy} \equiv b \pmod{m}$. We prove that a solution of $a^{px+qy} \equiv 1 \pmod{m}$ can be obtained by $(\pm k\varphi(m) + x_0, \pm l\varphi(m) + y_0)$, where k and l are non-negative integers. When (x_o, y_o) is a solution of $a^{px+qy} \equiv 1 \pmod{m}$ with both x_o, y_o are not simultaneously zero, the obtained solution is transformed to a solution of $a^{px+qy} \equiv b \pmod{m}$ when $\gcd(p, q) \mid b$. The former result can be used to obtain a solution for the congruence in the form of $a^{px+qy} \equiv b \pmod{m}$ when m is prime and a is a primitive root modulo m. In future, we hope to generalize this method when m is composite and a is not a primitive root modulo m.

Keywords: Congruence, Primitive root, Modular arithmetic, Modular exponentiation

Abstract No: PS-38

Electrochemical conversion of graphite to graphene oxide: A preliminary study

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Graphene-based materials are two-dimensional atomic crystals composed of sp^2 hybridized carbon atoms. The family includes graphene, graphene oxide (GO), reduced graphene oxide, and graphene quantum dots. Graphene is an allotrope of carbon with hexagonal lattice and it has gained immense attention in many industries due to its exceptional applications in electronics, water purification, adsorption studies, etc. Many recent studies proposed different routes of GO synthesis. This study reports an electrochemical conversion of locally available raw graphite obtained from Bogalapathala to GO. Electrochemical conversion of graphite to graphene has great potential in the production of graphene oxide and it has gained the attention of the scientific community due to its easiness and environmentally friendly practices. The significance of the electrochemical conversion process is the minimal chemicals requirement compared to other methods developed. The local graphite powder was compressed into pellets using a pellet maker designed by the researcher with a cavity to accommodate the Pt electrode. The graphite pellet was tightly wrapped with a permeable cellulose membrane to avoid loosening of the pellet during electrochemical process. The electrochemical cell consisted of a Pt rod as the working electrode and a carbon rod is as the counter electrode. These electrodes were immersed in an $(NH_4)_2SO_4$ solution and a constant potential of 10 V was applied for 2 hours. The resulted product was dissolved in deionized water and centrifuged to collect the supernatant. The supernatant was heated at 90 °C under atmospheric pressure on a hot plate to evaporate the water and the residue was characterized using FTIR, UV visible spectrophotometry, and X-ray diffraction techniques. The UV and FTIR absorption spectra and the X-ray diffraction patterns confirmed the partial transformation of graphite to GO while the maximum yield of GO obtained after the evaporation was 1% (based on the mass of graphite powder used) and further investigations need to be performed to increase the yield.

Keywords: Graphite, Graphene oxide, Electrochemical conversion, Characterization

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Abstract No: PS-39

Catalytically induced pyrolysis of LDPE to liquid fuel

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Plastics are used in a wide range of applications because of their durability, lightweight, easy fabrication, and desired chemical and physical properties. Usually, plastic products are discarded after use to the environment as solid waste. Therefore, the low degradability of plastics and the high demand for plastic products have created a serious environmental issue. Recycling is one of the methods used in plastic waste management. As a recycling method, energy recycling or producing fuel oil from plastic waste has gained a promising interest. In this study, it was expected to convert selected used plastics to fuel oils through a pyrolysis process using a catalyst. A laboratory-scale pyrolysis system was developed and a low-cost conversation process for plastics to fuel oil was investigated in an environmentally friendly manner. Initially, virgin low-density polyethylene (LDPE) was used in this conversion as the control sample. Then waste wrapping materials made of LDPE were subjected to pyrolysis. A two-neck round bottom flask was used as the reactor while the heat was supplied by a LP gas burner. To control overheating and possible heat losses, the reactor was dipped in a soil bath during heating. A constant heating rate and a constant inert gas flow rate to the reactor were maintained throughout the experiment. The gases evolved by the pyrolysis were condensed. The distillate was collected while the uncondensed fraction was trapped first in a non-polar organic solvent and further in a basic aqueous solution to prevent possible hazardous emissions. A locally abundant mineral was tested as a possible catalyst for the pyrolysis to improve the quality of the resulting products. It was observed that the purity of the resulting fuel oil had been improved with the use of the catalyst. The resultant liquid fraction was conveyed for factional distillation and the fractions were characterized with GC-MS and FTIR techniques.

According to the GC-MS analysis, the major constituents in the fraction obtained from virgin LDPE through uncatalyzed pyrolysis were decane, undecane and 1-tetradecene. The major constituents obtained through the catalytic pyrolysis of virgin LDPE were cyclopropane, 1-decene, undecane and pentadecane. The pyrolysis of waste LDPE resulted in cyclopentane, decane, undecane and 1-pentadecene as fractional distillates. The mineral tested as the catalyst has given significant improvement in the purity of the oil fractions produced. The *combustion characteristics and v*iscosities of the resultant oils are to be determined and those will be compared with the commercially available fuel oils. The study will be extended for other plastic waste types including mixed waste.

Keywords: Recycling, waste LDPE, Pyrolysis, Mineral catalyst, Fractional distillation

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Software Intensive Systems

Abstract No: SI-01

Availability and reliability analysis in 5G communication scenarios in IoT applications

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Due to the increasing usage of wireless communication devices, the demand for fifth-generation (5G) cellular network access is growing rapidly. Facilities that might be seen with 5G technology include, far better levels of connectivity and coverage. 5G cellular networks provide dynamic coverage with respect to time and enduring overlapped cell areas. Due to this reason, 5G network users can be covered by numerous cells and Radio Access Technology (RATs). This could be done, especially by taking full advantage of network capability to facilitate extreme performance that includes supporting hugely inter-tethered devices attributed to IoT applications in 5G. The main challenge in IoT applications is that scalable and efficient connectivity for a massive number of devices sending very short packets, is not done adequately. In such scenarios, IoT devices are expected to select the most appropriate cell based on the channel availability information of each cell. Therefore, efficient cell selection is needed in 5G. Additionally, in a heterogeneous network with overlapping cells, cell selection could be a critical decision for 5G users. The proposed research is aimed at implementing two schemes for cell selection based on the availability and reliability performance in 5G. The study proposes an algorithm by considering two schemes. The first scheme is contingent on the distance. That is the distance to the base-stations must be considered. If the base stations are close to devices, signal strength is high. The second scheme is based upon the channel availability and the distance while priority goes to the channel availability of each cell. These two schemes were simulated by using a simulation program, which was developed in MATLAB. For cell selection, scheme 2 is much fairer than scheme 1 because by using scheme 2, channels availability is balanced through cells. Despite this, the nearest device is allocated to the nearest place by scheme 1 and as a result of that, signal strength is higher in those devices. By considering all the results obtained, it can be concluded that the proposed schemes are efficient cell selection schemes, which can be used to improve the overall system performance.

Keywords: 5G, Cell selection, Channels availability, Signal strength

Abstract No: SI-02

Application of artificial neural network in customer analytics: A literature and classification

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Industries are relying on increasing the customer base as a means of growth of the industry, irrespective of churn prediction. It could be argued that churning of customers, have the same or even greater consequence on the company itself. According to a recent study, churn helps the business have a better roadmap about future revenue prediction. Hence, for churn prediction, different researchers have used different methods in distinct sectors which primarily depend on customer participation. It is especially difficult in customer churn to prevent and predict in a world where business models, demands of customers, and services are constantly changing. In such a structure, providers get to know the actual value of sustaining customers in the workplace. Customer churn is a challenging and critical issue for many sectors, with the acquisition cost of customers increasing. Thus, it is a mandatory and absolute necessity for service providers to prevent the churn phenomenon in order to attain the availability of service. Every-year companies are losing up to 30% of customers because of churn and obtaining new customers are 5-10 times costlier than retaining the existing customers. The paper chooses distinct approaches to Artificial Neural Network (ANN). It will create a strategic plan which is practiced on the customer's analytics according to a particular sequence to classify them into distinctive categories. The four main approaches can be customized for churn prediction. Based on the ability and potential of a customer, customers will be categorized. The classification will be based on different research studies with their unique methodologies and dimensions. The outcome will show the final classification of churn according to ANN. In Custom Analytics (CA), the two proposed dimensions namely, customer retention and customer identification will sort out the identity of customers in four major categorical approaches. They are ANN, Ensemble Approach, Growing Self-Organizing Map (GSOM), and Self-Organizing Map (SOM). Hence, this effective strategy for customer retention would help industries make better informed decisions.

Keywords: Artificial Neural Network, Churn prediction, Churn retention, Classification

Abstract No: SI-03

Tourist volume forecasting: An approach with supervised machine learning algorithms

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The tourism industry generates almost US$4 billion of income and provides direct and indirect employment to a large number of people in the country. Expert knowledge on the travel behaviour of tourists is an important part of planning and aids decision making for all stakeholders including the government and private business organisations. There was a severe drop in tourist arrivals during the civil war and was also apparent after the more recent Easter Sunday bomb attack. The study compared the predictions of different forecasting models on tourist arrivals in Sri Lanka, in an effort to identify the most appropriate model. The supervised machine learning algorithms (MLA) applied were Time Delay Neural Network (TDNN) and Feedforward Neural Network (FFNN) with two different algorithms namely Levenberg-Marquardt (LM) and Scaled Conjugate Gradient (SCG). Recently, MLA has started playing a vital role as an effective forecasting tool. A better model in forecasting was identified using the performance criteria of the Normalized Mean Squared Error (NMSE). As an initial step, monthly data from December 2019 to January 2000 were standardized to maintain the consistency of data. The aforementioned models were trained for 100, 200 and 500 epochs separately, with different numbers of hidden layers and hidden neurons, and detected the model with minimum NMSE for further training. For the selected model from TDNN, subsequently, the transfer functions and time delays were modified. A better model was identified in 500 epochs for the network with 2 hidden layers of 4 and 3 hidden neurons with tansig transfer functions from time delay of 3 (NMSE 0.3537). For the FFNN model, input combinations were recognized using the Pearson correlation coefficient and Spearman's rank correlation coefficient. Among the trained models with the different input combinations, the model with MA3, MA6, MA9, MA12, and MA15, lag 1, lag 2, lag 3, lag 11 and lag 12 indicated the lower NMSE of 0.5244 where Moving Average (MA) indicates current and past values and depends linearly on the output variable and lags being predetermined fixed quantity of passing time. For the FFNN, a better model was identified with the adjustment of parameters. A better model was identified in 100 epochs for the network with 3 hidden layers of 3 hidden neurons in each layer with tansig transfer functions, a learning rate (η) of 0.01, a combination coefficient (μ) of 0.001 and a decreasing factor as 0.1 and increasing factor as 10 of μ (NMSE 0.2234). For the SCG algorithm, the lowest performance measurement value, NMSE was 0.3193. The model had 500 epochs with 3 hidden layers of 3, 2 and 2 hidden neurons respectively, transfer functions with tansig in all hidden layers, a sigma parameter value of 5e (-5) and a lambda of 5e (-7). The main conclusion is that all the discussed network models capture the actual behaviour of the testing set while the minimum NMSE was identified in the FFNN with the LM algorithm. The findings of the analysis are beneficial, as tourism is a global service industry and a source of foreign exchange earnings and a key employment generation sector for the country.

Keywords: Feedforward neural network, Machine learning algorithms, Normalized mean squared error, Time delay neural network, Tourism

Abstract No: SI-04

Usability of voice-activated interfaces: A comprehensive literature review

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User interaction designing has been changed drastically in the recent past. Cutting edge technologies have enabled users to interact with digital products in more natural ways. For example, Natural Language Processing (NLP) and speech recognition technologies have revolutionized the user interaction experience. As a branch of Artificial Intelligence (AI), NLP introduces a computer-human interface where linguistic phenomena act as User Interface (UI) controls for software applications. As a result, most of the modern smart devices such as smartphones, smart speakers and smart home systems are equipped with voice interfaces. Natural language and voice interfaces are especially beneficial for elderly users and users having disabilities because they might not be able to use conventional user interfaces such as Graphical User Interfaces (GUI) and Command-Line Interfaces (CLI). However, the percentage of usage of elderly users is very low when compared to all users, and in numbers as well, approximating to about 20.1%. Moreover, this technology is not widely used in Sri Lanka in comparison to European countries. In this study, we systematically review previous research studies with two main objectives. First, exploring the strengths, weaknesses and vulnerabilities of the existing voice-activated interfaces. Second, analysing and summarizing the usability of four popular Voice Assistants (VA) namely Alexa, Siri, Cortana and Google Assistant. As the methodology, we selected research papers for this systematic review using keyword-based clustering and we obtained mainly four clusters namely usability, voice interface, methods, appliances and machine learning. We then extracted keywords from the abstracts of published papers in top ranked conferences. Further, we chose research papers using their references. Our investigation revealed that, though we are in a technological era, there are a number of common weaknesses and issues in VUIs, such as lack of understanding of voices other than the frequently used voices, incorrect capture of non-English words such as names of the cities, and commands have to be repeated to accomplish a certain task. Moreover, the main vulnerabilities identified are privacy and security issues with voice-activated interfaces. For example, smart voice-enabled devices record everything, including background noises may even sometimes violate a person's privacy. Furthermore, we identified that the above mentioned widely used smart VAs support more than 20 languages, on average. Then we summarized the usage of popular voice interfaces and we found that Apple Siri is the most popular and most accurate VA while Amazon Alexa is the least popular. Apart from that, according to the previous paper reviews, Google Assistant gives the most natural responses. The study will beneficial for the researchers who try to solve issues and try to improve existing features of voice-activated interfaces.

Keywords: Natural Language Processing, Usability, User experience, Voice user interface

Abstract No: SI-05

A review of product based recommender systems used in online shopping platforms

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Online shopping platforms have drastically changed customer behaviour. Customers can make their choices far easier with the help of recommender systems which are an integral part of modern online shopping platforms. As a result of rapid growth in the number of products in the market and due to the complex lifestyle of people, choosing the right product, takes extra time and effort. Therefore, online shopping platforms provide users with recommender systems to help choose shopping items. A recommender system is a software tool used to recommend items of interest to users. Some recommender systems provide personalized recommendations by analysing user persona, personal interests, and requirements. In other words, there are personalized and non-personalized recommendation systems, though personalized recommender systems are becoming increasingly popular and the norm. For example, Netflix movie recommender systems, Amazon product recommender system are among many other generic book and music recommendation systems out there. In this study, we review some of the existing personalized recommender systems and analyse its strengths, weaknesses, and vulnerabilities. The basic components of a recommendation system are Items, Users, and Transactions. Apart from that, recommender systems use filtering methods such as collaborative filtering, knowledge-based filtering, constraint-based, content-based and community-based systems. The study investigated around 100 related research papers. There, we found 43 research studies based on a collaborative filtering approach, 31 based on knowledge-based, 8 studies using both methods as a hybrid approach, with the remaining 26 papers using other filtering methods. The acceptance rate of the personalized recommendations made by collaborative filtering is higher because recommendations are made based on user profile similarity and their purchasing behaviour. For example, 60% of movies are chosen by users based on Netflix's recommendations. This shows that collaborative filtering is effective for personalized recommendations. In contrast, the knowledge-based filtering method uses the description of the product and its properties/features with the profile of the user's preferences. For example, the Pandora music streaming service uses knowledge-based filtering for song recommendation and needs very little information to make similar recommendations. However, there are limitations in collaborative filtering and knowledge-based filtering methods. For example, key limitations of collaborative filtering are 'cold start problem', 'sparsity', and 'scalability'. Knowledge-based filtering shows limitations such as 'overspecialization' and 'domain-dependency'. Studies analysing hybrid recommendation methods have indicated better performance, in making recommendations. Further, we investigated some of the privacy issues and vulnerabilities in recommender systems. To our knowledge, only a handful of studies have investigated vulnerabilities of recommender systems. For example, Cyber-attacks can make significant damages to existing recommender systems. One study has simulated 6 inference attacks per user with 90% accuracy. Thus, security and privacy issues of existing recommender systems need to be explored and investigated. The review paper provides some valuable insights about the usability of existing recommender systems and their vulnerabilities. Future work will specifically focus on security issues of recommender systems and investigating novel systems such as GPT-3 empowered recommender systems.

Keywords: Collaborative Filtering, Online Shopping, Recommender Systems, Vulnerabilities

Abstract No: SI-06

Hybrid recommender system for categorized Sinhala news articles

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Despite the existence of popular news recommendation systems like Yahoo, there exists no such site for the Sinhala language which provides personalized news recommendations. Hence, there is a need to implement a similar platform which recommends categorized Sinhala news articles according to user preferences. Though, there are several recommender systems that are widely used, the proposed solution is focused on two famous recommender system methods, named Collaborative Filtering and Content-Based Filtering. Collaborative filtering is a method of making automatic predictions about the taste of users by processing information about interactions between many users and items, whereas content-based filtering uses item features to suggest other items similar to what the user likes, based on their previous behaviour. There are many weaknesses of using these recommender systems individually, such as making recommendations for novel users/articles and limited content analysis in item profiles. Therefore, the main objective of this study is to propose a hybrid recommender system that combines both approaches to eliminate the mentioned weaknesses. Furthermore, it has been implemented for recommending Sinhala News Articles specifically, combining Multi-Layer Perceptron with Skip-Gram Architecture, which is novel and not seen previously. The study implements Collaborative Filtering using Multi-Layer Perceptron, which is a deep neural network, owing to its performance on imbalanced data with infrequent users and items. It also uses a deep neural network architecture named Skip-Gram Architecture due to the fact that it predicts similar articles from context words for given target words to implement the Content-Based Filtering. Both of these deep neural networks are combined to create a hybrid recommender system to recommend Sinhala news articles as the methodology of this proposed work. The experiments were conducted using five data sets, which had 17,350 Sinhala news articles. Datasets were prepared by using scrapped Sinhala news articles, categorized under Political, Religion, Crime, Cricket, Football, Rugby, and Entertainment and combined with MovieLens users' and items' profile dataset. For training purposes, several optimization algorithms were used in order to reduce the loss value and a few activation functions were used in order to determine the output of the deep neural network. Few loss functions were used including Mean Absolute Error, to measure the loss in the hybrid model. One hundred and fifty epochs were conducted with 0.2 as the test size for the proposed model. Best performance, that is, the least loss of the hybrid model was given by the Rectified Linear Unit activation function along with Adam optimizer which contains 0.01 as the learning rate accompanied by Mean Absolute Error. The study revealed that the hybrid recommender system used. performed well to eliminate the above mentioned weaknesses found with the other two recommender models, and with higher accuracy. However, the loss decreases with the number of documents in one dataset, and the higher the number of articles, the lesser the loss value. Other than that, a higher number of epochs also helps minimize loss, thereby increasing accuracy.

Keywords: Collaborative filtering, Content-based filtering, Hybrid recommender system, Recommender system

Abstract No: SI-07

A qualitative analysis on strengths and weaknesses of Cyber Security Bill 2019 in Sri Lanka

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The Internet as we know it today, is a stark contrast to what it was in its formative years in terms of accessibility, usage, security, user interface and cost to the user. With the development of the Internet and its wide use by businesses for commercial reasons, cybercrimes are also increasing. It is becoming more difficult to protect the computer systems against these crimes. In recent years, an increasing number of cyber-attacks on government domains and private infrastructure within Sri Lanka, raised the need for a robust Cyber Security Strategy to regulate and protect against cyber-attacks. The objective of this research is to qualitatively analyse the strategies and weaknesses of the Cyber Security Bill, 2019 (Bill). The study is carried out as a library-based qualitative analysis based on the Bill as the primary data source while conference papers, journal articles, and online news resources were used as secondary sources. The data collection method was via the Internet. The analysis was carried out by comparing the Bill with reliable sources, including, National Institute of Standards and Technology (NIST) and Computer Emergency Readiness Team (CERT). Throughout the Bill, a lack of interpretation of the extract definitions of terms has been identified. According to the proposed Bill, there are three principal government bodies responsible for identifying and mitigating cyber threats: Cyber Security Agency of Sri Lanka (the Agency), National Cyber Security Operations Centre, and CERT. The newly established government entities must work alongside with well-established private organisations, which may cause conflicts when critical decisions have to be made. Furthermore, the Bill has not mentioned any proactive or reactive mechanism for surveillance, monitoring, and response to social media abuses. Even though the Bill has introduced penalties and imprisonment for violation of the Act, there were no clear limitations defined in the context of cybersecurity and cybercrimes; at what minimum level, an action became a cybersecurity law violation and became a cybercrime. The mechanism to appoint the Director-General of the Agency is not at an acceptable standard, while only two primary qualifications have been required. Well-defined and comprehensive interpretations of cybersecurity-related terms are necessary for this bill to avoid conflicts, while identifying, and regulating the cybercrimes and associated activities. From the perspective of the organisational structure, it might be more efficient to have a centralized structure to ensure timely, quick and critical action to mitigate cybercrimes. A Centralised responsible organisation to act for all cybersecurity-related issues, would be advisable. A suitable criterion for the appointment of the Director-General of the Agency should be established and should not be primarily driven by the seniority and experience, but also assess the suitability with background checks on the person with extensive qualifications. The Board of Directors are also appointed by the Minister himself, which might be driven by political biases. Instead, they can be selected by a panel of experts in the cybersecurity field, national security officials, and law enforcement authorities. Furthermore, a wide range of areas should be covered by the Bill, including power plant protection, banking sector, telecommunication, and healthcare. Proposing the Bill is an exceptional jump towards the brighter future of protection of Sri Lanka's Cyberspace. However, it should go through significant discussions and necessary revisions incorporated for it to become truly effective in combatting cybercrimes in the country.

Keywords: Cybercrime, Cyber Security Bill, Cyberwarfare, Information security, Sri Lanka

Abstract No: SI-08

Image-based deep learning approach for flood impact level identification

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Disasters are a global issue that could have catastrophic consequences on the local economy of the country. While they can be natural disasters or man-made, among natural disasters, floods can be classified as the most common disaster that disrupts human lives regularly in Sri Lanka. Floods contribute to the disruptions of people's day to day activities as well as causing economic hardship and property damage. It happens with little warning or prediction and to avoid the impact that can occur after flooding it is necessary to have a real-time warning system or risk analysis system. Identifying the flood impact level has become very important when managing a flood emergency in Sri Lanka. This paper proposes an image based deep learning model for automatically identifying a flood risk. The purpose of this study is to provide an approach for easily identifying the flood risk level using images. People can then easily identify the passable roads when traveling in the flood area without taking undue risk and rescue teams can easily access affected victims while avoiding the high-risk areas. The proposed methodology goes through the data collection, image pre-processing, deep learning model, active learning, performance evaluation, and practical implementation. It used social media image data because there is a huge volume of flood images shared on social media platforms like Facebook and Twitter. For this study, a total of 1543 flood images were collected. The images were classified under three risk levels, high-risk, medium-risk, and low-risk and divided into three datasets named train set (1243), test (250) and validate set (50). To analyze the most accurate models VGG16 VGG19, Mobilenet and Densenet169 were chosen for transfer learning as they are most suitable for image-based classification. Models are trained using trainset and after feature extraction, fine-tuned models performed with 63%, 68%, 86%, and 65% accuracy respectively. To test the accuracy of the model, the test set was used. In comparison to other models, Mobilenet model outperformed them with an 86% accuracy with high learning speed. To evaluate the models, validate set was used to measure the prediction accuracy and the model has an average of 83% prediction accuracy. As future work, authors suggest to improve the accuracy of the models using the ensemble method and create a real-time platform.

Keywords: Deep learning, Fine-tune, Image pre-processing**,** Transfer learning

Abstract No: SI-09

Predicting non-communicable diseases using machine learning techniques

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If diseases are not treated promptly, they can lead to many health issues and these could be sometimes fatal. These problems are exacerbated by the lack of specialists, doctors, and health facilities in Sri Lanka. Accurate diagnosis of treatment depends on the method used for diagnosis. In general, when one suffers from a particular disease, the person has to see a doctor, which is often a time-consuming and expensive task. Sometimes, patients have limited access to physicians and hospitals, and therefore run the risk of the illness not being identified. This would be relatively overcome, if an automated method can be used, saving both time and money and being efficient and effective for the patient as well as the doctors. This study aims to build a web-based application coupled with a mobile application, which predicts the disease by getting patients' symptoms as inputs. A questionnaire is used to obtain symptoms from the patient. Further, it would be possible for the patient to upload images which may assist the doctor in the diagnosis. For example, if a patient suffers from a skin disease he can upload an image of the diseased skin to the system. The system would also assist the user by suggesting the best physicians for the predicted disease and allow them to make appointments with those doctors and find the nearest hospitals those doctors are available. Moreover, the physicians would have the ability to make their channelling schedules through the system. Therefore, the system would be beneficial for both patients and doctors as it saves time and money. The system would allow saving the medical history of the patients too. A dataset of symptoms was gathered from two sets of patients at the Teaching Hospital, Karapitiya, with each dataset consisting of 300 patients. To classify the diseases, K Nearest Neighbour supervised machine learning algorithm was used. The average accuracy gained was 0.72 for the correct disease prediction. The lack of patients' data records for the data of the symptoms set resulted in the low accuracy of the system. The system intends to use more supervised machine learning algorithms like Naive Bayes and decision tree in further developments, to choose the best algorithm which, gives more accuracy for disease prediction.

Keywords: Disease Prediction, Image Processing, KNN Algorithm, Machine Learning, Non-communicable diseases

Abstract No: SI-10

Evaluating optimal lockdown and testing strategies for COVID-19 using multi-agent social simulation

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COVID-19 pandemic has become a major concern due to its rapid spread throughout the world. We can observe some countries are successful in formulating strategies effectively for managing the transmission of the pandemic, while some countries like USA, India and Mexico are struggling to identify effective policies. Recently, we can observe an increasing trend for COVID-19, surging in the Asian region. The study is based on the question of formulating effective policies for curbing the surge in COVID-19 pandemic by reducing community transmission. While many countries are suffering from the pandemic, it is a critical issue that the policymakers should be concerned with formulating effective policies to address the problem. Computational methods are used to foresee the future by creating a simulation model based on multi-agent methodology since statistical methods require the collection of large amounts of accurate data to train the model which is a challenge, currently. Multi-agent simulation helps in studying macro-level emerging patterns in a complex adaptive system such as a society, by simulating the micro-level interactions of individual entities in the system. A survey and literature review are carried out to collect data on people behaviour, responses for different policies, and social composition. When the model runs, simulated agents such as children, parents, and grandparents will engage in their daily tasks. They will have states of susceptible, infected, or recovered. Based on the testing rate and lockdown day parameters, it identifies different zones as contaminated, buffer, and sterile based on whether any infected people live in that area. The implementation of the model follows an iterative process for improving the validity of the model by comparing simulation results with real-world observations. The validated model can be used for exploring and analysing possible emerging patterns related to community transmission of COVID-19 in the society based on different lockdown and testing strategies such as closing schools and universities, reducing visits to supermarkets by the community, use of public transportation and using aggressive testing and lockdown strategies. The results show that when there are no policy measures taken, the pandemic spreads quickly in the community. When the schools and universities are closed, there is a delay in the pandemic, but eventually, most of the community will get infected. When there are policy measures taken to restrict visits to public places, closing schools / universities and a high percentage of people using private transport, show a slight improvement in controlling the pandemic. However, when aggressive testing and lockdown policies are implemented and carried out, the authorities will be able to control the pandemic within a reasonable period compared to other policies. Further, the implications of the study could be used as a decision support tool for analysing lockdown and testing strategies for controlling community transmission of COVID-19 pandemic.

Keywords: Complex adaptive systems, Multi-agent, Policymaking, Simulation

Abstract No: SI-11

Sinhala language-based social media analysis to detect fake news

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In a rapidly evolving digital age, societies rely heavily upon social media to express opinions and to share the news, publicly. With billions of users, this fast mode of information exchange takes only a few minutes to take polarized opinions, oftentimes malicious or misleading, to go viral. The objective of this research is to propose a detection technique that can be used to identify fake news published in the Sinhala language to evade public unrest. Approaches to detect fake news generally rely upon features intrinsic to either the user/source or features based on the content in the text or any hybrid set of above features. The hybrid methodology which was applied in this study, mainly focused on the verifiability of the news text content against credible sources and the credibility of the source was used to obtain the news content. Ordinary user tweets and credible sources' tweets (from 08 sources) were extracted from Twitter. The selected data set consisted of about 6000 credible sources' tweets. Then, ordinary user tweets were labelled as fake (120) and non-fake (250) using the domain knowledge about the news published in the particular month. Both types of tweets were converted into a numerical format. The text encoding was done using FastText, which derives a word as the vector summation of character *n-grams* and converts words into a 300-dimensional vector. The average of word vectors in a sentence was taken as the overall sentence numeric representation. Then, the vector representation of each user tweet was compared against credible news tweet vectors to check whether semantically similar contents appeared on credible sources within a given period. Out of the list of similarity scores obtained by each ordinary user-tweet, the maximum similarity score was used for further analysis. Moreover, a point scheme was introduced for features of a user-account by considering their contribution to the overall credibility of the user- account (e.g.: for each of the 10 followers $\rightarrow$ 1 point). The summation of the points was taken as the user-account credibility score. Then, the formula T_{val} (UC) + (1− T_{val}) TS [i.e. $T_{val} \in (0.5,1]$], where UC is the account credibility score, and TS is the text verification score was generated. Here, $T_{val} > 0$ decides the relative contributions of content verification and user-account credibility to the overall tweet's credibility assessment. In the initial implementation, for Tval = 0.7, results indicated a maximum accuracy of 70% with credibility detection of tweets, after comparison with human-annotated tags. While source credibility plays an important role in overall content's credibility, the study demonstrates that the use of the verification-based method is more effective in Sinhala fake news detection.

Keywords: Fake News, Hybrid Methodology, Social Media

Abstract No: SI-12

A deep learning approach to outbreak related tweet detection

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Social Media has become a good indicator that reflects the real-time behaviour of society. Due to the popularity of social media platforms around the world, people use to express their observations and concerns on social media. People tend to report and discuss real-world events, personal health complications, and disaster situations through these platforms. These social media data streams can be used as a means to track and detect different types of events that affect large groups of people, such as epidemics, public disorderliness and disasters. Initial outbreak reports may first appear in these platforms even before it appears in the formal sources. A mechanism to identify these outbreak-related social media posts are needed to predict the outbreak in advance. Early detection of outbreaks in advance using these social media platforms will help relevant authorities to take appropriate actions. Even though there are existing models for outbreak prediction they have limited intelligence as they have focused only on one type of an outbreak. The main objective of this research is to propose a generalized model architecture that can detect tweets related to different types of outbreaks. In this paper, we propose a deep learning model that can detect tweets that are related to different outbreaks like epidemics, public disorders, and disasters. The semantic of the tweet is very important when determining whether it might be related to an outbreak. GloVe (Global Vectors for Word Representation) word embedding are used as the feature extraction technique in this study as it can capture the semantic meanings of the tweets. Long Short-Term Memory (LSTM) which is a specialized Recurrent Neural Network (RNN) architecture that can capture long-range dependencies in sequential data like text, is used as the classification algorithm. In the process, first, outbreak-related tweets were manually collected and labelled to ensure that only true outbreak-related tweets are fed into the supervised learning model. Then the annotated Twitter dataset of 4393 tweets was curated using relevant Natural Language Processing (NLP) techniques. Pre-trained GloVe word embedding of 100 dimensions that were trained on a large corpus of tweets were then used to represent the words of the tweets. As the next step, a Deep Learning Model was trained by using LSTM technique on the curated Twitter dataset. Finally, the performance of the model was evaluated using a different dataset of 341 tweets. During this phase, the model was evaluated using performance metrics, accuracy, precision, recall, and F1-score. The proposed deep learning model performed accurately in the testing dataset with an acceptable accuracy of 89%. The results were then compared with an existing machine learning model architecture for outbreak prediction. These results indicate the effectiveness of the LSTM algorithm when detecting outbreak-related tweets and the GloVe word embedding technique when capturing the semantics of tweets. With the results of this study, we can conclude that the proposed deep learning model architecture is an accurate approach for outbreak-related tweet detection.

Keywords: LSTM, NLP, Outbreak prediction, Twitter, Word embedding

Abstract No: SI-13

Introducing a new statistical model to analyse the security of the shard-based public blockchain

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To support a large amount of data traffic and unyielding quality of service requirements, a highly scalable and reliable networking system is required for public use of blockchain technology. There are several types of studies carried out particularly in developing new methods to use blockchain protocols to manage data transmitted from a larger number of industry segments, such as supply chain, banking, healthcare, and the government sector. Nevertheless, the scalability of the blockchain system remains a problem because of the massive amounts of data generated through the networks. Current blockchain systems are incapable of handling large number of transactions per second (TPS). This results in current blockchain systems being unsuitable for large scale and real-time controlled networks. Recent studies carried out in this area, have proposed the use of shard-based consensus protocols which suggests splitting transactions into multiple committees or shards. These shards are processed in parallel. This parallel processing of split shards or sets of transactions improves the overall scalability, significantly. However, there is not enough scientific literature available to analyse the security of shard-based public blockchain protocols. The key contribution of this study is to introduce a probabilistic model to analyse the security of shard-based public blockchain technology by using the cumulative negative binomial distribution and hypergeometric distribution, based on the failure probability bounds of each committee/epoch. In this study, the classical bound of Chebyshev, Chvátal and Hoeffding bounds are used to evaluate the proposed model with the comparison of three bounds. Furthermore, the popular sharding protocols (Rapid-chain, OmniLedger, Elastico, Harmony and Zilliga) have been analysed to validate the introduced statistical model. The study proposes an approach, via a shard-based blockchain protocol, and defines the conditions that need to be met in order to keep the likelihood of failure smaller than a given threshold.

Keywords: Blockchain, Failure probability bound, Hypergeometric distribution, Negative binomial distribution, Sharding

Abstract No: SI-14

Prediction of the incubation period of COVID-19 patients using machine learning techniques

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Coronavirus Disease 2019 (COVID-19) is a respiratory infection caused by a newly discovered coronavirus. As of September 2020, within about eight months of this infectious disease being identified, more than thirty million cases and 950,000 deaths have been reported within two hundred countries and territories. The incubation period of COVID -19, is the time range between exposure to symptom onset. During this period, affected persons may not show symptoms of being infected but are still capable of transmitting the virus to others. It is very important to identify the incubation period accurately to decide quarantine periods and to develop policies. Based on the current findings, the incubation period ranges between 2 to 14 days. Since there is a range to the incubation period, almost all the suspected cases should undergo a quarantine period of 14 days, which sometimes leads to inefficient allocation of resources in some cases. Although there are many studies on assessing the incubation period, studies regarding the factors affecting the incubation period are limited. This study is primarily aimed at identifying the factors affecting the incubation period and to develop a model to classify the incubation period of suspected cases, using machine learning techniques. Publicly available patient records within different countries were used for the study. The gathered dataset consist of 500 patients records with the age ranging from 5 to 80 years. Out of those records, 285 were male and 215 were female. The dataset includes 205 patients from China, 51 patients from Japan, 36 patients from Malaysia, 24 patients from the United States, 41 patients from South Korea, 31 patients from France, 24 patients from Taiwan, 46 patients from Singapore, and 42 patients from other countries. The results indicate that factors such as patients' age, gender, geographic location, immunocompetent/immunocompromised state, direct/indirect contact with the affected patients, cause deviations to the incubation period. Chi-square test of independence and correlation analysis were used to identify the relationship among variables and to identify the factors which have the strongest relationship with the incubation period. Supervised learning classification algorithms such as Support Vector Machine, Naïve Bayes, Decision Tree, Logistic Regression, and Random Forest were compared in this study. Overall model performance was evaluated using the weighted average of the incubation classes. Random forest was selected as the best algorithm to classify the incubation period since it performed better than other algorithms achieving a 0.78 precision score, 0.84 recall score, and 0.80 F1 score. As the final step, AdaBoost algorithm was used to improve the performance of the Random Forest algorithm.

Keywords: AdaBoost, Boosted Random Forest, COVID-19, Incubation period

Abstract No: SI-15

CNN based deep learning model for tomato crop disease detection

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Tomato is one of the most commonly cultivated solanaceous short duration vegetable crops, grown in outdoor and indoor conditions, worldwide. However, unfortunately, many diseases affect these crops which have an impact on quality and the quantity of the produce, agricultural productivity, and causes considerable economic losses to the producers and to the contribution to the growth of the agricultural sector. Therefore, continuous monitoring of the crop is required throughout the growing stage to identify the diseases. The most traditional way of identifying diseases is naked eye observation, which is tedious and time-consuming. Today, advances in computer vision paved by deep learning have led to a situation where disease diagnosis is based on automated recognition. The main objective of this study is to develop an accurate tomato disease classification model which eliminates human error when identifying diseases. Due to a variety of similar disease and pathological problems, even experienced agronomists and plant pathologists often fail to recognize the correct disease. This computer vision system will assist agronomists in detecting a variety of tomato crop diseases. The proposed algorithm consists of four main steps; data collection, data pre-processing, CNN model creation, and evaluation of performance metrics. A leaf is a good indicator of the tomato's health. Therefore, tomato leaf images belonging to 10 different classes with a resolution of 256x256 were collected from the Internet to build, validate, and test the model. Collected images were normalized and image augmentation techniques were applied to increase the size of the training data set in the pre-processing phase. The CNN model of the study was built from scratch using the Keras library, which runs top of the Tensorflow backend. The model comprises four convolutional blocks followed by batch normalization, max pooling, and dropout layers. Two dense and flatten layers were also included at the end. A time-based learning rate scheduler was used with an initial learning rate of 0.001, momentum of 0.5, an epoch of 15 and a batch size of 27. The final model was able to achieve a training accuracy of 94% and a testing accuracy of 92%. This proposed system would encourage tomato cultivators to detect diseases at an early stage and start treatments without relying on experts. In the future, we hope to build an ensemble approach to classify plant diseases with real-time images towards the development of a decision support system.

Keywords: Automated disease recognition, Computer vision system, Tomato disease classification

Abstract No: SI-16

Fog computing and IoT based prediction system for healthcare using deep learning methods

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The rapid developments in the information technology arena over the last three decades, have seen a huge range of software application solutions being developed for various sectors of the economy. Cloud computing delivers tools to support businesses over the Internet, efficiently and effectively. However, the key problems currently faced in these cloud architectures are their minimal scalability, low latency, availability, network capacity, stability, and privacy to satisfy the needs of unified computing systems dependent on the Internet of Things (IoT). A modern computational model called Fog computing therefore provides low latency and energy-efficient approach to address cloud computing challenges. The study introduces a new architecture to embed ensemble deep learning in Edge devices and have applied it to enable automated analysis of disease. This architecture provides health care with IoT devices as a fog service and handles heart patient data which is effectively captured as user requests. Further, this architecture gathers the Cloud resources when Fog devises overload and optimize the architecture performance. The proposed architecture was deployed and tested for power usage, network bandwidth, latency, reliability, and timely execution efficiency of the proposed model. We used different edge devices to implement this architecture like a laptop, Raspberry pi, smartphone, and node MCU. Then they are employed as Fog nodes. We used a laptop as a Master Fog node, Raspberry pi as a worker node, and also used node MCU to connect sensors to gather patient data. A smartphone is then used with a simple android application to communicate through the Fog nodes by Rest API. We use a router to create a local network by connecting every node to the router. It was then possible to get sensor data to the android application from the node MCU. Then we can send a job request to the master node. After obtaining the job request, the master node checks the free worker node which is not overloaded and sends the IP address of that worker node back to the mobile application. The mobile application sends the data to the worker node with the IP address received from the master node and gets the predicted result. Then we developed the ensemble deep learning module and implemented it within each worker and the master node. We use Cloud Data Centre to predict the result when the Fog environment becomes overloaded and implement this architecture and evaluate that against only the Cloud environment. The study identified this Cloud-Fog architecture as providing better performance than a simple Cloud architecture.

Keywords: Cloud computing, Fog computing, Internet of Things, Latency

Multidisciplinary Research

Abstract No: MR-01

Sorption studies of metal ions by formaldehyde-based ion-exchange resins derived from anthranilic acid, salicylic acid and catechol

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Polymeric chelating ion exchange materials open a wide range of opportunities in industrial, environmental and biological applications owing to their metal ion-exchange selectivity and low cost of production and easy regeneration. Formaldehyde based two terpolymeric resins [Anthranilic acid- Catechol-Formaldehyde (ACF) and Salicylic acid- Catechol-Formaldehyde (SCF)] have been synthesized by condensing anthranilic acid with catechol and salicylic acid with catechol at 80 ± 5 ºC using Dimethylformamide (DMF) as a solvent. The main aim of this research was synthesis and comparative ion exchange study of newly synthesized formaldehyde-based ion-exchange resins, which derived from anthranilic acid, salicylic acid and catechol. The present abstract deals with synthesis and comparative ion exchange study of newly synthesized resin obtained by formaldehyde-based ion-exchange resins derived from anthranilic acid, salicylic acid and catechol. The resins were characterized by spectral analysis using Fourier-Transformed Infrared (FTIR) spectroscopy. The physico-chemical properties of the resins have been studied. Melting points of both resins were mostly high and that indicates the polymer resins under study are thermally stable up to high temperature. The exchange behavior of various metal ions viz. Cd^{2+}, Cr^{3+}, Ca^{2+} and Mg^{2+} towards synthesized resins have been studied depending on contact time and pH. Chelating properties of the two resins were pH dependent and an increase in pH value from 1 to 5 the exchange capacity of metal ions was increased. Sorption studies of ACF resins suggest that the ion exchange order of metal ions is time dependent. The order of the exchange capacity is: $Cd^{2+} > Ca^{2+} > Mg^{2+} > Cr^{3+}$. ACF is more suitable for the removal of hardness from water when compared to the SCF. SCF is a better chelating resin for the removal of heavy metal. The recovery of the metals from industrial effluents indicates the utilization potential of the synthesized resin for wastewater treatment.

Keywords: Terpolymeric resins, Exchange capacity, Chelating properties, Wastewater, Adsorbents

Abstract No: MR-02

Linear programming approach to assess an optimal cultivation plan: A case study

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An optimal cultivation plan refers to the procedure or action of making the best or most effective use of resources for cultivation in a sustainable manner while maximizing net return. Reaching an efficient cultivation plan and utilization of resources and requirements is often a challenging problem. To utilize resources and requirements such as water, land, manpower, fertilizers and seeds, optimization techniques are used. The objective of this research is to maximize the net return of the cultivation using linear programming technique and allocate the arable land optimally. Linear programming is the most convenient and effective tool to handle the objective function with many constraints. This study was carried out in a rural village located in Dompe divisional secretariat in Gampaha district using 150 farming lands, to determine the land resource allocation for twelve selected crops: bitter gourd, lady's fingers, manioc, potatoes, rambutan, banana, pineapple, beetle, rice, coconut, tea and pepper. The linear programming model is formulated for the optimal land resource allocation of 4477.2 perches. The maximum net return projected by the proposed model is Rs 6,370,512.00 for cultivation seasons. The proposed solution is a 34.96% increase in profit as compared to the actual profit obtained from the cultivations. Crops like rambutan, rice, manioc and pineapple which provides a higher return should be developed and cultivation extended under the supervision of the agricultural expertise or officers. The model suggests that some crops such as lady's fingers, potatoes, banana and coconut may not be providing comparable returns versus the other selected crops. The results reveal that linear programming approach will significantly improve the net benefits with optimal crop area allocation. The limitation of this study is that it is considered the soil condition is the same for all crops in the study area. Advanced operations research techniques like multi objective nonlinear programming models will be employed for this study in future work.

Keywords: Linear programming, Objective function, Cultivation, Net return

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Abstract No: MR-03

Beneficial functions of plant materials used in *shodhana* process of mercury in Ayurveda *Rasashastra*

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Shodhana process in *rasashastra* is a mandatory process for each material prior to use in herbo-mineral pharmaceutical preparations. Although different types of mercury (Hg) *shodhana"*processes are described in *rasashastra*, in Sri Lanka, Ayurveda herbo-mineral manufacturers use a three-step method with *Allium sativum* extract, *Piper betel* extract and the decoction using *Terminalia chebula*, *T. bellerica* and *Phyllanthus emblica.* Although this method is well-known within the Ayurveda community, there are no research evidences available to identify the support and the functions given by the plant materials in the mercury *shodhana* process. Therefore, this research was carried out to analyse the elemental changes that would occur to commercially available mercury during the *shodhana* process. *Shodhana* process was carried out as mentioned in the *Rasa Jala Nidhi* textbook (volume I) of *rasashastra* literature under the mercury section (eighth process). As the *shodhana* process involves three steps, there were four samples to be analysed namely, crude mercury, first step completed Hg, second step completed Hg and final step completed Hg. Samples were microwave digested using HNO_3: HCl in 3:1 ratio and diluted prior to the Inductive Coupled Plasma Mass Spectroscopy (ICPMS) analysis. These four Hg samples were then, subjected to ICPMS analysis. Standard 2A was performed to check Ag, Al, As, Ba, Be, Cd, Co, Cr, Cs, Cu, Fe, Ga, K, Li, Mg, Mn, Ni, Pb, Rb, Se, Sr, Tl, U, V, Zn elements and standard 2A Hg was performed to check Hg element. Cu, As and V were measured in He gas mode and rest were measured in no gas mode. The analysis was carried out in triplicate. Origin and R software were used for the comparison. According to the results obtained, Mg, Al, Fe, Co, Zn, Cd, Ba and Pb were present in the crude mercury as noticeable elements, but the element levels were changed with each *shodhana* step. Most importantly, it clearly shows the reduction of Pb level from 2347.25 ± 0.01 ppb to 173.20 ± 0.02 ppb. Furthermore, trace elements such as Li, Ni, Ga and U were completely removed from mercury after the completion of *shodhana* process. The reason for the reduction of metal ions can be attributed to metal iron chelation, detoxification procedures with plant bioactive compounds such as organic sulphides, polyphenols and flavonoids. Therefore, these results reflect the benefit of *shodhana* process and clearly explains the use of plant extracts as a removal agent of unwanted metal ions, which are trapped in Hg.

Keywords: Mercury, Ayurveda, *Shodhana*, Plant extracts

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Abstract No: MR-04

Modelling Sri Lankan traffic accident casualties: time series count data model approach

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Traffic accident related deaths and fatalities have become the first level global health problem within the past 20 years. Accurate forecasting of the number of traffic accident casualties for a particular geographical area is very important in order to reduce the fatality rate associated with traffic accidents. Health care authorities, hospitals and emergency ambulance services can have a general idea about the number of emergency patients that can be received in given time period. Law enforcement and health care authorities can develop strategic plans to prevent traffic accidents by effectively managing road traffic. Therefore, the ultimate objective of this research was to identify the associated factors, and forecast traffic accident casualties in Sri Lanka with higher accuracy. Usually, count data are modelled with Poisson regression, and time series data are modelled with Gaussian time series modelling techniques. In order to get better forecasting accuracies, both time series and count aspects of traffic accident casualty data should be considered simultaneously. These hybrid models had been rarely used in literature due to the limited awareness and the complexity of the models. Therefore, this research was planned to introduce time series count data modelling approach for Sri Lanka traffic accident data. General time series modelling techniques such as Auto-regressive Integrated Moving Average Models and time series count data modelling techniques such as Time Series Generalized Linear Models have been compared to choose the best model. All island Sri Lankan traffic accident data for years between 2003 and 2016 that was collected by Sri Lanka Police Traffic Head Quarters, has been used to build our traffic accident forecasting model. The data set contained 29 categorical and 11 numerical variables after data cleaning. The time series count data model was able to decrease the mean absolute percentage error by 14.2% The Poisson time series count data model that was fitted using daily accumulated traffic accident casualty time series has become the overall best model. The exploratory analysis shows that there is a strong relationship between number of traffic accident casualties and the variables which indicate the geographical location of the accident such as Province or Police division. Therefore, the forecasting accuracy was further improved by fitting separate Poisson time series count data models for each Police division in Sri Lanka. For example, the root mean squared error was 3.1 for the daily road casualty forecasting model of Nugegoda police division after forecasting for 365 days. Fitting separate models for each police division holds more practical value, since the authorities can get a specific idea about small geographic area. The results of this study have further shown that the variables such as day of the week, time of the day and weather related variables do not have any significant relationship with the number of traffic accident casualties.

Keywords: Traffic accident data, Poisson *tsglm*, INGARCH, Count time series

Abstract No: MR-05

Comparative study of novel virgin coconut oil-based mayonnaise with commercial mayonnaise for physico-chemical and sensory parameters

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Mayonnaise is a world-famous dressing that involves higher oil concentrations in the production process. Virgin coconut oil (VCO) as an emerging oil in the food industry is an ideal ingredient to be used in the production of mayonnaise. In this research, VCO was used as a functional ingredient in mayonnaise preparation and a comparative study was conducted between VCO mayonnaise and commercial mayonnaise. Samples of mayonnaise were prepared using trial and error method according to different oil: egg yolk ratios, and the best samples were selected. Chill thaw stable samples out of the best samples were selected by centrifugation, and the best sample was selected through a sensory evaluation using 30 untrained panelists. A five-point hedonic scale was used to access the parameters. The physico-chemical parameters including color, density, acid value, saponification value, iodine value of the best VCO sample and commercial mayonnaise were determined using standard methods and the two samples were compared for their sensory parameters (color, texture, flavor, taste, spreadability, overall acceptability). Results demonstrated significantly a lower acid value, iodine value and higher saponification values for VCO mayonnaise and physical parameters: color and density of the VCO mayonnaise were significantly different ($p < 0.05$) than the commercial mayonnaise samples. The sensory evaluation resulted a higher mean score of 4.97 for the overall acceptability of VCO mayonnaise while commercial mayonnaise scored 2.75. Studied sensory parameters including color, appearance, taste, flavor and texture of VCO mayonnaise scored higher mean values than commercial mayonnaise though spreadability parameter of commercial mayonnaise scored a higher value of 5.00 and VCO mayonnaise scored a lower value of 4.25. Therefore, the results of the study indicate that, mayonnaise with VCO is considered better, on its quality and organoleptic parameters compared to commercial mayonnaise and some organoleptic modifications are required to achieve better sensory quality.

Keywords: Chill-thaw stability, Mayonnaise, Physico-chemical parameters, Sensory evaluation, Virgin coconut oil

Abstract No: MR-06

Assessment of the quality of composts in selected commercial compost facilities in Sri Lanka

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Organic food production is one of the fast-growing sectors in Sri Lanka with an understanding of health and environmental impacts caused by the use of chemical fertilizers. Hence, there is a high demand for compost by organic agriculture and it is widely used in home gardening as a substitute for chemical fertilizers. The compost produced by using different raw materials are available in markets at present in Sri Lanka. Even though the quality of the compost has to be in accordance with the Sri Lanka standard specification (SLS 1246:2003) for compost from municipal solid waste and agricultural waste, enough studies have not been carried out on the assessment of compost quality. Therefore, the objectives of this study were to assess the quality of compost collected from the commercial compost producing sites and to investigate the time period that can maintain the SLS standards specifications in compost once it is packed. The compost bags of 1 kg were collected within a day from 4 sites (namely A, B, C and D) in Colombo and Gampaha Districts, which have been packed on the same day and stored in the laboratory till analysis. The composts collected have been made from MSW (sites A, B and C) and garden waste (D). The compost quality parameters were measured in monthly intervals for a period of 6 months with three replicates. Data analysis was done by One-way ANOVA. Data analysis revealed that organic matter content and total carbon content in compost of A were lower than the standard limits during the study period. According to the results, the color of the compost in all composting plants was brownish black and complied with the SLS 1246:2003 standards. The compost did not emit irritable odors in any of the compost samples. Phosphorous content of compost from A and C was lower than the standard limit (0.5%) and Potassium content were lower than the standard minimum limit (1%) in C and D. Nitrogen content in compost from all the sites was lower than the standard minimum limit (1%). Composts from A, B, C and D indicated moderate phytotoxicity according to the germination index % values of 74, 67, 74 and 76, respectively which may be associated with the immaturity of the composts. Sand content was higher than the standard limit (10%) in compost plant D. It was found that most of the composting facilities could maintain the Phosphorous and Potassium within the SLS standard limits. However, Nitrogen content in compost from all the sites were lower than the standard limits and it was decreasing with time during the study period. The results showed that the compost produced in selected sites does not meet the standard specifications given by the Sri Lanka Standards (SLS 1246:2003) and therefore, quality control and continuous monitoring are essential to maintain the quality of compost available in the market. The quality control of compost has to be started from the selection of raw materials up to the detection of maturity of compost in order to produce a good quality product.

Keywords: C:N ratio, Garden waste, Municipal solid waste, Phytotoxicity, SLS standard

Abstract No: MR-07

Survey on the health status of the undergraduates of Faculty of Science, University of Kelaniya

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The health status of an undergraduate has a huge impact on their individual aspects such as mental and physical wellbeing, academic performances on the university standards as well as on many key fields of a country. However, a small effort is put in identifying the factors affecting the health status and evaluating them with the objective of improving the health status of undergraduates. This survey presents valid evidence about the habits that determine their health status, physically and mentally. A sample of 384 out of 2203 undergraduates was selected from the faculty of science using a stratified sampling technique for the evaluation, considering the academic levels of the undergraduates. According to the analysis, majority of the undergraduates (63.54%) from the faculty of science are having preferable body mass index (BMI) value, but minority of undergraduates are having obesity. A significant amount of undergraduates having underweight and overweight BMI-categories was also observed. Out of the undergraduates, who were having preferable BMI values, a considerable percentage (51.82%) of undergraduates were observed to be consuming 2-3 liters of water per day. Due to the heavy workload in academics resulting the extra works such as assignments, tutorials, course work etc..., a high percentage of undergraduates were not engaging in physical exercises (59.38%) and sports (66.93%). Swimming was observed as the most popular sport among the undergraduates and it was followed by cricket and football. A higher percentage of undergraduates were observed to participate in sports activities and physical exercises in order to maintain good health and to reduce the anxiety and stress. The analysis highlights that the undergraduates who were having preferable BMI values consume 2-3 liters of water per day, engage in sports and physical activities, maintain good food patterns and have good sleep. Even though the above factors were taken into consideration, there could still exist certain other specific factors that have a significant influence on the health status of an undergraduate. Being healthy is rather a lifestyle that constitutes healthier and wise choices for food and level of water consumption, being positive minded etc. Thus, if the challenge of evaluating and optimizing the health status of undergraduates is achieved; they could make into being more content and positive in every aspect of his or her university performances and peer interactions.

Keywords: Sampling techniques, Stratified sampling, Pilot survey

Abstract No: MR-08

Electrodeposition and characterization of ZnO thin films for gas sensing

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The gas sensor is a sensing device that measures target gas molecules in a given atmosphere specially in the monitoring of environmental contaminants in air, water, and soil. Sensors based on semiconducting metal oxides are being widely used for gas or vapour sensing owing to their properties such as non-toxicity, biocompatibility, compact device structure, high sensitivity and stability and ease of syntheses. The most popular semiconducting metal oxides-based gas sensing materials are ZnO, SnO_2, WO_3 and TiO_2. Among them, ZnO is attracted more due to its other properties such as chemical and photochemical stability and high-electron mobility. Hence, ZnO is one of the most propitious materials in developing sensors in electronic and optical technologies. In this study, characterization and fabrication of ZnO for gas sensing applications using a simple and cost-effective electrodeposition method is discussed. Aqueous electrolytic solutions of Zn $(NO_3)_2$ and $ZnSO_4$ were used as the Zn precursors to find the best suited precursor to electrodeposit ZnO. The deposition was performed under a three-electrode electrochemical cell consisted of FTO coated glass (1×3 cm^2, 7 Ω/m^2), graphite rod (99.995%) and a saturated Ag/AgCl electrode as the working, counter, and reference electrodes respectively. The gas sensing ability of the ZnO films, developed under different deposition parameters (cathodic deposition potential, pH of the electrolyte, precursor concentration), was studied. By obtaining the workable cathodic deposition potentials (CDP) by cyclic voltammetry, the k best suited bath pH and the temperature to develop uniform ZnO thin films were found to be 3.5 - 4.5 and 55 ℃ respectively. Subsequently, the heat treated (425 ℃ for 1 hour) samples were characterized with UV/Vis spectroscopy, X-ray diffraction, scanning electron microscopy and energy dispersive X-ray techniques to investigate the bandgap energy, crystal structure, surface morphology and the material's composition respectively. The band gap energy of the material grown was fallen within 3.00 – 3.30 eV, while the crystals were found to be preferably grown along the [101] or [002] planes possessing hexagonal wurtzite structure in samples grown using two Zn precursors. SEM micrographs evidenced compact morphology with coral/rod-shaped appearance. According to the EDX analysis, Zn:O atomic ratio was revealed to be 1:1. The gas sensing ability of deposited films was examined against NO_2 and H_2S gases that causes due to electronic interactions between the crystallographic plane and the subjected gas molecules. The samples grown in 0.10 mol/L $ZnSO_4$ at CDP 1.00 V in pH 4.50 at 55 ℃ was found to have an average sensitivity of 5% and 11% while the samples grown in 0.10 mol /L Zn $(NO_3)_2$ at CDP 1.10 V in pH 3.70 at 55 ℃ were found to have an average sensitivity of 2% and 5% after exposing to NO_2 and H_2S gases respectively for 5 minutes at 30 ℃.

Keywords: Zinc oxide, Electrodeposition, Thin films, Three electrode system, Gas sensing

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Abstract No: MR-09

Development of an electrodeposition method to enhance the solderability of lead-free solder on nichrome alloy

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Nichrome (Ni/Cr) alloy is used in many industrial applications due to its unique electrical properties and marketability. These alloys consist of passive surfaces due to the chromium oxide layers formed on the nichrome surface. This passive oxide layer forms when exposed to the ambient environment and tends to change the alloy surface's energy. It also decreases the wettability of common soldering materials, which seriously affects the electrical and electronic manufacturing industry, as the low surface wettability leads to poor solderability. Poorly soldered wires can cause problems such as fluctuating resistance and short-circuiting. In this study, a novel passivity breakdown strategy is introduced to enhance the solderability on nichrome. Solderability was assessed by analyzing solder droplets on the nichrome alloy surface. The potential of nickel electroplating was investigated as a method to improve solderability. Simple electroplating will not give a stable nickel layer on the alloy. Therefore, the conditions and pre-treatments required to achieve a stable electroplated layer on the nichrome surface were studied. A nichrome tape with a thickness of 20 μm was used as the cathode electrode. One side of the nichrome tape was electrolytically polished, and a non-conductive polymer was coated on the other side. A nickel metal plate was used as the anode electrode. An acidic bath containing $NiCl_2$ was used to breakdown the passivity of nichrome. Next, a Watt's type bath was used to electrodeposit nickel on the pre-treated nichrome tape. The electroplating parameters such as plating time, pH, and current density of the Watt's bath were investigated, and the effects of these parameters on the quality of soldering were analyzed. An image processing software and contact angle measuring instrument were developed for the solder droplet analysis. The investigation was carried out by droplet shape analysis, and it was done by employing polynomial and ellipse fitting methods. After nickel electroplating, the contact angles of solder droplets were reduced, which in turn improved the solderability. The optimal conditions for obtaining a better solderability are pH of 4.0, current density of 400 A/m^2, and plating time of 3 minutes.

Keywords: Nichrome, Contact angle, Wettability, Solderability, Nickel electrodeposition

Abstract No: MR-10

Feasibility of support vector regression model in order to make an intelligent agent for forex trading

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Today forex market seems promising for trading, but a trader will suffer huge losses through incorrect predictions and losing opportune times in trading. As forex market is a highly fluctuating market, if a trader can predict it to the minute, there is a higher potential to make profits. Further, automating trading will be a solution to the losing of opportune times. In most of the researches, Support Vector Regression (SVR) has become a suitable technique in predicting time series like forex and in almost all of them, they have either used average per day data, average weekly data or average monthly data. This study identifies whether SVR is good for predicting per minute data and can be used to automate forex trading. The closing prices of per minute historical data of the three major currency pairs EURUSD, GBPUSD and USDJPY from 2012 to 2019 were taken for this study. The kernels of SVR linear, poly and radial basis function (rbf), were used to analyses the three currency pairs. They were studied by taking 70% of the first 7 years (2012 to 2018) as training data and the rest 30% as validation data and last year (2019), as a test to automate the prediction of future forex market trading. Gridsearchcv was used to find the best hyperparameters of kernels of SVR and they were evaluated by Mean Squared Error (MSE) and R-squared (r2) score. The linear kernel and the poly kernel did not give a good r2 score (not even a 50% in almost every currency pair) as the market fluctuates heavily it cannot be predicted linearly or with polynomial features. So in this study rbf kernel was more focused as it gave a r2 score of more than 96% for all three chosen currency pairs in both training and validating data as well as a very low MSE of around 0.0002 in EURUSD and GBPUSD. But when considering test data, all the answers were arbitrary worse. To thoroughly study, the back process was done two times taking years from 2011 to 2018 and from 2010 to 2017 for all three currency pairs, using the rbf kernel of the SVR as it gave promising results. Even then, more than 90% of r2 scores were obtained for the training and validation data, and for the test data, it was arbitrary worse. Finally, this study showed that the forex market is a highly fluctuating one and unlike in other studies of average per day data, average weekly data and average monthly data, linear, poly and rbf kernels of SVR are unable to predict per minute data of the future and this is not suitable to use in an intelligent agent.

Keywords: Forex, SVR, Time series, Gridsearchcv

Abstract No: MR-11

Novel *Strychnos potatorum* seeds derived activated carbon incorporated polyacrylamide composite for the removal of Cr (VI) residues from aqueous media

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Excessive amounts of Cr(VI) which are released to the environment mainly due to industrial waste water disposal, instigate a solemn threat to human health. Chromium is extensively used in metallurgy, leather, paints and textile industries. Its compounds are highly toxic due to its ability to cross the cell membranes and its strong oxidation properties. This causes adverse health effects such as lung cancers, ulcers, allergic reactions, kidney, gastric and liver damage. Even though many adsorbents with binding ability towards these pollutants have been developed, it is yet a challenge to develop a low cost, efficient adsorbent. With this regard, in this study, a novel composite has been developed using polyacrylamide and *Strychnos potatorum* seed derived activated carbon (PAAC) and characterized using FTIR-ATR and SEM. The incorporation of activated carbon into the polyacrylamide matrix increased the mechanical strength and the stability of the composite material. Batch adsorption experiments have been conducted by varying contact time, initial Cr(VI) concentration and adsorbent dosage at pH 4 and at 25 ^{o}C. Adsorption isotherm and kinetics studies were performed. Batch adsorption results showed that the optimized parameters for the adsorption of Cr onto PAAC sample were contact time of 180 min, initial concentration of 5 mg/L and adsorbent dosage of 0.25 g. Under these optimized conditions, a quantitative Cr reduction percentage of 57% and maximum adsorption capacity (q_{max}) of 0.55 mg/g was achieved for Cr(VI) at pH 4 at 25 ^{o}C. Obtained adsorption capacity is acceptable since Cr(VI) is present in residual concentrations in water. Experimental data were best fitted to Freundlich isotherm than Langmuir isotherm model. Therefore, adsorption on a heterogeneous surface can be predicted. Cr(VI) adsorption kinetics were well described by pseudo second order rate model. Adsorption thermodynamic studies indicated the spontaneous nature of the adsorption. FTIR analysis revealed the presence of various functional groups that are responsible for the adsorption. Based on the results observed, it can be concluded that the novel PAAC composite could be used as a cost effective, stable and efficient adsorbent for Cr(VI) removal from water.

Keywords: Cr(VI), *Strychnos potatorum*, Polyacrylamide, Composite, Adsorption

Abstract No: MR-12

Removal of diazinon pesticide from water using a polyacrylamide - *Strychnos potatorum* (Ingini) seeds derived activated carbon composite

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Water is one of the essential resources on earth and it is very important to protect water for the survival of all living beings. Modern agricultural activities are highly chemically intensive and can be considered as one of the major polluters of drinking water. Therefore, removing pesticide contaminants from water sources that are used in agriculture is an essential requirement. Among pesticides, diazinon has been identified as one of the major organophosphorous pesticides (OPPs) which are used in Sri Lankan agricultural fields. However, pesticide removal from water by means of low cost and efficient technologies is still a major challenge. In this study, a novel adsorbent material was synthesized using polyacrylamide (PAM) and activated carbon (AC) from *Strychnos potatorum* seeds. Polyacrylamide-activated carbon composite (PAAC) were successfully prepared through aqueous solution polymerization. The synthesized PAAC composite was characterized by FTIR and SEM. The adsorption of aqueous pesticide samples on PAAC composite was studied. High Performance Liquid Chromatography (HPLC) technique was used to determine the diazinon concentration in the medium. Batch adsorption experiments were conducted by varying contact time, initial diazinon concentration and adsorbent dosage at pH 5 and at 25^{o}C. Adsorption isotherm and kinetics studies were also performed. Batch adsorption results showed that the optimized parameters for the adsorption of diazinon onto PAAC sample were contact time of 60 min, initial concentration of 10 mg/L and adsorbent dosage of 0.25 g. Under these optimized conditions, diazinon reduction percentage of 62% and maximum adsorption capacity (q_{max}) of 1.48 mg/g were achieved for diazinon at pH 5 and at 25 ^{o}C. The obtained results are satisfactory since diazinon is present in water in mild concentrations. Adsorption data were found well behaved with the Freundlich adsorption isotherm. Therefore, adsorption on a heterogeneous surface can be predicted. Diazinon adsorption has shown pseudo first order kinetics. Based on the results observed, it can be concluded that the novel adsorbent material could be used as an economical and highly efficient adsorbent for diazinon removal from water.

Keywords: Adsorption, Diazinon, Pesticides, Polyacrylamide, *Strychnos potatorum*

Abstract No: MR-13

Study on phlebitis status of the patients after Peripheral Venous Cannula insertion in Moneragala District General Hospital

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Peripheral Venous Cannula (PVC) insertion is a method in which the cannula is inserted through a peripheral vein. These PVCs are used predominantly to deliver different medications such as drugs, blood products, dyes and contrast media into the body. There are many complications associated with PVC which sometimes can lead to death. The most common complications are infections and phlebitis. This study was conducted to find the potential factors that are associated with the phlebitis status of the patients at the Moneragala District General Hospital. The data used in this study was obtained from the National Intensive Care Surveillance (NICS) Ministry of Health, Sri Lanka. The data were collected in the period of November to December 2017 and March to April 2018. The dataset was comprised of 523 observations. Visual Infusion Phlebitis (VIP) score was the measurement, used to measure the status of phlebitis of the patients, which is a standard score. It scales from 0 to 5 where 0 indicates no phlebitis and 5 indicating the serious stage of phlebitis. Initially, descriptive analysis was conducted to determine the important patterns of the data then Kruskal Wallis test and Pearson Correlation test were used to find the factors associated with the VIP score. 21.4% of the patients considered in the study resulted in phlebitis with 15.49% of the patients with VIP score 1 and 5.93% patients with VIP score more than 1.The Kruskal Wallis test resulted that the ward, size of cannula, type of dressing, intravenous medications are the variables that yield a significant association on the occurrence of phlebitis at 5% level of significance and the variable age was found to be significant at 5% level of significance from the Pearson Correlation Test. Results showed that the patients who sited their cannula in the wrist were highly infected compared to the patients who sited the cannula in the hand or forearm. Also, PVC inserted to the right side resulted in the inflammation more than to the left side. Findings also revealed that the patients who inserted a yellow colour and grey colour PVCs have not resulted with phlebitis but the patients who inserted a green colour and pink colour PVCs have resulted with first stage of phlebitis. In addition, patients that used a tape to dress the PVC were highly infected compared to the patients who used a bandage. Surprisingly, phlebitis resulted more on the patients who didn't transfer intravenous medications into the body through the PVC. Furthermore, the median age of the patients who resulted phlebitis (50 years) was higher compared to the non-inflamed patients showing that there is a high risk of developing phlebitis in the older community. In conclusion, ward, age, cannula size, type of dressing and intravenous medications has an association on the development of phlebitis according to this study. Therefore, hospitals should adopt appropriate guidelines in order to minimize the risk of developing inflammation.

Keywords: Cannula, Phlebitis

Abstract No: MR-14

Synthesis and evaluation of 2,3-diphenylquinazolin-4(3H)-one as a corrosion inhibitor for mild steel in acidic media

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Corrosion is an oxidation-reduction process where a metal is oxidized to a more consistent form such as its oxide, hydroxide, or sulfide by atmospheric oxygen. Corrosion is an excessively costly issue that is reported to cause significant economic damage globally each year. Therefore, the discovery of novel corrosion inhibitors is highly desirable. Corrosion inhibitor molecules are first absorbed into the metal surface by electrostatic interactions. Then coordinate covalent bonding occurs by share or transferring electrons from the inhibitor to the metallic surface. The inhibitor adsorption on to the surface of the metal hinders its active sites where oxidation occurs, and results in reduced corrosion. The adsorption process depends on the inhibitor structure, surface morphology, temperature, pressure as well as the pH. Compounds that possess heteroatoms such as nitrogen, oxygen, phosphorous, and sulfur atoms and multiple bonds in their structure have better corrosion properties as they have higher basicity and higher electron density. Quinazolinone derivatives have various biological, chemical, and physical activities, especially we focused on anticorrosive activities. Quinazolinone derivatives are widely employed as excellent corrosion inhibitors as well. They are capable of decreasing the corrosion process and protect steel in acidic environments. In this research, a quinazolinone derivative, 2,3-diphenylquinazolin-4(*3H*)-one was synthesized using anthranilic acid via intermediate, 2-phenyl-4H-benzo[d][1,3]oxazin-4-one and aniline and confirmed the structure using infrared (IR), ^{1}H-NMR, and ^{13}C-NMR analysis. The corrosion inhibitory activity of the 2,3-diphenylquinazolin-4(*3H*)-one on a mild steel, JIS 3113SPHE in 0.5 M hydrochloric acid solution was determined by two different corrosion analysis methods namely, the weight-loss method and the polarization method. Mass loss dependence on the content of inhibitor in the corroding medium, temperature of the corroding medium, and the pH of the solution were measured. Corrosion inhibition of 2,3-diphenylquinazolin-4(*3H*)-one was analyzed using different concentrations (1×10^{-4} M - 5×10^{-4} M). The compound exhibited maximum inhibition efficiency of 80-84 % at 5×10^{-4} M. When increasing the temperature, mass loss and the corrosion rate was increased. Though the corrosion rates increase gradually as temperature rises, even at 333 K, the corrosion rate of 2,3-diphenylquinazolin-4(*3H*)-one at 5×10^{-4} M was only 2.3 x 10^{-3} $gcm^{-2}hr^{-1}$. The mass loss was decreased as the pH of the medium was increased. The results of the potentiodynamic polarization method suggest that 2,3-diphenylquinazolin-4(*3H*)-one act as a mixed type corrosion inhibitor in the acidic medium. According to the experimental results 2,3-diphenylquinazolin-4(*3H*)-one is an efficient corrosion inhibitor.

Keywords: Corrosion inhibitor, 2,3-diphenylquinazolin-4(*3H*)-one, Inhibition efficiency

Abstract No: MR-15

Case study of credit risk analysis and creditworthiness prediction at loan approval

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The credit risk is considered as the risk associated with a borrower's failure to pay the loan or interest amount on time. An increase in Non-Performing Loan (NPL) ratio directly affects the financial performance of the banks as well as the economy of the country as a whole. Therefore, this case study was carried out for a specific bank in Sri Lanka with the objectives of developing a predictive model to assess the creditworthiness of potential loan applicants at the approval and to identify factors associated with time to first default. The data used for this study consisted of bank loan details of 10,626 existing customers in their current loan portfolio and their repayment behavior over 2.5 years. It consisted of 11 continuous and 7 categorical variables including customer's demographic details, personal financial details and bank-specific ratios. Furthermore, it included 10 transaction variables which all are categorical. The univariate tests such as Mann Whitney Test and Chi-Square Independence Test and graphical analyses identified that apart from variables "Age at Approval" and "CRIB Status at the approval", all the other variables showed a significant relationship with the variable of interest, "Loan Status". As only 33% of the respondents were non-performers, the Synthetic Minority Oversampling Technique (SMOTE) was used to handle the class imbalance. Several machine learning techniques such as Logistic Regression, Random Forest, Support Vector Machine, and Artificial Neural Network were applied with and without SMOTE Sampling to achieve the optimal model by comparing the ROC-AUC value of each model. The Artificial Neural Network model applied with SMOTE sampling was found to be the best model with a ROC-AUC value of 91.6%. Furthermore, the study data consisted of the borrowers' default status in every quarter. Therefore, a discrete-time hazard survival model was developed to identify the predictors that affect most of the risk of first default. It was found that the risk of first default to be higher in early quarters and decreases over time with the best fitted discrete survival model. Particularly, "Security type", "Loan to value ratio", "Tenure", "Purpose of the loan" and "Interest rate" were some of the variables found as the most significant variables that associate with the risk of first default.

Keywords: Creditworthiness, Machine learning, Non-Performing loans, Synthetic minority over sampling technique, Survival analysis

Abstract No: MR-16

Estimating separability of magnetisation signals by fast implementation of Bloch equation simulations across multiple tissues and distance correlation function

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Magnetic Resonance Fingerprinting (MRF) is an emerging field in Magnetic Resonance Imaging (MRI) where tissues to be identified are subjected to a series of magnetic pulses. The resulting magnetisation signal is governed by both the tissue properties as well as the chosen pulse acquisition parameters. By employing a suitable classifier, the tissue properties are recovered from the magnetisation signal in MRF. Depending on the chosen pulse acquisition parameters, the resulting magnetisation signals must be unique for different tissue properties for MRF to be effective. But the acquisition parameters of magnetic pulses in MRF are traditionally chosen in random. Hence, it is possible that the magnetic signals for tissues of concern may not be sufficiently distinguishable for efficient classification. Therefore, to explore the possibility of optimising the level of separability of magnetisation signals of different tissue types, optimal values of acquisition parameters of the pulse sequence must be carefully engineered. This task requires means of estimating the level of separability of magnetisation signals for different tissues. In this study, a fast simulation mechanism is implemented that estimates the level of separability of magnetisation signals generated in MRF for a chosen set of tissue properties and pulse acquisition parameters. An in-house built Bloch equations simulator was used to model nuclear magnetisation of atoms for both Balanced Steady State Free Precession (BSSFP) and Echo Planar Imaging (EPI) pulse sequences with variable pulse acquisition parameters. For the two pulse sequences chosen, calculating the magnetisation signal for a single tissue is sequential by nature. However, the calculations are parallel when repeated across multiple tissues. Therefore, the simulator was implemented on a Graphical Processing Unit (GPU) to exploit the parallel nature of the problem and to shorten execution time. To determine the level classification of magnetisation signals, distance correlation Function, which measures both linear and non-linear association between two signals was chosen. Since for N number of tissues, there are ${}^{N}C_{2}$ number of correlation computations, the computational demand will be prohibitively expensive with higher numbers of tissues. Therefore, the distance correlation which, given the parallel nature of calculations, was reformulated as a series of array operations to be able to execute in the GPU. It was observed that as compared to a CPU only implementation, GPU execution of Bloch equation calculations sped up significantly. Through reformulation as array operations, calculation of distance correlation, which computationally is more expensive than Bloch equation simulations, sped up roughly by a factor of 10,000 times. With the fast execution time through GPU, the implementation provides practical means of evaluating a vast number of tissues to indicate the level of separability for a chosen set of pulse acquisition parameters within a few seconds. Therefore, the system developed facilitates a designer to carefully engineer the optimal pulse sequence parameters to ensure that the magnetisation signals generated are efficiently classifiable prior to carrying out physical scans for MRF using the MRI machine.

Keywords: Bloch equations, Distance correlation, GPU, Pulse sequences

Abstract No: MR-17

Finding an efficient solution system for leaching extractable proteins from natural rubber gloves

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Natural rubber latex (NRL) is used to manufacture a large number of useful products such as gloves. Allergy to NRL gloves is caused by latex proteins extractable into sweat. Extractable proteins (EP) come in contact with the skin causing allergic reactions. The protein allergy caused by latex products has become an acute problem to human health. Certain proteins or peptides eluting from NRL products can cause immediate hypersensitivity reactions (Type I allergy) in people sensitized to those proteins. The amount of total EPs in NRL gloves was assumed to reflect their corresponding amount of allergenic proteins. The major objective of this research was to develop an economical method to reduce EPs in finished NRL gloves. The current study was focused on developing a leaching solution system to remove the extractable NRL proteins from the gloves using $CaCl_2$ solution and sodium dodecyl sulphate (SDS) solution. Rubber films were leached with varying aqueous $CaCl_2$ (5%, 10%, 15%, w/v%) concentrations followed by leaching with SDS (5%, w/v%). After leaching, the water extractable proteins were analyzed by the analytical methodology based on the modified Lowry method according to ASTM D5712. Distilled water leached samples were used as the reference. When $CaCl_2$ concentration in leaching was increased, the removal efficiency of EPs was increased. When the samples were leached with $CaCl_2$ followed by SDS, they illustrated a further reduction of EPs. Thus, the amount of remaining EPs in the product decreased considerably. A maximum removal efficiency could be seen when the rubber films were leached with $CaCl_2$ (15%, w/v%) followed by SDS (5 %, w/v%). The effect of leaching solvents on the final product was analyzed by measuring the mechanical properties such as tensile strength, tear strength and aging resistance. Distilled water leached samples were used as the reference. The mechanical properties did not change to a greater extent when rubber films were leached with $CaCl_2$ followed by SDS when compared to that of water leached samples. Therefore, leaching rubber gloves with $CaCl_2$ (15%, w/v%) followed by SDS (5%, w/v%) may be an efficient method for reducing EP content of the final product and thus reducing the allergenic conditions of sensitized people for NRL gloves.

Keywords: Allergy, Extractable proteins, Gloves, Natural rubber latex

Abstract No: MR-18

Identifying the key success factors in third party logistic services: Sri Lankan context

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To be more cost-effective as well as to maintain a sustainable competitive advantage, many enterprises tend to improve their business practices by having a strong relationship with third-party logistics (3PL) service providers. 3PL service providers mainly focus on warehousing, inventory management and control, planning, cross-docking and transportation. By outsourcing such processes, enterprises gain benefits such as reducing costs, improving product quality, and improving the flexibility of operations. Sri Lankan 3PL service providers also provide many services for their clients but compare to other countries Sri Lanka is facing more challenges including poor infrastructure, complex tax regulations, insufficient use of technology and limited service offerings. According to the World Bank's Logistics Performance Indicator ranking (LPI) for 2018, Sri Lanka is ranked 94th out of 160. Compare to the previous year Sri Lanka's rank has dropped down. This indicates a need for Sri Lanka to improve the quality of its logistics services. Better performance of the 3PL service providers is one factor which can contribute to improving the quality of logistics services. Therefore, it is important to investigate key success factors of 3PL industry in Sri Lanka which can support to increase the performance of 3PL service providers. The main objectives of this paper are to determine key success factors associated with the Sri Lankan 3PL industry and prioritize those key success factors. This study used the systematic literature review and expert's opinion to identify the key success factors of 3PL industry in Sri Lanka. In total, 20 key success factors were obtained, and those key success factors were grouped into four categories as organization strategy, management and process, human resources and customer orientation. The study used the Q-sort technique to group key success factors into four categories and Analytic Hierarchy Process (AHP) to identify the priorities of the key success factors. Survey analysis is conducted with four Sri Lankan 3PL service providers to collect the data. Data were collected through questionnaires from executives, middle and senior-level managers of 3PL firms who got more than least five years of experience in 3PL industry. Totally, 36 experts in 3PL industry have participated in the data collection process. The geometric mean was used to consolidate different experts' opinions to a single value in pairwise assessment matrix. The result shows that business expansion, technology and automation, internationalization of operations, management and leadership style are the most important key success factors in the Sri Lankan 3PL industry. These factors explain that most of the Sri Lankan 3PL service providers are currently in the growth stage of the 3PL industry and these key success factors will lead them to reach the maturity level. Therefore, managers need to focus more on these factors to increase the performance of 3PL companies. This is the first research that addresses the key success factors of 3PL industry in Sri Lanka. The outcomes of this study can help managers/practitioners to formulate flexible decision strategies for better performance in their 3PL firms and experience a competitive advantage against the competitors.

Keywords: Key success factors, Third-party logistics, AHP application

Abstract No: MR-19

Classifying risk and vulnerability in the supply chain during an epidemic outbreak

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Companies always try to maximize shareholders' value by reducing the cost and maximizing profits in the long terms. However, one of the primary difficulties they face in doing so, is because of disruptions in the supply chain (SC). The supply chain can be disrupted due to natural disasters, manmade catastrophes, strikes, legal disputes, and special cases like epidemic outbreaks. The study explores what causes the supply chain to be disrupted in a company during an epidemic outbreak. It focuses on the Sri Lankan apparel industry as it contributes 6% to Sri Lanka's GDP and 44% percent to Sri Lanka's National Export Revenue, which is a significant proportion of the country's economy. The primary objective of this study is to identify the supply chain risks in order to be prepared, mitigate the effects and ensure business continuity. The study proposes a model to identify the SC risks and vulnerabilities during an epidemic outbreak, and which risks should be prioritized. The model was primarily developed through a systematic review of literature and information collected from experts in the apparel sector was used to validate the findings. Leading apparel manufacturing companies in Sri Lanka were selected through convenience sampling and managers with more than five years' experience were selected through random sampling. Using the output, the identified risks are then analysed and mapped in a vulnerability matrix considering cost and time factors. The model was tested and validated using 80%-20% rule. 80% of the collected data was used to develop the model and 20% of the collected data was used for testing and validation. Moreover, experts' opinions were also used to validate the vulnerability matrix. Loss of local key supplier, loss of international key supplier, local port closure, international port closure, transportation link disruption (other than ports), raw materials delays and shortages, human resource shortages, product demand variations, order cancellations and lead time variations are SC risks which are considered for this study. The loss of international key suppliers and order cancellations were classified as high risks, whereas, human resource shortages were classified as the least risk. Though, a generalized vulnerability model is developed in this study considering cost and time factors, it can be customized using different factors and risks depending on the experience and needs of the company. Participants for the survey assumed that customers are international, and suppliers are both local and international. The study can be further developed to identify the SC strategies which should be taken to mitigate the SC disruptions during an epidemic outbreak or during a major global crisis.

Keywords: Supply chain disruptions, Supply chain risks, Epidemic outbreak, Risk model, Vulnerability matrix

Abstract No: MR-20

Developing a methodology for evaluating the sustainability performance of logistics service providers using AHP

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Sustainability and sustainable development have become a buzzing topic in today's business world. Business organizations are now more towards making themselves more economically, socially, and environmentally sustainable. With the introduction of concepts like "Sustainable Supply Chain Management" organizations have determined not only to make themselves sustainable but also to make the whole supply chain sustainable as well. Many manufacturers and retailers often outsource their logistics functions to Logistics Service Providers (LSPs) to focus more on their core business process. Due to the competitiveness and the popularity of the sustainability concept, those organizations evaluate their prospective LSPs not only based on economic aspects like cost, service quality but also on social and environmental aspects as well. This paper proposes a methodology for evaluating the sustainability performance of LSPs using the Analytical Hierarchy Process (AHP). A Composite Sustainability Performance Index (CSPI) was developed using AHP since multiple dimensions and indicators need to be incorporated when measuring the sustainability performance and composites indices assist in aggregating all dimensions and indicators into a single measurement which will be easy to interpret, compare and benchmark. CSPI can be used by organizations when selecting the LSPs as their business partners based on the performance of three traditional dimensions of sustainability; Economic, Social, and Environmental, and a newly included technological aspect. The proposed methodology is flexible as it depends on the sustainability requirements of a particular organization when selecting LSPs as the relative importance of the dimensions and its indicators are up to the organization to decide. Analytic Hierarchy Process (AHP) has been used to create a model and give relative importance for each dimension/indicator and then the sub-dimensions or sub-indicators under each dimension are compared. Weighted and evaluated indicators are then aggregated using linear additive aggregation to construct the CSPI based on which the LSPs can be evaluated. This proposed model enables the selection of the best LSP according to the organization's preference or requirements. The proposed methodology was then used to compare and select the 3 prospective LSPs of an apparel manufacturing organization using the data obtained through interviews and questionnaires. According to the results, the highest importance of the organization was given to the economic dimension (0.5498), then to environmental (0.2748), then social (0.1202), and least to the technology dimension (0.0554) by the decision-makers. CSPI values are computed as 3.6863, 3.1644, 3.3044 for LSP 1, LSP 2, LSP 3, respectively. Among them, the highest values were obtained by LSP 1 which is 3.6863 and it is the best selection among the three alternatives. The reason LSP 1 got the highest CSPI is, it has performed best in the highly weighted sustainability performance indicators by the organization when compared to the other two LPSs.

Keywords: Analytic hierarchy process, Composite index, Logistics service providers, Sustainability, Sustainability indicators

Abstract No: MR-21

Comparison of rainwater quality of three areas located in the vicinity of an oil refinery and thermal power plant in Sri Lanka

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The chemical composition of rainwater, a form of wet deposition, differs over time due to a broad range of physical, chemical, and biological factors. The purpose of this analysis was to establish and compare the key ionic composition and water quality parameters of bulk deposition samples considering rainfall patterns, rainfall rates and pollutant sources. Three sampling sites were selected for the study in the Gampaha District in Sri Lanka which were separated by 7 km from each other. The first site was in the Makola South (MS) which represented an area in the vicinity of an oil refinery and thermal power plants; the second and third sites were in the University of Kelaniya (UOK) and Orugodawatta (OW) respectively, representing urban environments. Bulk depositions were collected after the container was almost filled avoiding any overflow. The chemical analyses of anions (F^-, Cl^-, NO_3^-, SO_4^{2-}) in bulk depositions were carried out using the Dionex ICS-900 ion chromatography system and metals (V, Cr, Mn, Fe, Ni, Cu, Zn, As, Cd, Pb) were analyzed using the ICP-MS 7800-Agilent system. The average pH in MS, UOK and OW sites was 6.70, 7.15 and 7.31 respectively, and it was almost neutral due to atmospheric neutralization. The average conductivity values of MS, UOK and OW sites were 40.96 μScm^{-1}, 35.63 μScm^{-1} and 38.93 μScm^{-1}, respectively. The average values of other water quality parameters (salinity, TDS) were higher in the MS site than the other sites. The dominant metals were Na, Cr, Fe, Cu, As, and SO_4^{2-} was the dominant anion in the MS site than the other two sites showing the pollution may be due to the influence of oil refinery and the thermal power plants situated near the MS site. The results indicated that the metal concentrations, anion concentrations and the water quality parameters from the rainwater collected among the MS, UOK and OW sites, the MS site has higher concentrations and higher pollution due to its location being in the vicinity of the oil refinery and thermal power plant. According to the results obtained it can be stated that rainwater analysis can be used as an indirect method to determine ambient air quality.

Keywords: Anion concentration, Bulk deposition, Heavy metals

Abstract No: MR-22

Developing a model for effective supplier selection using Analytic Network Process (ANP)

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If any organization needs to survive in this intensively competitive market, they should possess a competitive advantage over other companies. An effective supplier selection process is a major determinant of the degree of competitive advantage within an organization. The common drawbacks in the existing supplier selection processes which hinder the selection of effective supplier/suppliers are the absence of a systematic mechanism and subjectivity of decisions. It is also a disadvantage from suppliers' perspective, as a supplier cannot systematically align their processes because requirements and expectations differ from organization to organization. Therefore, the objective of this research is to propose a mechanism and a general model to prioritize criteria, sub criteria, and alternative suppliers along with appropriate set of criteria and sub criteria and to validate it across few industries. With the scope of this paper, supplier selection was considered as a multi criteria decision making problem (MCDM) because supplier selection is the evaluation of trade-offs between inconsistent, contradictory and competing criteria with each other. Analytic Network Process (ANP) which is a technique to solve MCDM problems in which the criteria affect each other and have nonlinear correlation, is used here to prioritize criteria and alternatives. In this study, a systematic review of literature was conducted to identify the different research approaches, limitations, and gaps and to determine most appropriate criteria, sub-criteria, tools and techniques used for supplier selection. Then developed the tentative criteria list and tentative ANP model using data gathered through literature review. Then this model and criteria list was finalized through a survey in a chemical manufacturing company, by acquiring industry experts' opinion. After finalizing the model, it is validated by feeding data obtained through past supplier selection records into it. Here results were compared and constructed with the actual results in each case. The results of the survey show that most important criteria that should consider when selecting suppliers for the selected product in this chemical manufacturing company are the production capability, delivery capability, financial capability and service capability of the supplier. In the current supplier selection process in this company, they consider only factors like the quality and price of product and punctuality delivery goods by suppliers. But these limited set of criteria have led to choosing ineffective suppliers. The result of this study shows the scope and the importance of criteria and sub criteria that should be used for supplier selection in this company. Here when comparing these results with past literature, it can be concluded that industry wise prioritizations are not exactly similar but can relate to general model with few modifications and assumptions. Also, when comparing the finalized model and mechanism with past literature it can be concluded that this model is more appropriate for large scale manufacturing companies who are mainly focusing on exports, procuring products than services, procuring products use as the raw materials in manufacturing processes.

Keywords: Analytic Network Process (ANP), General supplier selection model, Supplier selection process

Abstract No: MR-23

Cost minimization model through consolidation: application to a third party logistics distribution center

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Third Party Logistics (3PL) providing industry has become an essential service for the manufacturers due to the numerous benefits they could obtain by outsourcing their logistics activities to a 3PL provider. When considering the 3PL industry in Sri Lanka, growth can be seen in the past few decades. Since the distribution of goods of multiple clients in a 3PL Distribution Center (DC), is handled by the 3PL providers, they are much interested in minimizing the distribution cost which will not only ultimately benefit to the 3PL provider but also the client as well. However, managing the distribution of multiple clients at the same time with an optimized cost is challenging for 3PL service providers. The consolidation of goods of multiple clients in the distribution process is one of the main cost-effective strategies that the 3PLs could use. But due to several reasons such as compatibility constraint of goods transported, client concerns, complicated scheduling, consolidation is not practiced by many of the 3PLs in Sri Lanka. Therefore, this study was conducted on identifying the main factors to be considered when consolidating goods of multiple clients, and to develop a mathematical model to minimize the distribution cost in a 3PL DC by shipment consolidation. This paper proposes a mathematical model considering the Vehicle Routing Problem (VRP) as an extension found in the literature, where the compatibility of the products distributed has been added as a new constraint. The mathematical model has been tested and validated using the actual data obtained from few of the 3PL firms in Sri Lanka and has been simulated using the Supply Chain Guru Software. Different scenarios are created in the software to check the feasibility and accuracy of the model. The results obtained showcase an average cost reduction of nearly 25% when consolidating shipments of multiple clients in a 3PL DC. Therefore, it is evident from the study that, the 3PL firms could obtain a significant cost reduction by consolidating shipments of multiple clients. It was also identified that factors like compatibility of the distributed goods, cargo tonnage, clients' privacy concerns and scheduling of shipments should be considered when consolidating goods of multiple clients to distribute in a 3PL DC. The findings of this research will help the 3PL providers to consider consolidating shipments of several clients and the mathematical model proposed in the research will help them to minimize the distribution cost. Furthermore, the trucks can be properly utilized, the number of trucks and fuel wastage can be reduced and the impact on the environment will be lesser. Future researches could be done on adding more complexity to the model by considering different constraints such as time windows for the orders.

Keywords: Third party logistics, Consolidation, Vehicle routing problem, Simulation

Abstract No: MR-24

Framework to select the most suitable production line in an apparel firm in Sri Lanka: use of Analytical Hierarchical Process

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The apparel industry is considered as one of the most labour-intensive industries in the world despite the technological advancements and the amount of automation. Line planning in the garment industry is the process of scheduling and allocating production orders to production lines according to the product setting and due dates of manufacturing completion. Most of the apparel manufacturers in Sri Lanka have switched to lean model production, in which large sewing departments are split into smaller, self-balancing sewing lines. The decisions that address the production line selection process for a particular production order still heavily rely on production planners, based on their experience. These decisions tend to be neither consistent nor scientific because of the lack of interdepartmental connectivity. Little emphasis has been placed on the impact of the planning considerations and ways to apportion certain production orders to the appropriate production system with specific characteristics. This problem is addressed in the research through the development of a multi criteria decision making framework to enable the incorporation of all the parameters to select the best production line for a particular sales order using Analytical Hierarchical Process (AHP). AHP method is adopted for decision making which models multiple, possibly conflicting factors dependent on each other and it makes appropriate trade-offs to recommend well-balanced solutions to different stakeholders. The production line selection criteria identified through expert opinions and literature review were applied in the AHP conceptual model. 23 factors were identified and they were categorized under 5 areas which are characteristics of the product, characteristics of the production order, characteristics of the production line, technical support and quality parameters. In order to build the AHP model, 4 manufacturing firms and 4 senior and middle level managerial industrial experts from each firm were selected and interviewed through AHP questionnaires. After the pairwise comparisons, each criterion was weighted and prioritized. Most of the interviews resulted in high priority for delivery date, technical infrastructure, skills inventory of the line, the efficiency of the line, and cadre requirement while the ability to adopt changeovers, prioritization of machine service, and infrastructure support by the technicians were given low priorities. This interprets that, for any kind of a production order the mostly prioritized criteria are important to be considered. Therefore, focusing on them in line selection would lead to improved planning efficiency. After the criteria comparison, each alternative production line was given a score against the planning criteria and the production lines were ranked in order to select the best production line. Through data analysis, it was found out that the results obtained from different industrial experts representing different apparel manufacturing firms vary from each other depending on individual perspective and policies inherent to the manufacturing firm. However, the framework can relate to any apparel manufacturing firm by allowing Decision Makers to select the valid criteria depending on the Production Order and its related parameters. Also, the framework can be used for other manufacturing industries with few modifications and assumptions. In order to avoid the subjectivity in AHP method, a Linear Programming model can be developed as a future improvement and optimize the production lines selected through AHP ranking.

Keywords: Apparel manufacturing, Production planning, MCDM methods, AHP method

Abstract No: MR-25

Developing a model to identify the factors affecting customer satisfaction and their impact on third party logistics services in Sri Lanka

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Locating on a major east-west trade route near India, Sri Lanka has significant geographic advantages that are necessary to become a major logistics hub in South Asia. Despite its underdeveloped economy, the island country's total trade volume is around $ 88.9 billion (2018), making it a major hub for the region. A number of shipping lines use this site to, consolidate and deconsolidate cargo for transhipping to various destinations. Considering logistics performance, Sri Lanka was ranked 94th out of 167 countries according to the World Bank's 2018 Logistics Performance Indicator (LPI). Therefore, Sri Lankan Logistics and Freight Forwarder Association has identified that the country needs to move up on the index, while providing a competitive service to the customers' need. Both practitioners and scholars recognize the fact that embracing corporate sustainability as well as enhancing customer satisfaction can produce several relevant business benefits such as decrease of the intention to switch. Although past research captures the relationship between customer satisfaction and service quality through a combination of the SERVQUAL (service quality) model or the SERVPERF (service performance) model, however, the controllable factors may influence this relationship when considering the Third Party Logistics (3PL) industry in Sri Lanka. The model developed explores both service and performance, and other controllable factors affecting on customer satisfaction and their impact on the 3PL industry in Sri Lanka. It considered all key influencing factors and their relationship with each other using a systematic review process and complemented by reviews from industry experts. The model constructs include relationship performance as the independent variables while the impact of the 3PL industry on customer satisfaction has been measured using customer loyalty, customer switching behaviour and customer complaints which also been considered as dependent variables. Tech initiation has been recognized as a moderator variable for the operational performance and the Organizational image has been recognized as a controllable variable of customer satisfaction. The study results show that there is a statistically significant impact of the overall dimensions on the customer's satisfaction and it implies that 8.09% of customer Loyalty depends on the above four independent variables and 18.85% of Switching Behaviour and 6.30% of Customer Complaints depends on all the independent variables. The proposed model which has verified will lead 3PL service providers, to distinguish significant factors, which have a considerable effect on the customer satisfaction. Further, the outcomes would assist the 3PL providers to minimize customer switching behaviour and switching costs, as they have a clear idea about the expectations of customers that should be fulfilled when delivering 3PL services.

Keywords: Customer satisfaction, Third party logistics (3PL), Logistics management, Logistics performance

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