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UNIVERSITY OF PERADENIYA

SRI LANKA

PGIS RESEARCH CONGRESS 2020

PROCEEDINGS

26th - 28th November 2020

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Message from the Director, Postgraduate Institute of Science

The Postgraduate Institute of Science (PGIS), University of Peradeniya, which was established in the year 1996, is a National Institute dedicated for Postgraduate Teaching and Research in many scientific and related disciplines. The vision of our Institute is to be a leader in sciences in the region and the world, and in fact, we have been leading in research, teaching and collaborative projects. The PGIS has made an admirable progress during the past two decades under eleven Boards of Study, catering to several thousands of postgraduate students drawn from almost all universities of Sri Lanka and many other universities abroad. The teaching staff of the PGIS comprises of distinguished academics and renowned researchers of Sri Lankan universities and other institutes. Their dedicated services have enabled the production of nationally and internationally recognized scientists through various postgraduate programmes, which have been specifically designed for advancing new knowledge and innovation in both theory and practices of sciences.

The PGIS organizes and conducts many national and international symposia as well as numerous workshops and short courses. The annual research congress (RESCON) is such a main event of the PGIS which provides a platform for postgraduate research students and senior scientists to highlight their findings, interact and exchange ideas with leading Sri Lankan and foreign scientists. This is indeed a unique forum provided by the PGIS for its postgraduate research students to expand their scientific knowledge to face challenges in scientific careers.

The Organizing Committees of RESCON-2020 have worked hard to produce a high-quality conference, and a pleasing and enjoyable social event. I wish to express my sincere appreciation to the Organizing Committees, and reviewers who reviewed conference submissions and provided feedback to authors. Over 550 reviewers participated in the review process, working efficiently to meet a very tight conference organization schedule. I have no doubt that the participants will have fruitful discussions and interaction for furthering research in the emerging areas of science although the technical sessions will be held electronically due to the prevailing pandemic situation.

Professor H.M.T.G.A. Pitawala
Director/Postgraduate Institute of Science

PGIS Research Congress 2020

Message from the Congress Chairman

The Postgraduate Institute of Science (PGIS), University of Peradeniya, has organized its 7th Annual Research Congress, RESCON 2020, from 26th to 28th November 2020. On behalf of the Organizing Committee, it is a great honour and privilege for me to welcome you all to the RESCON 2020. This is a multi-disciplinary congress that provides academics, research scientists, and postgraduate students an excellent opportunity to present their innovative research, scholarly contributions, share new ideas with stimulating discussions on future research trends and exchange information on cutting-edge new technologies. We are honoured to have Prof. Sampath Amaratunge, Chairman, University Grants Commission, as the Chief Guest, and Prof. S.H.P.P. Karunaratne, Senior Professor of Zoology as the keynote speaker.

While regretting that the COVID pandemic has prevented our planned congress at PGIS, we are excited about the opportunity presented to us to hold the first ever virtual PGIS RESCON. Holding the virtual congress will be a great opportunity for PGIS to explore 'New Frontiers in Early Intervention' as well as using digital and social media during the pandemic to reach a wider audience all across Sri Lanka than previously planned.

It is very pleasing to note that 230 research papers, the highest number ever received for a PGIS RESCON, will be presented on five key-themes: Earth and Environmental Science, ICT, Mathematics and Statistics, Life Sciences, Physical Sciences, and Science Education, at 29 virtual technical sessions using four video conferencing rooms over two complete days. RESCON 2020 has brought together a rich diversity of researchers from almost all the state universities, non-state universities, research institutions and industries to share ideas and new perspectives in a wide range of topics. Behind the success of the congress lie the collective and untiring efforts of Prof. H.M.T.G.A. Pitawala, Director/PGIS, Dr. Ashwini Amarasinghe, and Dr. Prasanga Manthilake Co-Secretaries/RESCON 2020, Prof. L.R.K. Perera/Editor-in-Chief, Prof Namal Priyantha/Editor, all Conveners and members of sub-committees and their valuable advices and luminous suggestions. Contributions the reviewers made by thorough and timely reviewing of the papers were very valuable to improve the research presentations, and postgraduate students worked closely with us in planning and organizing the congress. The organizing committee appreciates the honorary service provided by the Session Chairs for all 29 Sessions. Mr. Dilan Chathuranga contributed tremendously since the receipt of applications through CMT system until completion of the proceedings volume.

Finally, my deepest appreciation goes to the authors who submitted their outstanding research papers to the RESCON 2020. The Congress would not have materialized without financial support from the University Grant Commission and all the other generous sponsors. I wish that the congress will be highly stimulating, enlightening, and enjoyable to all participants, who will join us through the virtual classroom mode.

Prof. G.W.A. Rohan Fernando,
Chairman/PGIS RESCON 2020

Message from the Editor-in-Chief

It is a pleasure and a privilege to be the Editor-in-Chief of the PGIS Research Congress 2020 and the largest volume of proceedings of the RESOCN PGIS has ever produced during its history. This would not have been possible without the enthusiasm shown by the researchers from all most all state and non-governmental higher educational research institutions around the island who contributed 281 submissions on five thematic areas. Dedication of the Editorial Committee and the efforts of more than 170 reviewers who peer reviewed the submissions, and the Editor, the theme coordinators and many colleagues that tirelessly went through the reviewers' comments to select 213 submissions for oral presentations and 17 for poster presentations are behind the success story of this proceedings volume. A majority of the authors are postgraduate students and their supervisors affiliated to the PGIS. I am really grateful to the Editor, the Theme Coordinators, the reviewers and all colleagues for their dedication and hard work that stimulated the authors to present the science contained in this volume informative and thought provoking. I also take this opportunity to thank the authors for their positive responses to the call for submissions and thoughts, advice and suggestions of the reviewers. In addition to the research submissions, this volume contains the abstracts of the keynote and plenary speeches. I wish that PGIS RESCON 2020 will be a memorable occasion for all scientists involved.

Professor L. R. K. Perera
Editor-in-Chief, PGIS RESCON 2020

PGIS Research Congress 2020

Message from the Chief Guest, Chairman, University Grant Commission

It is with great pleasure that I convey this message to mark the 7th Annual Research Congress (RESCON) of the Postgraduate Institute of Science (PGIS), Sri Lanka.

The journey of the PGIS, from its inception in 1996, has been a productive one; fulfilling national needs in scientific disciplines, including, Biochemistry & Molecular Biology, Chemical Sciences, Computer Science & Statistics, Earth Sciences, Environmental Science, Mathematics, Physics, Plant Sciences, Science Education and Zoological Sciences. The newly introduced Board of Study in Biomedical Sciences has expanded the services of the PGIS. The PGIS offers many postgraduate programmes, namely, Postgraduate Diploma, M.Sc., M.Phil. and Ph.D. in the above disciplines of science. Thereby continuing its legacy of producing intellectuals that will serve the nation and the world.

Initiating the postgraduate programmes with the first batch of 14 students graduated who in 1997 with three PhD degrees in 1998, the PGIS has journeyed far from its humble beginning and is now able to provide postgraduate training for more than 1,000 students. Being a national institute, the PGIS has attracted outstanding academic staff from the Faculty of Science, University of Peradeniya, and from other universities and government research institutions, departments and the private sector of the country for teaching panels of postgraduate programmes, thereby offering its students the best the institute can offer. Further, the PGIS, with the establishment of instrumentation and research laboratories, has been able to produce high quality research that has in many ways contributed to the development of the nation.

I understand that over 225 research presentations of novel research findings from almost all the state universities, non-state universities and research institutes covering a broad spectrum of sciences will be delivered at RESCON 2020. I consider this as a great achievement of the PGIS. The University Grants Commission commends your effort and encourages further strengthening of postgraduate teaching and research in years to come.

I take this opportunity to appreciate the efforts of the Organizing Committee headed by the Director of the PGIS to have the technical sessions of RESCON 2020 as a virtual event due to the global pandemic situation, which has affected our nation and the world. At times like this, adapting shows the strength of the institution and I deeply appreciate this effort.

While I wish this event every success, I hope that the PGIS will continue their good work and aid us in our efforts to develop the nation through education, research, and innovations

Senior Professor Sampath Amaratunge
Chairman
University Grants Commission

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A Brief Biography of Professor S.H.P. Parakrama Karunaratne,

Keynote Speaker, RESCON 2020

S.H.P. Parakrama Karunaratne obtained his B.Sc. Honours in Zoology in 1984 and his M.Sc. by research in 1990 from the University of Peradeniya. Then he proceeded to the United Kingdom and completed his Ph.D. in 1994 at London School of Hygiene and Tropical Medicine, University of London. Since his return from the UK, he has served the Department of Zoology first as a Senior Lecturer, and then as Professor and Chair of Zoology since 2001. Parakrama Karunaratne was promoted to the grade of Senior Professor in 2009 and presently he is serving as the Deputy Vice Chancellor, University of Peradeniya since 2018. Professor Parakrama Karunaratne has also served as the Dean of the Faculty of Science, University of Peradeniya and as the Director and Senior Research Professor of the National Institute of Fundamental Studies, Hantana, Sri Lanka. He was also a Wellcome Trust Research Fellow and a Visiting Research Professor at Liverpool School of Tropical Medicine, UK, and was also Visiting Research Fellow, School of Biosciences, Cardiff University, Wales, UK. Since 2015, Professor Karurnaratne is a Member of the DDT expert group WHO/UNEP, Geneva, Switzerland. He has 92 peer reviewed full research publications to his credit and has ranked as a Google Scholar with `h'-index of 27; He has earned 2742 citations for his Research publications; He is an Elected Fellow of the National Academy of Sciences since 2006 and an Elected Fellow of the Royal Entomological Society since 1997. Professor Karunaratne as an outstanding researcher has won the following prestigious research awards to his credit. General Research Committee Award, SLAAS, Sri Lanka; CVCD Excellence Award for the most outstanding Senior Researcher in 2016 from the UGC Sri Lanka; Vestergaard Frandsen Award for outstanding research contribution, NAVBD, Indian Council of Medical Research in 2011; Bernard Soysa Memorial Award (Gold Medal) for Outstanding Scientific Research, SLAAS, Sri Lanka in 2005; Hiran Thilakaratne Award for Outstanding Postgraduate Research, UGC, Sri Lanka in 2001; Young Scientist Award, TWAS- Italy and NSF- Sri Lanka in 1999; He has also won 17 Presidential Awards for Research Publications between 1999 & 2019; NRC Merit Award for Scientific Publication in 2012 & 2013, NRC- Sri Lanka; NSF Merit Award for the Best Scientific Research in Biology in 1999, NSF- Sri Lanka; Wilson Peiris memorial Award (1989) Sri Lanka Medical Council. Professor Karunaratne's research interest include the following: Mosquito control, Insecticide resistance in insects, Molecular mechanisms of insecticide resistance, Control of insect pests in agriculture and insect vectors of human and livestock diseases, DNA barcoding and phylogeny of insects, Insect ecology, behaviour and molecular biology.

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Abstract No: 11 ***Earth and Environmental Sciences***

PRIORITIZATION OF WATERSHEDS IN UVA PROVINCE, SRI LANKA, BASED ON SOIL EROSION HAZARD

I.D.U.H. Piyathilake[1*], R.G.I. Sumudumali[1], E.P.N. Udayakumara[2], L.V. Ranaweera[2], J.M.C.K. Jayawardana[2] and S.K. Gunatilake[2]

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Uva Province in Sri Lanka is most significant in terms of its hydrological contributions since it consists of ten major river basins including source areas of three tributaries of Mahaweli River. The Province is affected by human-induced soil erosion by water. Hence, identification of soil erosion hazards and prioritizing them based on watersheds are crucial for improving soil conservation and water management plans. This study assessed the mean annual soil loss from the Province and watersheds separately using the Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) Sediment Delivery Ratio (SDR) model introduced by the Stanford University, USA, using ArcGIS 10.4 environment. To cover the spatial extent of the Uva Province, the raster maps of Digital Elevation Model (DEM), rainfall erosivity factor (R), soil erodibility factor (K), and land use land cover (LULC) maps were prepared using ArcGIS 10.4. A biophysical table was formulated as a .csv (Comma Separated Value) table containing crop management (C) and support practice (P) factors corresponding to each land use classes in the LULC raster. Ultimately, all the raster data layers and parameters were integrated into the InVEST SDR to obtain model outputs. The estimated mean annual soil loss from the Uva Province, 25.6 t ha^{-1} $year^{-1}$, is ~ 3 times faster than the soil loss tolerance in Sri Lanka. The mean soil loss rates of major watersheds in the Province range from 0.9 and 117.8 t ha^{-1} $year^{-1}$ with the highest by Badulu Oya (117.8 t ha^{-1} $year^{-1}$) and the lowest by Walawe River (0.9 t ha^{-1} $year^{-1}$). The watersheds were further classified into five soil erosion hazard classes as low (< 5 t ha^{-1} $year^{-1}$), moderate (5 - 12 t ha^{-1} $year^{-1}$), high (12 - 25 t ha^{-1} $year^{-1}$), very high (25 - 60 t ha^{-1} $year^{-1}$), and extremely high (> 60 t ha^{-1} $year^{-1}$). The study revealed that under the existing land use scenario, Uma Oya, Badulu Oya and Loggal Oya watersheds fall into extremely high class; Menik River and Kirindi Oya watersheds fall into high class; Gal Oya, Kumbukkan Oya and Ulhitiya Oya watersheds fall into moderate class; Heda Oya and Walawe River watersheds fall into low class in Uva Province. Moreover, watersheds with the high, very high and extremely high soil erosion hazards are related to high mean annual rainfall (900 - 2500 mm), steeper slopes, high erodible soil types and the effect of seasonal soil erosion-induced agricultural practices. The findings of this study would help in formulating new watershed management policies in the Uva Province.

Keywords: GIS, InVEST SDR model, Soil erosion, Uva Province, Watersheds

Abstract No: 12 ***Earth and Environmental Sciences***

SYNTHETIC NANO γ-Fe_2O_3 COATED LATERITE SAND FOR ADSORPTIVE REMOVAL OF FLUORIDE FROM NATURAL WATER

L.M. Thilakarathne[1], W.M.A.T. Bandara[1*] and I.P. L. Jayarathna[2]

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Fluoride is one of the major chemical contaminants which causes a reduction in the quality of drinking water available in many parts of the world including Sri Lanka. The fluoride content in natural waters increases to extreme levels by both natural and anthropogenic activities. It has been estimated that more than 200 million people worldwide rely on drinking water with fluoride concentration that exceeds the WHO guideline of 1.5 mg L^{-1}. Although fluoride is considered as an essential element for human health, excess intake leads to various diseases, among which dental and skeletal fluorosis are prevalent. From among the several materials and methodologies available for the removal of fluoride from water; adsorption is identified as an efficient and cost-effective methodology that can be used by direct addition of natural materials such as laterite sand which is rich in iron and aluminum oxides. Surface coating of laterite sand with maghemite (γ-Fe_2O_3) nanoparticles improves the efficiency of laterite in adsorption of fluoride. Maghemite nanoparticles were synthesized via the chemical co-precipitation method. The samples synthesized were characterized using Fourier transform infrared spectroscopy, X-ray diffraction, particle size analyzer and scanning electron microscopy. Additionally, the fluoride removal efficiency was estimated using the concentration of fluoride determined by fluoride ion-selective electrode for different adsorbent dosage, pH, contact time and initial fluoride concentration. The optimum removal percentage up to 85% was obtained at pH = 2.0. When pH < pH_{zpc} (point of zero charges at pH = 6.83), the surface sites of maghemite are positively charged; this favours fluoride adsorption exhibiting the highest capacity.

Keywords: Adsorption, Co-precipitation, Maghemite, Nanoparticles

Abstract No: 14 ***Earth and Environmental Sciences***

SOLID WASTE MANAGEMENT ISSUES WITHIN VAVUNIYA URBAN COUNCIL LIMITS

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Rapid increase in population and change in lifestyle have resulted in a dramatic increase in solid waste generation, and its management becomes a challenge for the Local Authorities (LAs) in Sri Lanka, including Vavuniya Urban Council (VUC). A study was conducted to identify issues associated with Soil Waste Management (SWM) and to improve the existing system. Direct observations and focus group discussions with relevant professionals were used to collect the primary information at the VUC level, whereas secondary data were gathered from existing databases and available literature. The main issues associated with current SWM systems are inadequate awareness among stakeholders, insufficient infrastructure development, inadequate resources, and incorrect budgetary allocations. It has resulted in not separating biodegradable wastes consisting of 62 – 66% in urban solid waste. Unfortunately, the mixed and commingled wastes are directly disposed of in the Pampaimadu dumpsite causing pollution due to leachate generations and odour nuisance. The problem has become further aggravated because of abandoning the market waste composting programme, owing to inadequate labour force and budgetary allocations. Financial constraints of VUC have halted the purchase of collection vehicles to enable higher frequency of collecting the increased generation of wastes. It has encouraged backyard burning and improper disposal on streets even though these are not permitted based on the existing rules and regulations. It is imperative to introduce 'polluter pay' fee for introducing source separation programme at all waste generating locations to promote composting and divert the degradable waste from disposal. It will reduce transportation and disposal costs while providing adequate funds to purchase and maintain collection vehicles. Public-private partnership is beneficial to increase recycling and reduce the financial burden on VUC. A time-bound comprehensive SWM plan is essential to access current and future waste management needs by setting priorities and allocating resources accordingly.

Keywords: Recycling, Solid waste, Source separation

Abstract No: 43 ***Earth and Environmental Sciences***

PHOTO-DEGRADATION OF REACTIVE TEXTILE DYE EFFLUENTS USING MAGNESIUM OXIDE NANOPARTICLES

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Photocatalytic degradation is one of the most effective methods to degrade organic waste into environmentally-friendly products. In this study, nanoparticles of MgO were synthesized to degrade a major type of textile dye called Reative Yellow for the first time. Although bulk MgO insulator does not show any photocatalytic activity, its nanoparticles show the activity due to the structural defects which induce reactive exited electrons and holes on surface promoting photocatalytic degradation reactions. In the synthesis method of MgO nanoparticles, freshly distilled methyl methacrylate monomer and $MgCl_2$ (100 mL) were added, dropwise, to 1.0 M Na_2CO_3 (100 mL) solution with $Na_2S_2O_8$ (1.0 g) initiator dissolved in it. In order to synthesize $MgCO_3$/poly (methyl methacrylate) (PMMA), the reaction mixture was stirred for 2.0 h while the temperature was set at 80 °C. Then $MgCO_3$/PMMA composite was washed with hot water and calcined at 650 °C for 3.0 h to produce MgO nanoparticles. Photocatalytic activity of MgO nanoparticles was investigated by adding MgO nanoparticles (0.020 g) into 5 ppm Reactive Yellow (5 mL) solution and irradiating the mixture with UV radiation using 200 W Xennon arc lamp in time intervals of 10, 20, 40, 60, 80 and 100 min. X-ray diffraction pattern confirms that the product is comprised of MgO nanoparticles with average crystal size of 40 nm while electron microscopic methods confirms their spherical morphology. Dye degradation efficiency calculated using UV-Visible spectra of the dye demonstrates considerable dye degradation (68% degradation after 100 min). Degradation efficiency should further be investigated with improvements in nanoparticle topology.

Keywords: Magnesium oxide, Nanoparticles, Photocatalytic degradation, Reactive textile dye waste

Abstract No: 45 ***Earth and Environmental Sciences***

IMPACT OF ASSOCIATED ANIONS ON LEAD UPTAKE BY *Pistia stratiotes* AND *Salvinia molesta*: A NEW PERSPECTIVE FOR PHYTOREMEDIATION

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Contamination of water with toxic metal ions is a worldwide concern due to recalcitrant impact on the ecosystem. Phytoremediation is a potentially cost-effective and eco-friendly technology to address this problem. Though many compilations on Pb(II) phytoremediation were reported, the impact of the counter ion for cation uptake was not examined. However, wastewater is a mixture of anions and cations. Accordingly, the counter ion effect on Pb(II) uptake was investigated by changing the anion type of Pb(II) salts ([Pb(II)] = 10 mg L^{-1}). Different lead salts *viz.,* $PbCl_2$, $Pb(NO_3)_2$, $Pb(C_2H_3O_2)_2$, PbF_2 and $PbHAsO_4$ were analysed as potential lead contaminants in wastewater using macrophytes, *Pistia stratiotes* and *Salvinia molesta*. Anion concentrations were altered to 10, 15 and 20 mg L^{-1} by adding $NaC_2H_3O_2$, $NaNO_3$ or NaCl, while Na-EDTA was used as a desorption simulator. Samples were analysed for cation and anion concentrations using atomic emission spectroscopy ([Pb(II)] = 0-10 mg L^{-1}) and ion chromatography, respectively. Statistical analysis was performed in one-way ANOVA with a Tukey pairwise comparison. The results show that the average Pb(II) removal exceeds 85% in all cases indicating the hyperaccumulative behaviour of macrophytes. However, *S. molesta* is more tolerant of Pb(II). Regardless of the plant type, the most effective counter ion was $C_2H_3O_2^-$, followed by NO_3^- and Cl^-. The highest Pb(II) removal was observed with 15 mg L^{-1} of anions for *P. stratiotes*. With *S. molesta*, the optimal concentrations were 10 mg L^{-1} of NO_3^- and Cl^- and 20 mg L^{-1} of $C_2H_3O_2^-$. In binary anion mixtures, Pb(II) removal was comparatively low. Na- EDTA was effective in desorbing Pb(II) from plant tissues, perhaps forming stable complexes with Pb(II). Thus, Pb(II) removal capacity of *P. stratiotes* and *S. molesta* can be influenced by the type of anion and its concentration associated with Pb(II). These findings can be utilized to maximize the effectiveness of Pb(II) phytoremediation by modifying the solute conditions and selecting the appropriate macrophyte as per the major anion type and concentration.

Financial assistance from the University of Peradeniya (*Grant No. URG/2017/51/S*) *is acknowledged.*

Keywords: Anions, Hyperaccumulators, Lead, Phytoremediation, Wastewater

Abstract No: 50 ***Earth and Environmental Sciences***

PERFORMANCE OPTIMIZATION OF ELECTROCOAGULATION REACTOR FOR SIMULTANEOUS REMOVAL OF HARDNESS AND FLUORIDE BY SURFACE RESPONSE METHODOLOGY

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Groundwater is a major source for rural water supply schemes in the dry zone of Sri Lanka. Due to excess residence time of water in aquifers, the water in dry zone is often exerts high concentrations of hardenss and fluoride. Presence of excess hardness and fluoride in water are not only detrimental to human health but also imparts serious impact for industry. Treatment methods, such as reverse osmosis, ion exchange or nanofiltration, are widely used to treat hard water. Pressure driven reverse osmosis technology removes constitutents in water than what is required which renders water unplatable. Ion exchange methods are the oldest and hardness removal is bulky. Both ion exchange and membrane metods generate substantial wastes. Therefore, developing a sustainable technology to mitigate excess hardness and fluoride is important. The electrochemical water treatment methods are robust, low-cost and can be automated, readily minimizing user engagements. Out of electrochemical methods, electrocoagulation holds a great promise in the water treatment industry due to *in-situ* chemicals generation, and low-cost. From electrolytic oxidation of sacrific anode, metal hydroxides act as a coagulant and provide active sites for contaminants removal. Apart from adsorption, sweep coagulation, bridge coagulation and co-precipitation also play a role during the treatment process. In the present work, the relationship between the simultaneous hardness and fluoride removal with current and electrolysis time was examined. Response surface methodology was used for optimization, while keeping most design parameters constant. Borehole groundwater (9G32+FR Mihintale, Rajarata University) was used for the experiments. The efficiencies of hardness and fluoride removal are 63% and 97% at 0.03 A applied current and 52 min reaction time, respectively. The energy consumption was 1.98 kWh m^{-3}. Both hardness and fluoride were removed from the water at near-neutral pH. The residual Al^{3+} in treated water is 2.33 g m^{-3}, which exceeds WHO limits posing a severe health risk. Further experiments are in progress using different anode materials to improve the efficiency of electrocoagulation.

Financial assistance from the National Research Council (*Grant No. 16-015*) *is acknowledged.*

Keywords: Electrocoagulation, Fluoride, Groundwater, Hardness, Response surface methodology

Abstract No: 67 ***Earth and Environmental Sciences***

MICROPLASTICS IN STREAM WATER AND SEDIMENTS OF RAWAN-OYA TRIBUTARY OF MAHAWELI RIVER IN KANDY DISTRICT

R.W.M.G.K. Kapukotuwa[1*], N. Jayasena[2], C.L. Abayasekara[3], K.C. Weerakoon[4] and R.S. Rajakaruna[5]

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Microplastic contamination has become a global environmental problem in freshwater systems. This study determined the presence of microplastics along the Rawan-Oya tributary of the Mahaweli River. Water and sediment samples were collected from four sites along an urban-rural gradient (catchment, rural, urban and semi-urban areas) from October 2019 to February 2020. A total of 640 L (80 L × 8 samples per sampling time) of surface water from each site was sieved through a 0.1 mm mesh using a steel bucket, and the residues collected on the sieve were transferred into glass jars (n = 32). Sediment samples (n = 32) were collected from the river bank, and microplastics separated using density separation with a 1 M NaCl solution. Sieved residues (0.1–5 mm) were subjected to wet peroxide oxidation using aqueous Fe(II) (0.05 M) and hydrogen peroxide (30%), below 75 ºC. Density separation was performed using NaCl, and microplastics extracted on to a membrane filter (0.45 μm) were enumerated using a dissecting microscope. Fourier transform infrared spectroscopy was used to identify polymer types. Generalized linear model with a negative binomial distribution was used to determine whether the density of microplastics varied by site for water and sediment separately. Pairwise comparisons were used to determine differences along the urban-rural gradient. Both tests showed significant differences in density of microplastics among sites ($p < 0.001$). In water, significant pairwise differences were seen between all such comparisons with a single exception between rural and semi-urban areas. In sediment, pairwise differences were seen between the catchment and all other sites. The majority of microplastics were microfibers (53.5%), while there were 31.4% microfilms, 14.9% microparticles and 0.1% microfoams. Of the 10 types of polymers identified, resin-dispersion (30%) polychloroprene (17%) and polyethylene (17%) were notable. The results provide baseline information on the presence of microplastic contamination along the stream.

Financial assistance from the National Science Foundation of Sri Lanka (*Grant No. NSF/SCH/ 2019/04) is acknowledged.*

Keywords: Freshwater, Microplastics, Rawan-Oya, Sediments

Abstract No: 77 ***Earth and Environmental Sciences***

ENHANCING PERFORMANCE OF RECHARGEABLE LITHIUM-ION BATTERIES BY ALKALI ROASTING AND ACID LEACHING OF VEIN GRAPHITE

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Global consumption of natural graphite has increased by using graphite in various novel industrial applications, such as nanotechnology, batteries and fuel cells. Sri Lanka is the leading producer of vein graphite with its high crystallinity and high purity. Recently, Sri Lankan natural vein graphite has been developed as battery grade graphite suitable for the anode application of the rechargeable Lithium Ion Battery (LIB). The present study aims to find the optimum NaOH concentration and the suitable method to purify the vein graphite to develop it into highly purified battery-grade graphite. To achieve this, raw graphite and HCl acid leached purified graphite were treated with different concentrations of NaOH, roasted under air, and acid leached with H_2SO_4 followed by vacuum filtering and drying. Analysis of carbon content of the purified graphite samples revealed that the Carbon percentage in Alkali Roasted Raw Graphite (AR-RG) and Alkali Roasted HCl acid leached Purified Graphite (AR-PG) samples can be increased over 99.1% and 99.9%, respectively and best results given by 25.0 vol.% NaOH concentration. X-ray diffraction analysis revealed that the crystal structure still remained unchanged while the minor phases of impurities such as pyrite, chalcopyrite, and calcite were significantly removed by the purification processes. However, some traces of pyrite and chalcopyrite impurities have been detected in the AR-RG samples. Therefore, AR-PG process could enhance the purity to a higher level than the AR-RG method even though 25.0 vol. % NaOH concentration had shown higher purity level than the other concentrations. Fourier transform infrared spectroscopy analysis has not shown any additional peak for newly attached group other than the raw form. Therefore, the alkali roasting and acid leaching processes can be considered as effective purification methods. The LIB coin cells assembled with these developed vein graphite anode materials showed promising electrochemical performances. Galvanostatic charge-discharge study of the LIB coin cells assembled with the above materials revealed that the cycling behavior considerably improved with no obvious reversible capacity fading after purification. Hence, LIB coin cells assembled with battery-grade vein graphite developed by the AR-PG process showed more electrochemical performances than those developed by the AR-RG method and 25.0 vol. % NaOH sample gave the best electrochemical performances. Therefore, concentration of 25.0 vol. % NaOH can be considered as the optimum NaOH concentration for purification and the alkali roasted HCl acid purified method can be introduced as more favoured purification method for the development of anode materials for the LIB.

Financial assistance from General Treasury under a Cabinet paper of the Government of Sri Lanka (*Grant No. 17/1907/16/038*) *is acknowledged.*

Keywords: Acid Leaching, Alkali Roasting, Lithium Ion Battery, Vein Graphite

Abstract No: 78 ***Earth and Environmental Sciences***

EFFECT OF ABAMECTIN CONCENTRATION AND TEMPERATURE ON ITS BIOREMEDIATION BY *Staphylococcus nepalensis*

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Abamectin is widely used in agriculture in controlling insect and other pests. However, its improper use is harmful to the environment due to less specific modes of action. Previously isolated *Staphylococcus nepalensis* bacteria can be used for bioremediation of Abamectin contaminations in soil. Bioremediation ability is dependent upon the level of Abamectin contamination and soil temperature. To test the fluctuation in the ability of the bacterium to bioremediate upon the Abamectin concentrations, flasks containing Mineral Salt Yeast Extract (MSYE) broth supplemented with a series of concentrations (from 10 - 200 mg L^{-1}) of Abamectin were aseptically inoculated with loopful of a 24-hour culture of *Staphylococcus nepalensis*. For each Abamectin concentration triplicate of flasks were inoculated. Growth was tracked at 24-hour intervals, measuring optical density at 600 nm for 72 hours. Uninoculated MSYE broth supplemented with respective Abamectin concentrations were used as controls. To test the effect of temperature the above procedure was repeated keeping flasks incubated at different temperatures (4, 25, 30, 37, 60 °C). The bacteria showed the highest growth in the flask supplemented with 50 mg L^{-1} of Abamectin. Up to 100 mg L^{-1} growth increment was in the order of 100 mg L^{-1} < 10 mg L^{-1} < 25 mg L^{-1} < 50 mg L^{-1}. r (1) = 0.998, $p < 0.05$, indicates a statistically significant positive correlation between the growth of the organism with Abamectin concentration up to 50 mg L^{-1}. The Bacteria showed the highest growth at 37 °C. Growth increment was in the order of 4 < 25 < 30 < 37 °C. The value of r (2) = 0.895, $p > 0.05$, indicates that the correlation between temperature and the growth of the organism is statistically not significant.

Keywords: Abamectin, Bioremediation, MSYE broth, *Staphylococcus nepalensis*

Abstract No: 84 ***Earth and Environmental Sciences***

ALLELOPATHIC EFFECT OF AQUEOUS EXTRACT OF INVASIVE ALIEN PLANT, WEDELIA (*Sphagneticola trilobata*) ON BEANS (*Phaseolus vulgaris*)

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Sphagneticola trilobata is an invasive plant that demonstrates allelopathy as an attribute for their ecological success. The allelopathic effect of aqueous extract of *S. trilobata* on *P. vulgaris* was studied in the current study, using fresh and dry plant parts, separately. Fresh *S. trilobata* plants (75 g) were collected, immediately cut into pieces and ground using an electric grinder. The extract was dissolved in 0.1 L of distilled water to prepare a stock solution with concentration of 7.5×10^2 g L^{-1} at room temperature of 30 °C. Stock solution of dry plant parts was also prepared using the same procedure. From the stock solutions, another two test solutions with 2.5×10^2 g L^{-1} and 5.0×10^2 g L^{-1} concentrations were prepared. To determine the effect of these test solutions on the germination of *P. vulgaris* seeds, four sets of petri dishes were used. One hundred *P. vulgaris* seeds were introduced into petri dishes. Aliquots of 30 mL of 2.5×10^2 g L^{-1} (T_1), 5.0×10^2 g L^{-1} (T_2) and 7.5×10^2 g L^{-1} (T_3) of aqueous extracts of fresh plant parts were added daily into each petri dish separately, while a similar volume of distilled water was added to the control. The entire study was replicated thrice and the number of germinated seeds was counted after five days. The same procedure was repeated using dry plant part extracts. To determine the effect of aqueous extracts of fresh plant parts of *S. trilobata* on the growth of *P. vulgaris,* four sets of pots filled with compost mixture were prepared with three replicates as described above. Five *P. vulgaris* seedlings (age of 5 days) were planted in each pot. Plants in three treatments were treated with 100 mL of 2.5×10^2 g L^{-1}, 5.0×10^2 g L^{-1} and 7.5×10^2 g L^{-1} concentrations of aqueous extract while distilled water was added to control pots. Plant height and leaf area of *P. vulgaris* seedlings were measured weekly. Fresh shoot mass, dry shoot mass, root length, fresh root mass, dry root mass, length of the pod and average yield were measured at the 7th week. Analysis of variance (oneway ANOVA) and Pearson correlation test were used for statistical analysis. The number of germinated seeds in T_1, T_2 and T_3 petri dishes was significantly low compared to control ($p < 0.05$, oneway ANOVA). For fresh plant parts, number of germinated seeds corresponding to control, T_1, T_2 and T_3 were 84, 55, 31 and 9, respectively, while dry plant extracts resulted in 80, 53, 33 and 8, respectively. There was a strong negative correlation between the concentration and the number of germinated seeds. Plant shoot height, leaf area, fresh shoot mass, dry shoot mass, root length, fresh root mass, dry root mass, length of the pod and average yield of *P. vulgaris* plants were significantly low in T_1, T_2 and T_3 pots, compared to the control pots ($p < 0.05$, oneway ANOVA). Further, a strong negative correlation was shown between the concentration and the above growth parameters of *P. vulgaris* plants. In conclusion, aqueous extracts of fresh and dry plant parts of *S. trilobata* denoted allelopathic effects on *P. vulgaris*.

Keywords: Alien invasive plant, allelopathic effect, aqueous extract

Abstract No: 90 ***Earth and Environmental Sciences***

ALTERATION OF PHYTOPLANKTON GROWTH BY SOME SELECTED ZOOPLANKTON SPECIES FOR THE APPLICATION IN BIOMANIPULATION

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Biomanipultion directly targets the aquatic food web and prevents the formation of harmful algal blooms (HABs) by reducing the rapid growth of phytoplankton. It can be done through planktivorous fish and/or zooplanktons, and in this research, zooplanktons were used to alter the growth of phytoplankton. In order to find a potential candidate for the application in biomanipulation, four zooplankton species *viz. Daphnia magna, Alona* sp.*, Stenocypris* sp. and *Cyclops* sp. were used. Four phytoplankton species, *Monoraphidium* sp.*, Mougeotia* sp.*, Microcystis* sp. and *Aphanothece* sp. were used to investigate the suitability of the selected zooplanktons. Grazing ability of the zooplanktons was assessed individually and as a Mix Culture (MX). After the initial introduction of 40 zooplankton individuals (for the MX, 10 from each species) to pure cultures of phytoplankton, the number of phytoplankton cells in 1ml was counted using the Sedgwig Rafter cell, weekly for 12 weeks. According to Pearson coefficient of determination (R^2) and probability values (p), individual zooplankton species and the MX demonstrated varied grazing abilities. *Mougeotia* sp. was controlled well by *Stenocypris* sp. and the MX was less effective. The growth of *Monoraphidium* sp. was greatly suppressed by *Daphnia magna. Stenocypris* sp. and *Microcystis* sp. were well controlled by MX and also by *Daphnia magna* and *Stenocypris* sp. For the control of *Aphanothece* sp. both *Daphnia magna* and the MX can be used. In this study, large-bodied zooplanktons, *Daphnia magna* and *Stenocypris* sp., exhibited a better grazing potential against other two species. The MX of zooplanktons should be experimented further in order to get more promising results for controlling phytoplankton. These different capabilities of grazing in zooplankton can be used to construct a suitable composition for the MX by considering phytoplankton species present in a bloom. They can be used for the application of biomanipulation in lentic freshwater systems in the near future.

Keywords: Biomanipulation, Freshwater systems, Harmful Algal Blooms, Phytoplankton Growth Alteration, Zooplankton Grazing

Abstract No: 94 ***Earth and Environmental Sciences***

STUDY OF ADSORPTION, KINETICS AND EQULIBRIUM OF Cu^{2+} ON ADSORBENT FORMED BY REACTION BETWEEN PARA-NITROACETANILIDE AND CONCENTRATED SULFURIC ACID

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Pollution of drinking water is a pragmatic problem in the world today. Out of many causes of water pollution, the contamination by heavy metals and dyes are considered to be a major concern. This study focused on a new adsorbent made by reaction between para-nitroacetanilide and concentrated sulfuric acid. The resulting substrate has a high surface area and a porous structure. The adsorption of Cu^{2+} has been studied on this substrate. The prepared material was characterized by Fourier transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), X-ray fluorescence spectroscopy (XRF) and point of zero charge (pzc) analysis. The SEM images of the substrate showed the presence of a porous and rough surface. FTIR spectra revealed the presence of COOH, OH, C≡N, C≡C, C=C, NO_2, α, β-unsaturated C=O, C-O and C-N functional groups. The XRF analysis was used to confirm the adsorption of Cu^{2+} metal ions. This occurs through the formation of coordination bonds. The pH at which the net charge of total surface was calculated to be zero is 3. The adsorption experiments were carried out as a function of pH, the shaken time, the initial Cu^{2+} concentration and the adsorbent dosage. The optimized conditions were found to be pH 6, shaking time of 50 minutes and 96.25 mg L^{-1} of the initial Cu^{2+} concentration for 0.125 g of the substrate. The adsorption data fits the Freundlich isotherm at higher concentration revealing multilayer adsorption. The adsorption kinetics fit more towards a pseudo second order kinetics with a R^2 value of 0.99 suggesting a chemisorption process. It was concluded that at lower concentrations, chemisorption will take place, while multilayer adsorption takes place at higher concentrations. At lower concentrations, surrounding water molecules which are chelated with Cu^{2+} ions form hydrogen bonds with the surface. However, at higher concentrations, it tends to form multilayers by other copper ions forming weak van der Waals interactions with already adsorbed species.

Keywords: Chemisorption, Copper adsorption, Para-nitroacetanilide, Physisorption, Water purification

Abstract No: 96 ***Earth and Environmental Sciences***

GEOTAGGED ADDRESS INFORMATION FRAMEWORK FOR SERVICE PROVIDERS

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In Sri Lanka, various organizations have adopted the use of Geographical Information Systems (GIS) for their internal affairs and community. Numerous researches and related publications have been made in this favor. The requirement of a proper methodology for defining community residences in GIS applications is emerging. Enrolling children in schools, providing relief at the time of disaster, and many other activities essentially need a location identification system. Even though there is a high level of usage of Google® Earth™, Google® Maps™ and the maps issued by the Government Survey Department, the data obtained are not accurate as expected. This research addresses the problems encountered during the use of residential data from the above maps. The objectives of the research were to introduce an effective method to find the exact location, explore how the geotagging method is used for the situation, and to make a platform for service providers. According to the classification and position of 5,267,159 residential houses in Sri Lanka, geotagging is the best method to spot the locations. The research samples were Malwatta and Diyabubula Grama Niladhari divisions in the Kandy district. Magellan® eXplorist™ 610 handheld device was used to obtain longitudes and latitudes of a location. The collected data were processed using a web-based software platform and were distributed through an Application Programming Interface (API). The objective of the API is to provide background for the institutions that are required to meet personal demands. Thus, the result of the research is expected to establish a residential identity, to provide a platform for service providers to access the geo-coordinates of related postal addresses, and to maintain their service attributes with high responsibility of managed credentials. Institutes and authorities can use this API for implementing the public policy of providing direct services to the public. It is imperative to provide access to the relevant institutions while keeping these data secure, with state intervention. Further, proxies with the ability to adapt to changing government policies should be developed to mitigate the problems of the existing methods identified in the present study. HTTPS protocol, cloud server, one-meter accuracy devices, and manpower of forces are recommended to successfully disseminate this research for the country. This research demonstrated the necessity of a correlative geo-based system for emergencies and disasters and it breaks the gap between the government and the public and, lays the foundation for effective strategies.

Keywords: Application Programming Interface, Geographical Information Systems, Geo-Services API, Remote Sensing, Service Broker Framework

Abstract No: 105 ***Earth and Environmental Sciences***

MANAGEMENT OF MUNICIPAL SOLID WASTES: AN OVERVIEW OF THE COLLECTION, COMPOSITION AND FATE OF SOLID WASTE OF LOCAL AUTHORITIES IN HAMBANTOTA DISTRICT IN SRI LANKA

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Solid waste collection by the Local Authorities (LAs) is rapidly developing and getting serious attention in Sri Lanka. However, a proper management plan for collection of solid waste has not yet been implemented to achieve the full potential with increasing inputs and technologies. This study was focused on finding the total amount of urban solid waste collected daily by the twelve solid waste management sites operated by the LAs of Hambantota District, and to analyse the waste composition and its fate thereafter. Average daily collection of each category of solid waste was calculated using the daily records at each waste management site. This amounts to 52.587 tons/day. The weights of different solid wastes collected in this study are: compostable organic materials 24.320 tons/day, paper 0.815 tons/day, clothes 0.487 tons/day, plastic and polythene 4.545 tons/day, rubber and leather 0.685 ton/day, steel 0.439 tons/day, glass 2.338 tons/day, electronic waste 0.539 ton/day and other mixed waste 18.232 tons/day. The results revealed that daily waste collection of LAs in the district varied from 1-2 to 10-20 tons/day. The dominant range was within 1-2 tons/day. This study also found high variability of the status of waste collection among Municipalities, Urban Councils and Pradeshiya Sabhas. The results of weight and composition of the solid waste collected in this study clearly indicated a positive relationship with urbanization. The LAs which have high population with large jurisdiction land area do not collect large amounts of solid waste. The administrative areas with less land but moderate urban waste generation could be more efficient in collecting urban solid waste than the areas with high land extent. If population spreads throughout a large land area, the people would have adhered to manage their solid waste with their own methods. Therefore, LAs should be strengthened in parallel to urban development to achieve the success of solid waste management. When considering the ongoing rapid development activities of Hambantota District, the amount of daily waste collected is expected to rise largely. However, the results of this research did not reflect a significant improvement of waste collection within the district. The results of this study also highlighted a few malfunctions of the LAs of Hambantota District, such as improper collection of solid waste and not maintaining proper records on collected solid waste. These issues should be carefully studied because strengthening of LAs has not yet been implemented compared to other development activities with compromised needs of the population. Therefore, preliminary findings of this study could be used to develop a systematic and sustainable solid waste management model for Hambantota District.

Keywords: Hambantota, Local Authorities, Management, Municipal solid waste

Abstract No: 114 ***Earth and Environmental Sciences***

DRAINAGE NETWORK QUANTIFICATION IN A MOUNTAINOUS WATERSHED: A GIS-BASED APPROACH IN BADULU OYA BASIN, SRI LANKA

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Quantification of drainage network elucidates many characteristics of a drainage area. GIS is a widely applied tool to derive drainage networks from spatial data. The present study aimed to assess the drainage network parameters of Badulu Oya Catchment (BOC) in Uva province of Sri Lanka in terms of linear, areal and relief characteristics. The contour-based Digital Elevation Model (DEM) was used to derive the drainage lines and watershed with the aid of hydrology tools in ArcGIS 10.4.1 platform. Results of the drainage network analysis revealed that the Badulu Oya is a sixth order stream channel, extending for 39.7 km along the elongated drainage basin which encompasses an area of 404.7 km^2 illustrating a dendritic drainage pattern. Bifurcation ratio of less than 5 (1.84) indicates that the drainage basin is underlain by uniform materials, and the constituent streams are usually branched systematically with large number of first, second and third order tributaries implying low influence of geologic structures on channel controls. Highly branched stream network indicates lower influence on flooding. Low values of elongation ratio (0.57), foam factor (0.26) and circulatory ratios (0.3) further confirm basin shape and low risk of floods. High drainage texture (21.25) implies the sparse vegetation of dry climate condition in the basin. Drainage density (2.95) and stream frequency (6.82) indicate prevalance of good level of percolation and infiltration processes in the basin. The relief parameters such as basin relief (1,900 m) and ruggedness number revealed that the basin is characterized by high relief and steep gradient. Similar pattern has been observed in a study of Kelani River basin. As per the current knowledge this study is the first morphometric analysis of the BOC, hence comparison with the previous findings is lacking. An analysis of published drainage network in a topographic map further confirms the validity of the derived stream network.

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Keywords: Catchment, Drainage network, GIS, Morphometric analysis

Abstract No: 116 ***Earth and Environmental Sciences***

GRAIN SIZE CLASSIFICATION OF SEDIMENTS IN A COASTAL CURRENT MIXING PROGRADING ZONE ON THE SOUTHEAST COAST OF SRI LANKA

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Southeast (SE) coast of Sri Lanka has been identified as a progressive type beach, which is located in a coastal current mixing zone of the Indian Ocean. Although studies on the ocean current circulations have been carried out, sedimentological characterization on the coastal sediments has been less studied despite their significance. The present study aimed to investigate the grain size and related textural parameters of surface sediments in order to interpret the deposition environment and transportation dynamics of such a coastal current mixing zone. A total of 124 sediment samples (each ~ 5 kg) were collected from a pit on the berm zone (50 cm depth) at an interval of 500 m covering a distance of 68 km, from Oluvil to Panama coast from October, 2019 to January, 2020. A field survey and grain size distribution (GSD) analyses were carried on each sample using GRADISAT software. The resulted bulk unimodal GSD patterns reveal that the environment is dominated with medium to fine sands (92.7%) indicating a moderate to low energy conditions for the regional sedimentation. Sediment distributions are dominant with moderately well sorted to moderately sorted near symmetrical skewness indicating uniform sedimentation characteristics of each sampling site. Grain size statistical parameters indicate that the geomorphological variations of the coast slightly affect the sedimentation where river inputs and lagoonal environments are present. As evident from the scatter plots of mean size, sorting, kurtosis and skewness, the majority of the sediments have a fluvial origin. Linear discriminatory functions of the samples showed that the sediment deposition was prominent at an agitated shallow marine environment. Passega diagram unravels that the SE beach environment interacts with tractive current depositional agent through bottom suspension and rolling sediment transportation modes. The merged results deduce that the local river inputs have been reworked in the same region due to the energy controls of the coastal currents. The sedimentary environment is characterized with bottom suspended rolling sedimentation in the low energy shallow marine environment. Hence, it can be concluded that the SE ocean current mixing zone controls the sedimentation of the coastal environments by reducing the energy of the terrestrial inputs.

Keywords: Grain size distribution, Prograding beach, Sediment mixing zone, Sediments depositional environment, Southeast coast of Sri Lanka

Abstract No: 123 ***Earth and Environmental Sciences***

SIMPLE METHOD TO SYNTHESIZE OF Fe_2TiO_5-TiO_2 HETEROSTRUCTURES FROM ILMENITE AND THEIR PHOTOCATALYTIC ACTIVITY FOR DEGRADATION OF METHYLENE BLUE

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The quest to find practical solutions in producing a clean environment is a global challenge due to the environmental pollution caused by the anthropogenic activities. TiO_2 is the mostly experimented semiconductor that degrades pollutants via advanced oxidation process due to its ability to achieve complete mineralization. The main objective of this study is to synthesize photocatalytically active pesudobrookite-titania heterostructure nanoparticles from natural ilmenite that is extensively available in the coastal areas of Pulmodai and Induwara, Sri Lanka. In order to achieve this, purified ilmenite was acid digested in conc. HCl, and conc. NH_3 was added dropwise to that solution. Brown coloured precipitate was annealed at 800 °C for 2 hours. The product was characterized by X-ray diffractormetry (XRD), transmission electron microscopy (TEM), UV-Visible spectroscopy, Raman spectroscopy, scanning electron microscopy (SEM), X-ray photoelectron spectroscopy (XPS) and energy-dispersive X-ray spectroscopy (EDS). According to the XRD and Raman spectroscopic data, the nanoparticles synthesized consist of a heterostructure of Fe_2TiO_5 and TiO_2 where both rutile and anatase phases of TiO_2 are present. TEM and SEM images show agglomerated nanoparticles of about 50 nm and EDS spectra prove the presence of Ti and Fe. Higher resolution XPS spectra show that the surface of the nanoparticles consists of Fe^{3+} and Ti^{4+}. The band gap was calculated as 2.05 eV by diffuse reflectance UV-Visible spectroscopy and a type I heterostructure has been produced. Photocatalytic activity of the synthesized heterostructure nanoparticles was evaluated by photodegradation of methylene blue by direct sunlight. Fe_2TiO_5-TiO_2 heterostructures show 76% conversion of 3 mg L^{-1} methylene blue after 2 hours, and addition of H_2O_2 improved the catalytic activity resulting 96% conversion of methylene blue. This result clearly indicates that electron-hole pair recombination has taken place in the synthesized new heterostructure and that has been prevented by addition of an electron acceptor such as H_2O_2.

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Keywords: Heterostructure, Ilmenite, Pesudobrookite, Photocatalysis, Titania

Abstract No: 127 ***Earth and Environmental Sciences***

SYNTHESIS OF NANO-SIZED CU-ZEOLITE USING A NEW MICROWAVE ASSISTED METHOD

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Zeolites are mesoporous materials that have various applications, such as water purification and catalytic processes. Due to their tunable properties, such as high porosity, large surface area, ion exchanging ability and high thermal stability, zeolites have attracted the attention of scientists to enhance the catalytic action of the material in a variety of applications. During this project, zeolite was modified to be used as a catalyst in removal of NO_x and SO_2 from vehicle exhaust. Modification of zeolite was performed using $Cu(NO_3)_2$ via a microwave assisted method, and the resulted samples were characterized by fourier transform infrared spectroscopy (FTIR), powder X-ray diffraction (PXRD) and particle size analysis. Since the PXRD pattern of the synthesized zeolite and the modified samples have similar peak positions, the crystal structure of the modified zeolite can be considered as conserved up to a certain level when modified. However, modified samples show a decrease in the intensity of peaks due to the high absorption coefficient of Cu compounds in Cu-zeolite for X-ray radiation. Additional peaks in the PXRD pattern of Cu-zeolite at 35.50° and 38.61° are characteristic peaks for CuO which does not appear in the PXRD pattern of synthesized zeolite. The results obtained show that the synthesized zeolite has LTA (Linde Type A) crystal structure. According to the FTIR data, there is a peak around 1,383 cm^{-1} in the spectra obtained for Cu-zeolite which is not present in the synthesized zeolite. This is an indication of variable amounts of Cu present in the ion exchange sites by replacing the proton in the Cu-zeolite. The band that appears at 3,443.73 cm^{-1} in Cu-zeolite spectrum is due to the Cu-O vibrations and it is not observed in the synthesized zeolite. Synthesized zeolite had a narrow particle size distribution with an average size 300-600 nm. Unlike other methods, the microwave assisted method of zeolite modification was carriedout at a temperature as low as 110 °C and nano-sized LTA type zeolite was successfully obtained.

Financial assistance from the National Research Council (*Grant No. 19-090*) *is acknowledged.*

Keywords: Catalyst, Copper, Microwave, Modification, Zeolite

Abstract No: 151 ***Earth and Environment Sciences***

LOW ENERGY STEREO-SELECTIVE EPOXIDATION OF TRANS-STILBENE: SHAPE SELECTIVE HETEROGENEOUS CATALYSIS USING MORPHOLOGY CONTROLLED MIXED METAL OXIDES

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Morphology controlled $LaVO_4/Cu_2V_2O_7$ mixed metal oxide has been synthesized via a hydrothermal process using oleic acid/oleylamine (OL/OA) surfactant mixture and studied for stereo-selective epoxidation of trans-stilbene into cis-stilbene oxide in a low energy pathway. Surfactants have the ability to adhere to certain facets of the nanocrystals that can govern the growth rate and prevent particle agglomeration. Material synthesized in the presence of OL/OA mixture was composed of monodisperse nanocrystals. The material was characterized by powder X-ray diffraction, FE-SEM, EDX, nitrogen physisorption experiments, and TG-MS. The gas chromatography – mass spectroscopic (GC–MS) method was used for the quantitative analysis and identification of the reaction product. Stereo-selective epoxidation of trans-stilbene was carried out under low energy conditions with 100% selectivity. According to GC–MS results, trans-epoxide was formed as the initial product, however, with the course of the reaction, it was completely converted into cis-epoxide confirming that the catalyst shows 100% conversion and selectivity at 60 °C. Since no byproducts are formed, the atom economy is 100%. As trans-epoxide was also formed during the reaction, desired stereo-chemical product can be isolated by controlling the reaction time. The cooperative effect of the surfactants was further validated with a series of experiments with no observation of 100% cis-epoxide selectivity confirming that the OL/OA ratio has a great influence on the product selectivity. The reaction was truly catalytic showing only a 22% conversion after 21 hours without the catalyst and a very high reusability giving a 92% conversion and 100% selectivity even after the 4th cycle. There is no evidence on heterogeneous catalysts which convert trans-stilbene into cis-epoxide with 100% selectivity at a comparatively low temperature as 60 °C. Therefore, this could be considered as a novel, low energy, environmentally benign, hence a highly sustainable green process.

Keywords: Catalysis, Energy, Epoxidation, Stereo-selective, Sustainable

Abstract No: 157 **Earth and Environmental Sciences**

ATMOSPHERIC POLLUTION BY MICROPLASTICS IN COLOMBO AND KANDY URBAN ENVIRONMENTS OF SRI LANKA

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Microplastics (MPs) have received considerable attention all over the world in the recent past since they are hazardous environmental pollutants. Even though several studies have been carried out on MPs in marine environments and inland water bodies of the world, less attention has been given to their occurrences in the atmosphere. The present study focused mainly on the characterization of MPs in the dust of Colombo and Kandy urban environments in terms of morphology and polymer chemistry. A total of 50 deposited and suspended dust samples were collected from households and roads of the municipal areas. Optical microscopic, scanning electron microscopic (SEM) and Fourier-transform infrared (FT-IR) analyses were carried out on the samples. The household dust samples showed a higher concentration of MP particles than road dust samples. Morphology of the studied MPs can be categorized into fiber, foam and fragment. Out of these morphologies, fibers are the most common fraction. SEM images of MPs in deposited dust samples showed presence of grooves, pits, adhering particles, fractures and flakes which indicate long-term exposure to the environment. In contrast, surfaces of MPs of the suspended dust do not show any degradation patterns and those are mostly fresh materials of recent derivation. Further, the fibers present in the suspended dust are shorter than those in the deposited dust samples. Therefore, it can be inferred that fibers in the suspended dust are more hazardous than fibers in the deposited dust since those can easily enter the respiratory system. High-density polyethene, polystyrene, nylon and acrylonitrile butadiene styrene are the major polymer types found in the deposited dust. The fibers observed in the deposited dust samples may have derived from synthetic textile fibers, possibly generated due to the degradation of synthetic textile materials. The degradation patterns indicate that MPs investigated have been subjected to different levels of mechanical processes and chemical alteration. The morphology of the MPs mainly depends on the type and structure of the crystalline structure of the polymer they are made of. The high abundance of the fibers may be due to its high production rate which leads to high waste generation. Due to the high width to length ratio of the fibers, they could be transported to long distances and could deposit in remote areas. MPs can be identified as a high potential source of atmospheric pollution in urban environments which could pose a high risk to human health.

Financial assistance from the National Research Council (Grant No. AB 19-004) is acknowledged.

Keywords: Household dust, Microplastics, Road dust, Suspended dust, Urban pollution

Abstract No: 159 **Earth and Environmental Sciences**

ENHANCED REMOVAL OF Cr(III) BY NaOH-MODIFIED SCRAPED COCONUT WASTE

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Increase in human population and industrial development cause severe damage to the environment. Industrial effluents release different types of pollutants, such as heavy metals, anions, dyes and pesticides, to natural water bodies, resulting in water pollution. Among these, heavy metals are considered to be the most hazardous. Consequently, removal of heavy metals from industrial effluents using low-cost biosorbents is becoming popular. However, improvement of efficiency of removal of pollutants by biosorbents has become a challenge. This study is an attempt made to enhance the removal of Cr(III) from synthetic waste-water by NaOH-treated scraped coconut waste (NSCW), which is readily available in tropical countries, such as Sri Lanka, at no cost. The optimum values of experimental parameters determined for most efficient biosorption of Cr(III) by NSCW are: 0.70 g NSCW mass; 5.0 initial solution pH; 90 min shaking time and 30 min settling time. Further, NaOH-modified SCW provides the highest extent of Cr(III) removal when the concentration of NaOH solution is 0.10 M, which is considered to be the optimum concentration of the modifying agent. Under the optimized conditions, NaOH treatment provides Cr(III) removal, enhanced from 53.6% in the absence of any modification to 92.9% when SCW is treated with 0.10 M NaOH solution. On the other hand, acid treatment leads to decreased extent of removal ruling out the possibility of ion exchange. It is thus proposed that the complexation is the most probable mechanism of Cr(III) removal which is enhanced by conversion of ester groups and carboxylic acid groups to negatively charged species by NaOH treatment promoting complexation with Cr(III). Isotherm studies show that Cr(III) on NSCW obeys the Langmuir adsorption isotherm better than the Freundlich adsorption isotherm, leading to adsorption capacity of 14.28 mg g^{-1}.

Keywords: Adsorption isotherms, Biosorbents, Parameter optimization, Scraped coconut waste

Abstract No: 163 ***Earth and Environmental Sciences***

DETERMINATION OF TRACE METAL LEVELS IN BULK DEPOSITION AT UNIVERSITY OF PERADENIYA

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The composition of atmospheric precipitation is an important criterion considered as a measure of ambient air pollution. It is usually determined with respect to wet precipitation and dry precipitation, or as bulk deposition in combined form. Although rainwater quality should be continuously monitored in order to predict the extent of air pollution, such investigation receives no attention in Sri Lanka. In order to fill this void, this study was aimed to determine the composition of bulk deposition collected weekly from February to December, 2019 at the University of Peradeniya premises. Parameters, namely rainfall, pH, conductivity, salinity, total dissolved solids (TDS), hardness and trace metals (Al, Cr, Cu, Fe, Mn, Pb and Zn) were quantitatively determined, employing standard analytical methods. The pH measurements indicated that no acid rains have occurred during the sampling period, and the trace metal contents showed the sequence Zn > Fe > Al > Mn > Cu > Pb indicating that Zn, Fe and Al are the dominant metal elements in bulk deposition in Perdeniya area. The sources of Zn pollution in this area could be Zn coated roof materials, lubricants, brass manufacture and vehicular activities. Further, the hardness values showed an averge of 18.97 mg L^{-1} $CaCO_3$ equivalent, indicating the contribition of burning limestone and dolomite, which is prevailent in the area. Bulk precipitation data analyzed using Pearson correlation showed that the high positive significant correlations were apparent between conductivity and salinity, conductivity and TDS, and salinity and TDS, among all water quality parameters. It is also found that, among the trace metals, the highest positive significant correlation was between Fe and Mn, indicating that these two metals would have originated from the same sources, which could be from soil dust particles. Continuation of rain water analysis for a longer period would be necessary to formulate an atmospheric model for prediction of consequences of air pollution.

Keywords: Air pollutants, Bulk deposition, Pearson correlation, Trace metals

Abstract No: 164 **Earth and Environmental Sciences**

AQUATIC INVASIVE WEEDS *Eichhornia crassipes* AND *Salvinia molesta*: HERBICIDAL PROPERTIES AGAINST *Brassica juncea* AND *Pennisetum polystachion*

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Eichhornia crassipes (Mart.) Solms and *Salvinia molesta* D. Mitch. are considered as the two most troublesome aquatic invasive weeds worldwide. Value addition to these plants via production of eco-friendly plant-based herbicides is a strategy to control their spread. The aim of the present study was to explore the potential of the two weeds as a source for developing plant-based herbicides by initially evaluating their phytotoxic properties against *Brassica juncea* (L.) Czern. (mustard) and the alien invasive weed *Pennisetum polystachion* (L.) Schult. (mission grass). Air-dried *E. crassipes* and *S. molesta* were powdered and each powder was extracted using combinations of dichloromethane (DCM), methanol (MeOH) and water at ambient temperature. The powdered plant material and solvent-dried extracts were tested in four replicates for their effects on seed-germination of *B. juncea* and *P. polystachion* and then on the early growth of seedlings of the surviving seeds, under laboratory conditions. The plant powders showed low to moderate inhibition of seed-germination of *P. polystachion* (< 16%) and *B. juncea* (< 40%). The DCM-MeOH (1:1) plant extracts displayed potent inhibition (90 - 100%) of seed-germination of *P. polystachion* and *B. juncea* having the following IC_{50} values: 665 ± 163 and 2446 ± 160 mg L^{-1} of *S. molesta* extract, respectively; 889 ± 131 and 2576 ± 165 mg L^{-1} of *E. crassipes* extract, respectively. The MeOH-water (1:1) extracts of both plants were less potent. The plant powders and extracts displayed concentration-dependent variable effects on growth parameters-root length, shoot length and biomass-of the developed seedlings of *B. juncea* and *P. polystachion*; growth promotion was observed at low concentrations of the extracts and growth retardation at high concentrations. The extracts of *E. crassipes* and *S. molesta* can inhibit the seed-germination of *B. juncea* and *P. polystachion* indicating their potential as a source for developing plant-based herbicides.

Financial assistance from Sri Lanka Council for Agricultural Research Policy (*Grant No. NARP/16/UP/PGIS/01) is acknowledged.*

Keywords: Aquatic invasive weeds, *Eichhornia crassipes,* Phytotoxicity, *Salvinia molesta*

Abstract No: 165 ***Earth and Environmental Sciences***

HERBICIDAL PROPERTIES OF TERRESTRIAL INVASIVE ALIEN PLANTS *Lantana camara* AND *Panicum maximum* AGAINST *Pennisetum polystachion* AND *Brassica juncea*

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Lantana camara L. and *Panicum maximum* Jacq. are troublesome terrestrial invasive alien plants (IAPs) in Sri Lanka. IAPs endanger ecosystems and biodiversity of native species and cause great economic losses. Value-addition to the IAPs by way of eco-friendly plant-based herbicides can regulate their intensive spreading and damage to ecosystems. The objective of this study was to determine the herbicidal effects of *L. camara* and *P. maximum* on seed-germination and early seedling-growth of *Brassica juncea* (L.) Czern. and *Pennisetum polystachion* (L.) Schult. The air-dried and ground *L. camara* (leaves) and *P. maximum* (whole plant) were extracted into methanol-dichloromethane (1:1) and methanol-water (1:1). The plant powders and solvent-dried extracts were tested in four replicates for their effects on germination of *B. juncea* and *P. polystachion* seeds and then on the early growth of seedlings of the surviving seeds, under laboratory conditions. The plant powders and extracts inhibited the seed-germination of *B. juncea* and *P. polystachion* in varying degrees and potencies. Except for *L. camara* against *B. juncea*, other plant powders and extracts showed a similar trend as follows: dichloromethane-methanol extracts > plant powders > methanol-water extracts having IC_{50} (equivalent plant powder) values of 184 ± 15, 445 ± 41, 452 ± 18 and 160 ± 30, 195 ± 31, 738 ± 30 mg for *P. maximum* against *B. juncea* and *P. polystachion,* respectively and 48 ± 10, 170 ± 16 and 323 ± 17 mg for *L. camara* against *P. polystachion*. With respect to *L. camara* against *B. juncea*, the order of potency was plant powder > methanol-water extract > dichloromethane-methanol extract with IC_{50} values of 140 ± 12, 275 ± 15 and 494 ± 120 mg, respectively. Methanol-water extracts of *L. camara* and *P. maximum* displayed inhibitory effects on growth parameters of *B. juncea* and *P. polystachion* seedlings such as root length, shoot length and biomass, which increased with concentration. Plant powders and dichloromethane-methanol extracts displayed concentration-dependent variable effects on the growth parameters. The herbicidal phytochemicals of *L. camara* causing inhibitory effects on seed-germination and seeding-growth of *B. juncea* and *P. polystachion* may include one or more of lantadenes, cineol, β-pinene and dipentene. *Lantana camara* and *Panicum maximum* are potential sources for developing eco-friendly plant-based herbicides.

Financial assistance from Sri Lanka Council for Agricultural Research Policy (*Grant No. NARP/16/UP/PGIS/01) is acknowledged.*

Keywords: *Lantana camara*, *Panicum maximum*, Phytotoxicity, Terretrial invasive plants

Abstract No: 168 ***Earth and Environmental Sciences***

IMPREGNATION OF COCONUT COIR BASED ACTIVATED CARBON WITH MAGNETITE TO ENHANCE EFFICIENCY OF WATER SOFTENING

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The hardness of water caused by the presence of excessive amounts of calcium and magnesium ions has led to a multitude of health and economic impoverishments worldwide. Adsorption techniques are celebrated as an excellent strategy to remediate water hardness at present. Even though activated carbon derived from charcoal has been widely employed as an adsorbent for hardness removal, it inherits many drawbacks such as lower adsorption rates and efficiency. Therefore, the development of novel advanced adsorbent materials for water softening has become essential. Identifying this requirement, we disclose the development of magnetite nanoparticles impregnated activated carbon derived from coconut coir (M-ACC) as a novel and efficient adsorbent material for water hardness remediation. The synergistic quantum effects arising at the nanoscale due to the surface functionalization of activated carbon with magnetite nanoparticles have awarded these nanohybrids enhanced adsorption properties and ease of removal after adsorption due to its magnetic behaviour. In this study, the applicability of M-ACC was tested and optimized conditions of the process parameters including contact time, adsorbent dose, and pH using representative natural water sample (total hardness-370 mg L^{-1}). The M-ACC was prepared by an *in-situ* one-pot synthesis approach where raw coir was dipped in a solution of 1 M $FeCl_3$, 1 M $Fe_2SO_4.7H_2O$ and 5 M NaOH followed by pyrolysis at 450 °C under N_2 gas flow. Characterization studies entrusted the successful impregnation of magnetite nanoparticles to activated carbon, and powder X-ray diffraction and Fourier transform infrared spectroscopy confirmed the formation of magnetite phase and its interactions with activated carbon matrix. This novel material was capable of removing total hardness of water over 70% with an adsorbent dose of 0.6 g/50 mL at normal pH (pH_{pzc} 5.29) by dual filtration. Therefore, we can claim the suitability of magnetite nanoparticles impregnated activated carbon derived from coconut coir as an adept adsorption material in developing next-generation solutions for restoring water softness.

Keywords: Coconut coir, Functionalized activated carbon, Magnetite nanoparticles, Optimization, Water hardness

Abstract No: 170 ***Earth and Environmental Sciences***

MOBILIZATION AND FRACTIONATION OF RARE EARTH ELEMENTS DURING WEATHERING OF CARBONATITES AT EPPAWALA, SRI LANKA

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Owing to the exceptional physical and chemical properties, rare earth elements (REEs) play a significant role in advanced technological applications. Weathered carbonatite complexes are known to contain significant amount of REEs. Understanding migration patterns of REEs during weathering is important when a deposit is evaluated for extraction of REEs. This study was conducted to investigate the mobility and the fractionation patterns of REEs in the weathered phosphate deposits at Eppawala, Sri Lanka. These deposits have been developed as a result of weathering of basement carbonatites. Samples collected from three working phosphate quarry sites were subjected to geochemical analyses on inductively coupled plasma-optical emission spectrometry and inductively coupled plasma-mass spectrometry in order to understand the distribution of major, trace and REEs concentrations. Enrichment of REEs in the weathered zones [total REEs concentration (ΣREEs) 1,097.47 - 10,931.90 mg L^{-1}] is clearly shown with respect to the parent carbonatites (ΣREEs 347.30 - 885.00 mg L^{-1}). $(La/Lu)_{cn}$ ratios of the weathered zones (28.94 - 63.13) are higher than those of the fresh carbonatites (13.89 - 17.67). It indicates the fractionation of La and Lu during the weathering as a result of differential mobility with solution complexes. REEs are positively correlated with Fe_2O_3 and P_2O_5. Hence, secondary iron oxide and phosphate minerals can be the major hosts for REEs. Mass balance equations further describe the total dissolution of carbonates and formation of secondary phosphates, aluminophosphates and clay minerals which could act as scavenging phases for REEs. The pH values of the weathered carbonatite samples are in the range of 5.24 - 6.97 suggesting that the apatite dissolution process be incomplete. Variation of anomalies of REEs of the main quarry deemed to be highly heterogeneous, which can be attributed to the mixing of weathered materials under the karst conditions. Elevated values of REEs are reported at the leached zone exposed at the hillock area located at the centre of the main quarry site while the lateritic zone shows depleted levels of REEs as a result of intense weathering and leaching. Hence, the intermediate leached zone can be utilized for the extraction of REEs.

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Keywords: Fractionation, Mobility, Rare earth elements, Weathered carbonatite

Abstract No: 181 ***Earth and Environmental Sciences***

SOIL ORGANIC CARBON IN BLUE CARBON ECOSYSTEMS OF NORTH WEST OF SRI LANKA

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Blue carbon ecosystems with intense carbon accumulation are a dynasty in atmospheric carbon mitigation. These ecosystems are highly encroached and polluted and has become defective in functioning. With the intention of identifying the current status of the soil carbon pools, available nutrient contents and other associated edaphic conditions in blue carbon ecosystems, sampling was conducted from the top layer of soil (0-15 cm from surface) in mangrove and saltmarsh ecosystems at Vidataltivu, Achchankulam, Naravillikulam and Umangri, in the Mannar District. Subsequently, these were analysed for available nitrate, phosphate, ammonium anions, Microbial Biomass Carbon, Permanganate oxidizable carbon and soil organic carbon (SOC). Principal Component (PC) analysis was performed to reveal the spatial heterogeneity of examined parameters in above mentioned ecosystems using Minitab 17. Results showed two significant PCs, in which the first PC represented an inverse gradient of SOC and pH (PC loadings for SOC = 0.54, Moisture content = 0.53 and pH = -0.38). A gradient of significantly low phosphate and nitrate availability with high EC level was featured by the second PC (PC loadings for nitrate = -0.65, phosphate = -0.51 and EC = 0.244; mean values for phosphate = 53.75 ± 10.60 mg kg^{-1}, nitrate = 1.95 ± 1.53 mg kg^{-1}, and EC = 7.70 ± 3.97 mS cm^{-1}, respectively). Well grown mangrove sites have adopted for lower availability of soil nutrients. Soil organic carbon ranged at the lowest level of less than 10% and the highest range of pH (7.8 - 8.5) was cited descriptively via clustering at the sites of mangrove invaded saltmarshes, mixed dry forests, grazing lands, and mid mangrove sites encroached by fishing industry and human dwellings. Highest SOC of more than 25% was found in areas where dense growth of mature *Avicennia* or *Rhizophora* spp. were present under persistent water logging conditions. Thus, we confirm that anthropogenic activities affect adversely on SOC stocking in considering blue carbon ecosystems.

Financial assistance from the National Institute of Fundamental Studies is acknowledged.

Keywords: Labile carbon, Mangroves and saltmarsh ecosystems, Microbial biomass carbon, Principal component analysis, Soil organic carbon

Abstract No: 194 ***Earth and Environmental Sciences***

STUDY OF GROUNDWATER RECHARGE IN MA-OYA MICRO CATCHMENT OF MAHAWELI RIVER

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Groundwater in an area is recharged in the following ways: natural lateral groundwater flows from outside, infiltrated rain water, streams, artificial sources and urban and rural wastewater. These factors of recharge are often considered theoretically. Therefore, this research was focused on the identification of groundwater recharge sources and quantification of fluctuations of the groundwater table in the Ma Oya, a tributary of the Mahaweli River in the central highlands. Depth to the groundwater table was monitored in 13 shallow domestic wells, situated in the regolith, and in a borehole that has been constructed in the lower reach of the catchment and in an alluvial formation. Rainfall data were obtained from three weather stations installed within the catchment. Groundwater level elevation was calculated by subtracting groundwater depth from the well head surface elevation. Temporal variation of recharge of each and every well was studied by comparing the water-level elevation with different conditions of cumulative rainfall, as one-day, one-week, two-weeks and one-month prior to the water depth measurement. Pearson Correlation Coefficient shows a strong positive relationship for water-level elevation and cumulative rainfall of two-weeks and one-month prior to the water depth measurement. This suggests that one-day rainfall has not significantly impacted the groundwater recharge. The study reveals that groundwater recharge has occurred over a period of one month and the response of the recharge is at a maximum during the period from one week to two weeks. This delay in recharge of aquifers could be attributed to the presence of a thick forest cover and low permeable, clay-rich thick regolith within the catchment. A strong positive relationship was found for water-level elevation in the borehole and the water-level in nearby stream during wet months when the stream water level increased. It could be concluded that the alluvial aquifer is recharged both by rainfall and stream water infiltration during the wet season, whereas the stream is recharged by the aquifer during the dry season with the change in the hydraulic gradient.

Financial assistance from the National Research Council (Grant No. 17-037) is acknowledged.

Keywords: Aquifer, Groundwater, Mahaweli, Recharge Sources

Abstract No: 199 ***Earth and Environmental Sciences***

EVALUATION OF MICROBIAL BIOMASS CARBON IN PADDY SOILS OF ANURADHAPURA DISTRICT, SRI LANKA

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Paddy (*Oryza sativa*) is the principle food as well as the main income source for many farm families in Sri Lanka. Both biotic and abiotic environments in paddy fields have been disturbed by excessive chemical inputs, which in turn disrupt the nutrient availability in agricultural fields. This leads to diminution of quantity and quality of the harvest. Paddy ecosystem serves as one of the favored habitats for a large number of soil microorganisms, which play a vital role in maintaining the nutrient cycles and soil fertility. Microbial biomass carbon (MBC) is the amount of carbon present within microbial organisms present in soil. This case study is aimed at assessing the status and functions of MBC of paddy-growing soils within a season in Anuradhapura, the largest paddy-growing district in Sri Lanka. Conditional Latin Hyper Cube Sampling design was employed in the study. Pooled soil samples (143) were collected from the Anuradhapura district at 0 - 15 cm soil depth. The soil MBC at each sample location was determined using chloroform fumigation and extraction method. Other soil parameters [pH, Electrical conductivity (EC), active carbon (AC) fraction, available potassium (K)] were also measured. Total soil carbon (TSC) content was estimated using CHN elemental analyzer. The results revealed that, the soil MBC varied in the range from 0.001 to 0.17 % and most of the soil pH values were scattered within the range of 5.76 - 8.62. The EC (r = 0.533), TSC percentage (r = 0.401), AC percentage (r = 0.326) and K percentage (r = 0.511) are positively correlated with the MBC percentage. The study revealed that the MBC, which may contribute to long term agricultural sustainability, can be maintained by managing the soil organic carbon and its fractions. Furthermore, it enhances the nutrient retention capacity and the availability of paddy soil.

Financial assistance from the National Research Council (*Grant No. 17-011*) *is acknowledged.*

Keywords: Microbial biomass carbon**,** Nutrient retention, Paddy, Total soil carbon

Abstract No: 201 ***Earth and Environmental Sciences***

SITE SUITABILITY EVALUATION OF CULTURAL PLACES FOR ECOTOURISM DEVELOPMENT IN JAFFNA DISTRICT, SRI LANKA

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Jaffna District is rich in cultural diversity and hence it may be regarded as a cultural hub in Sri Lanka. Buildings with archeological and historical value, religious places and monuments are the key cultural resources for the promotion of ecotourism. The objective of the present study was to identify and prioritize the potential cultural sites for the promotion of ecotourism using a Geographic Information System (GIS). GIS, together with Multi Criteria Decision Method and Criteria Ranking Method, were used for analysis. Five criteria *viz*. facilities base, tourist preferences, proximity to residential areas, proximity to accommodation, and distance from roads were used to evaluate the suitability of cultural sites in the Jaffna District. Those factors were selected according to expert opinion. The methodology used in this study helps in the identification of best cultural sites based on their current condition by using multi criteria. Among the declared 72 archeological monuments in the District, a total of 34 very popular cultural sites were selected for suitability analysis. The study revealed that among the 34 sites, 15 places represented high potential status, 17 sites were of moderate potential, and two sites were of low potential. The potential sites were derived based on the five criteria. Basic facilities for all cultural places have not been developed. Intangible cultural aspects such as life style, arts and music, festivals and events, livelihood system, traditional foods, products, traditional houses, household items and traditional villages are major culture-based potentials in the Jaffna District. The study also revealed that these sites have lack of basic infrastructure facilities and lack of promotion which have impacted on the promotion of ecotourism. Based on the analysis, potential status of cultural sites was identified; however, these areas have not yet been promoted from an ecotourism point of view. Hence these sites, with their associated local communities, offer good opportunities for ecotourism and local economic development. Local government bodies, Archeology and Cultural departments should give more attention on promotion of culture-based ecotourism for sustainable community development.

Keywords: Culture-based ecotourism, Intangible culture, Jaffna District, Multi criteria, Religious places

Abstract No: 206 ***Earth and Environmental Sciences***

ANALYSIS OF SELECTED PRINTING INK AND THEIR DEGRADATION PRODUCTS

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With the improvement in printing technology and the wide accessibility of advanced printers, printing products have become part of human life. With this worldwide usage, a need of determining the effect of the used printing products has become essential. The study was carried out to identify the constituents in representative common printing ink samples. It was also tested to see whether the selected ink samples release any toxic components to the environment during the common disposal methods practiced in Sri Lanka. After determining the constituents, the ink samples were burnt in an incineration setup and their fire debris and smoke were analyzed. In addition, the ink samples were buried in soil, dumped in open space and water. The effect was tested for soil, air and water respectively after six months. The instrumental techniques such as FTIR, FTIR-ATR, GC/MS, GC/FID and AAS were utilized in the study. The copper and zinc concentrations in the representative ink samples analyzed were in the range of 2.960 ± 0.020 mg g^{-1} of ink to 9.129 ± 0.108 mg g^{-1} of ink. Both a petroleum-based solvent and a natural oil were found in the tested samples. During the burning of ink samples, it was observed that pigment containing dust was released along with the emitted fume. The copper concentration in the collected particles in the smoke when burning the representative ink samples was in the range of 2.152 ± 0.018 mg g^{-1} of ink to 3.522 ± 0.010 mg g^{-1} of ink. When the tested ink samples were buried in the soil, persistence of the product could be seen and it was also found to be degraded to microparticles. The ink samples showed no signs of degradation within the six months of disposal to water and air. As analysis revealed, the tested samples release toxic components, therefore, it is highly recommended to implement a proper disposal method.

Keywords: Disposal methods, Environmental pollution, Heavy metals, Pigments in ink, Printing ink

Abstract No: 208 ***Earth and Environmental Sciences***

USE OF STARCH-BORATE-UREA-LIGNIN FERTILIZER MATRIX FOR CONTROLLED RELEASE OF UREA

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Controlled release fertilizers, by which nutrient release is synchronized with the plant uptake, are one approach to enhance crop production and mitigate environmental problems. Urea, the commonly used, hydrophilic nitrogen fertilizer, benefits from the concept of controlled release. In the present study, S-U-B-L fertilizer matrix was synthesized using starch (S), urea (U), borate (B) and lignin (L), for this purpose. Lignin was extracted by using coconut coir pith as the biomass source, under acid (A), alkaline (C) and organosolv (D) protocols. Lignin samples labeled as L_A, L_C and L_D, respectively, were selected as representative samples of each protocol, by FT-IR spectroscopic characterization. Lignin L_A and L_D had the highest and lowest yields of 31% and 2%, while L_C and L_A possessed the smallest and largest particle sizes, respectively. Lignin L_A and L_C with appreciable yields were used to prepare fertilizer films, S-U-B-L_A and S-U-B-L_C, respectively. In the urea release studies, lignin incorporated fertilizers showed a slower and gradual release rate of 70% within 5 hours, in contrast to pure urea, in which a burst release of 98% occurred within 90 minutes, and S-U-B, in which a fast release of 59% occurred within 75 minutes, with an overall release of 73% in 5 hours. S-U-B-L_C showed the highest efficiency with a 42% release, compared to S-U-B-L_A, which released 51%, within 75 minutes. Further, a lignin mass of 10% of the mass of starch was confirmed as the optimum content. In kinetic modeling, complete release profiles followed an exponential behaviour, while a linear function fitted the first 75 minutes of release. The FT-IR spectroscopic analysis confirmed the successful formation of the fertilizer. Powder X-Ray Diffraction confirmed the amorphous nature and Scanning Electron Microscopy revealed the surface morphology of fertilizer matrices.

Keywords: Coconut coir pith, Controlled release, Lignin, Nitrogen fertilizer, Urea

Abstract No: 213 ***Earth and Environmental Sciences***

VERIFICATION OF RUSLE MODEL FOR SRI LANKA: A GIS BASED CASE STUDY IN UPPER MAHAWELI CATCHMENT

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Erosion is a natural process of continual removal and transportation of soil, rock fragments, and ions from one location to another. However, in the last few centuries, it has greatly accelerated in many parts of the world due to human activities. Therefore, continuous monitoring of soil erosion rates is needed to determine suitable conservation methods. Soil erosion rates are estimated through conventional methods or empirical modelling. The empirical modeling is a popular technique for estimating soil erosion rates because field-based measurements are time consuming and costly. This study focuses on assessing the soil erosion risk in Upper Mahaweli Catchment (UMC) using the RUSLE Model, and evaluate the applicability of the model and GIS based methodology as a robust tool for determining the erosion rates. Soil erosion rates were estimated for six sub-catchments of the UMC using the RUSLE Model and GIS as a tool. The estimated erosion rates were compared with the same estimated using the river load data monitored by the Mahaweli Authority of Sri Lanka for the six sub catchments. A Digital Elevation Model was developed for the study area to derive topographic factors, while the other factors of the model were calculated using GIS on secondary data such as rainfall, land use, and soil maps. The model estimated erosion rates ranged from 250 to 800 t km^{-2} y^{-1}. The erosion rates for the six-sub catchments computed from measured river-load gauging data were between 130 and 2100 t km^{-2} y^{-1}. Importantly, the erosion rates predicted by the model tallied with the field-based erosion rates estimated using river-load data, within the uncertainties of both methods. Therefore, it is concluded that the RUSLE Model and the GIS methodology used in this study can be readily applied to infer erosion rates in catchments of Sri Lanka where soil erosion is an acute problem.

Financial assistance from the National Research Council (*Grant No. 17-037*) *is acknowledged.*

Keywords: Geographic Information System, Revised Universal Soil Loss Equation, Soil Erosion

Abstract No: 217 ***Earth and Environmental Sciences***

NAPHTHALENE DEGRADATION ABILITY OF PHYLLOPLANE *Bacillus* Sp. INHABITING URBAN AREAS IN SRI LANKA

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In the past decades, a wide variety of organic pollutants have been recognized as emerging pollutants in the phyllosphere environment. Naphthalene was considered as a major pollutant due to high carcinogenicity and genotoxicity effects to living beings. Even though there are numerous anthropogenic sources of polyaromatic hydrocarbons, the leading sources of naphthalene are vehicular emissions and products from oil refinery processes. The discharge of such air pollutants are getting settled over the phyllosphere through dry deposition and wet deposition in dense concentrations, while some of the phyllosphere bacteria are able to degrade naphthalene. The attempt of the current study was to identify the effective *Bacillus* species as naphthalene degraders from the phylloplane of urban areas. Bacterial isolations were carried out with leaf samples collected from Orugodawatta, Panchikawatta, Maradana, Pettah, Colombo Fort and Sapugaskanda oil refinery sites in Sri Lanka. Initially, naphthalene degradation ability of isolated phylloplane bacteria was screened using the plate assay method. Naphthalene degradation by each bacterial species was analyzed using UV-Visible spectrophotometry and high-performance liquid chromatography (HPLC). Results indicated that four *Bacillus* sp. were able to grow on naphthalene added Bacto Bushnell Hass agar medium, and they were identified up to species level through PCR amplification and sequencing the amplified fragments of the 16s rRNA gene using the primers 1492R and 27F. UV-Visible spectrophotometric and HPLC methods revealed that, out of these phyllosphere bacteria, *B. velezensis* (Accession No. MN190156) was the most efficient phyllosphere bacterial species which was highly capable of degrading naphthalene showing 71.63% degradation percentage while *Bacillus* sp. P_2B-02, *Bacillus* sp. 1 and *B. megaterium* show degradation percentages of 60.75%, 66.59% and 25.87%, respectively. These *Bacillus* sp. could be useful as potential biological agents in effective bioremediation of environments polluted with naphthalene-like polyaromatic hydrocarbons.

Financial assistance from the University of Sri Jayewardenepura, Sri Lanka (*Grant No. ASP/01/RE/TEC/2017/72*) *is acknowledged.*

Keywords: Aromatic hydrocarbon, *Bacillus*, Bioremediation, Naphthalene, Phyllosphere

Abstract No: 240 ***Earth and Environmental Sciences***

INFLUENCE OF WEATHERING OF CARBONATITE ON RARE EARTH ELEMENT CHEMISTRY OF EPPAWALA PHOSPHATE DEPOSIT, SRI LANKA

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Eppawala phosphate deposits have been formed as a result of weathering of basement carbonatites and are made up of primary and secondary phosphate minerals. Similar deposits around the world contain various types of secondary minerals which influence the Rare Earth Elements (REE) chemistry of phosphate deposits. The present study was focused on understanding the mineralogical changes occurring during the weathering processes and explaining their influence on the variation of REE chemistry of the Eppawala deposit. The samples collected from different zones of weathering profiles were investigated using inductively coupled plasma mass spectroscopy, X-ray diffraction and optical microscopy. The phosphate ores consist of fluoro-chloro apatite, magnetite and ilmenite as primary minerals and fluoroapatite, carbonate-fluoroapatite, crandallite, florencite, and monazite as secondary phosphate minerals. The present study revealed the presence of texturally and morphologically different five major types of apatite in the Eppawala deposit. Those include primary apatite derived from the carbonatite and four other types formed by the weathering and recrystallization processes. During the alteration processes of primary apatite, fluoroapatite, hydroxy apatite and carbonate fluoroapatite have been formed. Recrystallization has resulted in the formation of fluoroapatite, crandallite and florencite. Further, the formation of fluoroapatite is favoured for the depletion of REEs during the recrystallization process. The mineralogy, petrology of the phosphate deposit indicates that the recrystallization processes and secondary phosphate mineralogy highly influenced the variation of REEs in the ore bodies.

The financial assistance from the University of Peradeniya (Grant No. AHEAD/ICE/PDN/SCI/ Activity 4) is acknowledged.

Keywords: Carbonatites, Rare Earth Elements, Secondary phosphate, Weathering

Abstract No: 247 ***Earth and Environmental Sciences***

UNDERSTANDING ALTERATION PHENOMENA OF ASBESTOS-CEMENT SHEETS IN SRI LANKA

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Asbestos-cement sheets are one of the major roofing solutions in Sri Lanka, although asbestos fibres may enter the human body by inhalation leading to fatal diseases, such as mesothelioma, asbestosis and lung cancers. The objective of the present study was to understand the alteration processes on the surface of the asbestos sheets which may lead to the release of mineral fibres into the atmosphere. Fifteen samples were collected from asbestos roofing sheets having different alteration levels in Kandy and Colombo urban areas where different climatic conditions are experienced. Samples were scrapped carefully from the surfaces of asbestos sheets. X-ray diffraction and optical microscopic analyses were carried out in order to characterize the samples. Calcite, quartz, feldspar and chrysotile are the common minerals found in the studied samples. The cement material consists of calcite and portlandite. They may have been subjected to alteration, and both aragonite and calcite have been formed as secondary products. In contrast to the samples collected outside, those from inside of houses do not show any alteration products of calcite. It may be due to the low exposure to the environment. However, chrysotile is present in both samples collected from inside and outside of roofs. The fibres released from the inside surface of the roof or ceiling may cause more hazardous effects as they tend to deposit in the household due to lack of ventilation. Highly altered asbestos sheets are characterized by visible layers of fibres, and they can be easily removed from the cement matrix. It indicates that such fibrous materials can be blended with the atmosphere. Moderately altered sheets also have partially enclosed bundles of fibres which were seen in the cement matrix under microscopic analysis. There are no significant differences in terms of mineralogical compositions in the samples of both areas. Rapid alterations and physical processes occur on the surface of the roofs under the tropical climatic conditions resulting in the release of hazardous asbestos fibres into the environment. Therefore, the present study suggests that roofing sheets are one of the major anthropogenic sources of atmospheric pollution. Proper preventive measures, such as the introduction of effective coating or sealer on the surface of the roof, frequent maintenance of the roofs and encouragement to install wood ceilings, can be considered to prevent this issue.

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Keywords: Alteration, Asbestos-cement sheets, Atmospheric pollution, Fibres

Abstract No: 248 ***Earth and Environmental Sciences***

IMPROVED HEAVY METAL ADSORPTION BY MOF/TiO_2 NANO-COMPOSITES

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Over the years, heavy metal content in the environment has been increased drastically. Heavy metals have a high density and are toxic even at low concentrations. As heavy metals are non-biodegradable, they can be accumulated through food chains. As a result, to safeguard human health and other organisms in affected ecosystems, heavy metal removal from contaminated systems has been studied and practiced using different techniques. Adsorptive removal is one of the most practiced methods for heavy metal removal. Metal organic frameworks (MOFs) are one such efficient adsorbent. MOFs consist of a 3D porous network with a high surface area, that built up of metal ions/clusters and organic linker ligands. In this study, Fe-BTC [(BTC: 1,3,5-benzenetricarboxylate)] MOF was synthesized using hydrothermal method, and it was modified by incorporating TiO_2 nano-particles at the synthesis stage. Fe-BTC and TiO_2 are known adsorbents for heavy metals. An enhanced adsorptive removal was expected by combining these two materials to form a composite. Ni(II) and Pb(II) ions were selected for the adsorption study and removal efficiencies were studied for bare MOF, commercially available TiO_2 nano-particles, and MOF/TiO_2 composite. Parameters such as ion concentration, adsorbent dose, contact time and pH were optimized. Enhanced adsorptive removal was observed by incorporating TiO_2 in to the MOF structure. From a 5 ppm Pb(II) solution, 80%, 82% and 89% were removed within 3 hours, at pH 6 by bare MOF, TiO_2 and the composite, respectively. Furthermore, 90%, 85% and 99% of 5 ppm Ni(II) were removed within 4 hours at pH 10 by bare MOF, TiO_2 and the composite, respectively. Thus, there was a clear and a significant improvement in adsorptive removal efficiencies of both Pb(II) and Ni(II) by incorporating TiO_2 nano-particles to Fe-BTC MOF.

Keywords: Adsorption, Composite, Heavy metals, MOF, Optimise

Abstract No: 255 **Earth and Environmental Sciences**

EVALUATION OF GROUNDWATER QUALITY AND SUITABILITY IN LOWER WALAWE BASIN FOR DRINKING AND IRRIGATION

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The Walawe River basin is the fourth largest river basin in Sri Lanka, where rapid industrial and agricultural development is undergoing. Hence in this area, groundwater, which is the most important source of freshwater for consumption, has become very vulnerable due to irrigation influences. A detailed hydrogeochemical study was carried out in the lower region of Walawe River basin in order to assess its suitability for drinking and irrigation purposes. Thirty-two groundwater samples were collected during the dry season and analysed for their major and trace elements. The solute compositions were dominated by HCO_3^- (mean = 380 ± 30 mg L^{-1}), Cl^- (mean = 129 ± 50 mg L^{-1}), and SO_4^{2-} (mean = 89 ± 27 mg L^{-1}), which were balanced by Na^+ (mean = 79 ± 15 mg L^{-1}), Ca^{2+} (mean = 63 ± 13 mg L^{-1}), and Mg^{2+} (mean = 44 ± 10 mg L^{-1}). The Piper classification indicated that the groundwater in the region was dominated by Ca^{2+}-HCO_3^- type of water. The calculated water quality index rating showed that out of the 32 samples, only 53% of the samples were suitable for drinking purposes during the dry period. According to the US salinity laboratory and Wilcox's classification, two-thirds of investigated groundwater samples were suitable for irrigation purposes. The findings of this study suggest that water quality management in lower region of the basin is critical for the future sustainability of the water resource.

Keywords: Agricultural pollution, Irrigation suitability, Water quality index

Abstract No: 258 ***Earth and Environmental Sciences***

STUDY ON SPATIAL AND TEMPORAL VARIATION OF WATER QUALITY OF THE YAN OYA RIVER BASIN

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Yan Oya is the 5th longest river (142 km) in Sri Lanka, and it is the main surface water source in the areas of North Central Province (NCP). People reside in Padaviya and adjacent areas often suffer from drinking and irrigation water shortage. Therefore, a dam across the Yan Oya in Padaviya was constructed to make a reservoir to provide water for drinking and irrigation. The present study was focused on evaluation of water quality to find the spatial changes in surface water quality parameters of the entire Yan Oya river basin. Physico-chemical and microbiological parameters of surface water randomly collected from 40 sampling locations in the river basin were determined representing both dry and wet seasons. Temperature, turbidity, DO, pH, EC and TDS were measured *in-situ* while NO_3^-, NO_2^-, NH_3, total phosphate (TP), chemical oxygen demand (COD), total hardness (TH), fluoride, Na^+, K^+ Mg^{+2} and Ca^{+2} were measured using standard methods. Total coliform (TC) and faecal coliform (FC) counts were obtained by the membrane filtration method. The parameters, pH, DO, NO_3^-, NO_2^-, NH_3, TP, fluoride, Na^+ and K^+ varied from 6.6 to 8.8, 1.9 to 8.2 mg L^{-1}, 0.12 to 5.43 mg L^{-1}, < 0.001 mg L^{-1}, < 0.001 to 0.024 mg L^{-1}, 0.001 to 0.484 mg L^{-1}, 0.02 to 1.48 mg L^{-1}, 3.5 to 245.6 mg L^{-1}, and 21.2 to 185.6 mg L^{-1}, respectively, during both seasons. More importantly, the above values remained within acceptable levels given by the Sri Lanka Standards Institute (SLSI) for potable water. However, turbidity, EC, TDS, TH, COD, Mg^{+2}, and Ca^{+2} concentrations were deviated from the SLSI standards. The TC count exceeded greater than 200 CFU/100 mL in wet season and 3 to > 200 CFU/100 mL in dry season where FC counts were 23 to > 200 CFU/100 mL in wet season and 0 to > 200 CFU/100 mL in dry season, respectively. Thus, it was found that the river basin was contaminated from TC and FC bacteria. Further, EC, TDS, Na^+, and K^+ concentrations showed increasing trend from head zone to meandering zone. In the transitional zone, high turbidity as 58.6 NTU in wet season and 31.7 NTU in dry season were recorded where COD was recorded as 94.4 mg L^{-1} in wet season and 70.5 mg L^{-1} in dry season. Spatial GIS maps showed decreasing trend of pH and DO values, while nutrients (NO_3^- and TP), TH, Mg^{+2}, Ca^{+2} and fluoride concentrations showed increasing trend from head to meandering zone. However, clear cut temporal variation of water quality was found during both seasons, and the results suggest that the Yan Oya river be a good resource for drinking water. In can be concluded that a proper strategic plan is needed to protect water quality of the Yan Oya river basin from transitional to meandering zone in order to provide safe potable water to the people who suffer from drinking water crisis in the NCP.

Keywords: GIS mapping, Physico-chemical and microbial parameters, Surface water, Yan Oya

Abstract No: 259 ***Earth and Environmental Sciences***

MOHO DEPTH VARIATION IN MANNAR SUB-BASIN FROM GRAVITY DATA

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The Mannar basin, a sub-basin of the Cauvery basin, has always been the focus for geophysical and geological research because of its location between Sri Lanka and India. Wolfram Mathematica algorithm has generated 2D gravity response using the polygonal method in a counter-clockwise manner, identifying different layers present in the region of interest in relation to 2D seismic interpretations to provide evidence to the depth of subsurface structures. Four major horizons were demarcated in ten (10) 2D seismic profiles; water bottom, volcanic top, volcanic bottom, and acoustic basement in the time domain. These lines were extended in either direction across the basin to meet the landmasses to depict clear structural settings of the basin. The thickness of sedimentary horizons in extended parts were assigned using the theory of passive margins, and volcanic layer extensions were assessed through the Petroleum Resources Development Secretariat (PRDS) data repository. Velocity grids were used to convert subsurface models to depth domain using density values of 1.03, 2.50 and 2.90 g cm^{-3} for water, sedimentary and volcanic layers, assessed from well-logs available in the region. The density of the crust was assumed as 2.67 g cm^{-3} as globally accepted, and the mantle density was assigned a value of 3.40 g cm^{-3} to estimate the depth to a regionally arcuate, upwelled mantle. The maximum depth to the upwelled Moho was recorded as ~24 km along the profiles SL05-23 and SL05-25. Subsurface models clearly illustrate crustal thinning in the region. After removal of residual gravity, the regional mantle gravity grid correlates to an upwelled mantle. The maximum crustal thickness along a stretch of 50-150 km in the offshore region was recorded as ~15 km along the profile line SL05-05 and the minimum value of ~3 km was noted along the profile line SL05-25. The derived results classify the Mannar basin as a failed rift, which did not succeed to develop as a spreading centre within the oceanic crust.

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Keywords: Crustal Thinning, Failed-rift basin, Gravity modelling, Mantle upwelling, Seismic interpretation

Abstract No: 260 ***Earth and Environmental Sciences***

LEVEL OF TRIBUTYLTIN CONTAMINATION IN *Perna viridis*

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Tributyltin (TBT) that belongs to the group of Persistent Organic Pollutants (POPs) is an organotin compound extremely toxic to aquatic fauna. At micromole concentrations, TBT affects cell metabolism by causing malformations of the mitochondrial membranes with resulting reproductive abnormalities such as imposex. The lipophilic nature confirmed that TBT bioaccumulates in living organisms. Molluscs, bivalves and gastropods are the organisms most sensitive to TBT exposure. In this study *Perna viridis* (green mussel) was selected as a biological sample based on its availability, sessile lifestyle, easy sampling, etc. The main objective of this study was to detect the level of TBT contamination in the biological sample (*P. viridis*) using the modified HS/SPME-GCMS method. The average TBT concentrations of three different size classes (0 - 15, 15 - 30 and 30 - 45 g) of *P.viridis* were recorded as 12 ng kg^{-1}, 22 ng kg^{-1} and 42 ng kg^{-1}, respectively. The highest concentration of TBT in *P.viridis* was detected in the sample collected from Dikovita fishery harbor. The TBT concentrations in *P.viridis* were recorded in ascending order following the average body weight ranges of 0 - 15 g < 15 - 30 g < 30 - 45 g, respectively. A positive correlation between the number of *P. viridis* male and TBT concentrations ($p < 0.05$) was found suggesting possible imposex development in aquatic invertebrates exposed to high concentrations of TBT continuously. Therefore, continuous monitoring of TBT is needed to find its effect on the biodiversity in the coastal environment. Thus, in the present study, a sensitive, cost-effective and precise modified method was introduced to identify and quantify the concentrations of TBT in the environment at parts per trillion (μg L^{-1}) level.

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Keywords: Bioaccumulation, Imposex, *Perna viridis* (green mussel), Tributyltin (TBT)

Abstract No: 262 ***Earth and Environmental Sciences***

BIOTECHNOLOGICAL PROSPECTS OF MICROBIAL COMMUNITY IN WAHAVA HOT SPRINGS IN SRI LANKA

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Chemical waste generated by industries containing excessive amounts of chemical catalysts drastically affects the diversity of flora and fauna in the ecosystem. To minimize the discharge of chemical catalysts into the ecosystem, thermophilic bacteria inhabitants in hot springs could be a useful substitution. The extremozymes produced by Thermophilic bacteria can tolerate extreme chemical and physical conditions pertinent to industrial settings. The present study was focused on Wahava hot springs in Sri Lanka to identify and characterize industrially important extremophilic microbes in the microbial community in the hot springs. The Bacteria and Archaea diversity of artesian tube well and dug well at Wahava hot spring site were analyzed using 16S amplicon sequencing on Illumina MiSeq platform. Temperature, conductivity, pH, and dissolved oxygen (DO) were measured at the site. The temperature of the Wahava artesian tube well and dug well springs vary from 42.1 - 42.8 ^{o}C. The conductivity, pH, and DO ranges between 1,378 - 1,474 µS cm^{-1}, 7.91 - 7.97, and 3.50 - 1.05 mg L^{-1}, respectively. *Proteobacteria, Firmicutes* and *Deinococcus-thermus* were recorded in the artesian tube well, while *Proteobacteria, Firmicutes, Actinobacteria, Chloroflexi* and *Bacteroidetes* were found as the major bacteria groups in the dug well. Furthermore, Archaea percentage of the microbial community in artesian tube well and dug well were 0.004% and 0.03%, respectively. In both hot springs, 0.57% of each bacterial community belongs to *Deinococcus-thermus,* a group which is highly resistant to environmental hazards (extreme pH, extereme temperatures, xenobiotics, etc.). Thus, Wahava hot springs were identified as a rich source of thermophilic microbial community which can be used for the biotechnological prospects and further studies in this regard is being investigated.

Financial assistance from the University of Sri Jayewardenepura (*Grant No. ASP/01/RE/SCI/2017/52*) *is acknowledged*

Keywords: Extremozymes, Hot Springs, Microbial Community, Thermophiles

Abstract No: 263 ***Earth and Environmental Sciences***

SPATIAL PATTERNS AND MAJOR CAUSES OF ELEPHANT MORTALITIES IN MAHAWELI WILDLIFE CONSERVATION AREA, SRI LANKA

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In Sri Lanka, a major form of Human-Elephant Conflict (HEC) occurs due to crop raiding by elephants in agricultural lands. The farmers take matters into their own hands and a majority of elephant deaths are due to the farmers' retributory actions. Such unabated killing, if not addressed, may threaten the future survival of elephants in the wild. Therefore, understanding major causes of elephant deaths is crucial in order to explore practical mitigation measures that can be implemented to reduce HEC. In this study, the major factors responsible for elephant mortalities in the Mahaweli Wildlife Conservation Area at the divisional secretarial and district level were investigated. Official elephant mortality data from the post-mortem (PM) reports of elephant deaths were used for this study. A total of 107 PM reports from 2017 to 2018 were used for the analysis. A PM report includes detailed information about the cause of the death of an elephant. In Polonnaruwa District, human-caused elephant deaths were significantly higher than the deaths due to natural and unknown deaths (χ^2 = 33.24; p < 0.0001). However, the cause of elephant mortalities was not significantly different within the Matale District (χ^2 = 0.53; p > 0.05). It was found that hakkapatas, gunshot and electrocution were mainly responsible for direct human related elephant mortalities. Furthermore, road accidents accounted for a significant portion of elephant mortalities. The mortalities were biased towards adult male elephants (χ^2 = 30.25; p < 0.0001). Even though frequencies of elephant mortalities in dry and wet seasons were not significantly different (χ^2 = 0.348; p > 0.05), monthly elephant mortality shows two distinct peaks: highest in August and October and lowest in September. Further, the study shows that occurrence of conflict is not random. Dimbulagala and Welikanda are the two main hotspots identified with respect to elephant mortality in Polonnaruwa (Gi-Bin Score 3 at 99% confidence). According to the findings, conservation actions to mitigate HEC and thereby to reduce elephant mortalities should focus on identifying the factors that contribute to elephant mortalities at local level and also should study the spatial distribution of conflicts to identify hotspots of conflicts. Exploring those factors at the local level will facilitate in developing site-specific mitigation strategies rather than taking broader level conflict mitigation measures for effective resolutions to reduce HEC and thereby to conserve elephants.

Keywords: Elephant Mortality, Human-Elephant Conflict (HEC), Mahaweli Wildlife Conservation Area

Abstract No: 264 ***Earth and Environmental Sciences***

MID-HOLOCENE SEDIMENTOLOGICAL CHARACTERISTICS AND COASTAL LANDSCAPE OF SOUTHERN SRI LANKA: A HISTORY OF ADAPTIVE BEHAVIOUR OF PREHISTORIC POPULATIONS

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The sea-level changes that occurred during the Holocene period probably had an impact on the prehistoric communities in the southern coastal area. This study aims to reconstruct the Holocene sea-level changes and interpret middle-late Holocene paleoenvironmental evolution in the southern coastal region of Sri Lanka from Tangalle to Bundala with special emphasis on the adaptive behaviour of Mesolithic prehistoric populations. Sedimentological and archaeological investigations were carried out on sediment and soil profiles of three prehistoric sites at Pallemalala, Mini Athiliya and Bundala, as well as in an ancient lagoon at Kalamatiya, and at a coastal site in Henagahapugala. Comprehensive sedimentology and coastal morphology have been applied to unveil the nature of sedimentary sequences that were associated with the events of the Holocene marine transgressions and regressions. After the second episode of the high sea-level stand after 4,000 B.P., the southern coastal area witnessed a regression trend which is represented by prominent shallowing-upward succession of marine, lagoonal and paludal deposits. This 'regressive' trend, reflecting coastal progradation under a nearly stable sea-level extends to the termination of Mesolithic in the area. The expansion of vast, low-lying lagoonal and paludal areas was mostly induced by the lowering of sea-levels as well as Walawe and Malala Oya river systems. These changes in the landforms, which occurred during a period of variable climate conditions, have strongly influenced the mid-late Holocene Mesolithic hunter-gathers in terms of human settlement and social behaviour. A strong impact of human frequentation on depositional environments is observed in late Holocene, as the formation of coastal wetlands as lagoons and mudflats associated with river systems, might have promoted the resettlement in coastal areas and adoption of novel subsistence patterns and burial customs.

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Keywords: Holocene, Palaeoenvironment, Prehistory, Sea level changes

Abstract No: 266 ***Earth and Environmental Sciences***

BIODEGRADABILITY OF LOW DENSITY POLYETHYLENE BY SOIL FUNGUS *Talaromyces purpureogenus* ISOLATE SJP-GF085

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Low-density polyethylene (LDPE) is globally the most common single use plastic ingredient. The LDPE waste accumulation is considered as an adverse environmental issue threatening both terrestrial and aquatic ecosystems. Therefore, accelerating the biodegradation process is a potential eco-friendly alternative to manage persisting LDPE waste. The present study focused on isolation and screening of LDPE degrading fungi from selected urban dump-sites in Sri Lanka. Soil samples with partially degraded polyethylene were collected from Karadiyana, Meethotamulla and Kaduwela. Fungi with different morphological features were isolated from enriched samples and pure cultures were maintained. Primary screening tests were conducted in potato dextrose broth (PDB) which contained pre-sterilized LDPE pellets inoculated with fungus. Samples were incubated at 28 °C for 60 days and controls were maintained without inoculation of fungi. At 60 days of incubation, LDPE pellets were recovered and percentages weight loss (WL %) was calculated. Further analyses were carried out on potato dextrose agar (PDA) contained in a 5 × 5 cm^2 LDPE film inoculated with fungal isolates at 28 °C for 90 days. Treated LDPE films were then analyzed with Fourier-transform infrared spectroscopy (FTIR). Fungi were identified based on morphology and DNA sequence data. In total, 30 morphologically different fungi were assessed in this study. Among them, only 15 isolates indicated more than 3% of WL in primary screening. Among them, the LDPE tested with fungal isolate SJP-GF085 showed 6 ± 0.5% WL at 60 days of incubation in PDB and 15 ± 1.5% WL after 90 days of incubation on PDA. The isolate SJP-GF085 was identified as *Talaromyces purpureogenus* based on DNA sequence of nuclear ribosomal internal transcribed spacer region (ITS: GenBank MT756246). Minor shifts of FTIR spectrum of treated samples compared to the control LPDE indicated the initiation of biodegradation. This study highlights the potential of using *T. purpureogenus* isolate SJP-GF085 as a potential biological agent which can be used to enhance the LDPE waste degradation.

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Keywords: Biodegradation, LDPE, Mycotechnology, Waste management

Abstract No: 267 ***Earth and Environmental Sciences***

PHYTOREMEDIATION OF SYNTHETIC TEXTILE DYE (DIRECT BLUE 201) BY *Eichhornia crassipes* (MART.) SOLMS VIA BIO-SORPTION AND ENZYMATIC DEGRADATION

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Synthetic dye containing textile wastewater effluents are highly toxic causing adverse impacts on the environment and human health. The present study is aimed to identify the dye decolorization potential and phytoremediation pathway of *Eichhornia crassipes* (Mart.) Solms (Water hyacinth) as a low cost and environmental friendly textile wastewater treatment method. Four plants of disinfected *E. crassipes* were introduced into 1 L of 50 mg L^{-1} of Direct Blue 201 (DB 201) textile dye containing tanks and dye removal percentages were analyzed at 12 h intervals using a standard spectrophotometric method. The controls were maintained without the involvement of plants. The potential dye decolorization pathways were studied via involvement of endophytes, bio-sorption activity, and effect of crude extracellular and intracellular enzymes extracted from *E. crassipes* on DB 201 dye. Activities of lignin peroxidase, manganeses peroxidase, laccase, tyrosinase, azoreductase in decolorized dye solution were assayed spectrophotometrically, following optimized protocols. Toxicity of the decolorized dye was evaluated by seed germination assay using *Oryza sativa* (L.) and *Vigna radiata* (L.). In the present study, *E. crassipes* showed 98% of DB 201 dye decolorization within 36 h of incubation while control showed less than 1% of dye decolorization. None of the isolated endophytic bacteria (12 isolates) or fungi (14 isolates) were found to be the potential candidates for removal of DB 201 dye. *E. crassipes* showed 17.7% of dye decolorization by means of bio-sorption on to the plant roots. The crude extract of the intracellular and extracellular source of the enzyme showed 46% and 10% of dye decolorization, respectively. Compared to the initial stage, the activity of lignin peroxidase, manganese peroxidase, laccase, tyrosinase, azoreductase enzymes were slightly increased at the end of dye decolorization process. The shifts of transmittance in FTIR spectrum confirmed the alteration of original dye structure after the treatment. The treated dyes showed significant seed germination, for both *O. sativa* and *V. radiate* seeds, compared to the seeds treated with textile dye ($p \leq 0.05$). Hence, the present study confirms the potential applicability of *E. crassipes* for enzyme based, low cost treatment method to treat textile wastewater in future.

Financial assistance from the University of Sri Jayewardenepura (*Grant No. ASP/01/RE/SCI/2016/10*) *is acknowledged.*

Keywords: Biosorption, Dye decolorization, *Eichhornia crassipes*, Enzymatic degradation, Phytoremediation

Abstract No: 270 ***Earth and Environmental Sciences***

ASSESSMENT OF RURAL WATER SUPPLY IN SRI LANKA: A CASE STUDY FROM WATTEGAMA WATER SUPPLY SCHEME, KANDY

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Sustainability of rural water supply schemes (RWSS) is widely discussed, which are usually proposed to be managed by community-based organizations. Wattegama RWSS in Kandy district was selected for a case study as there were several complaints regarding the poor quality of drinking water. The study was focused on assessing the physical (Temperature, turbidity, total dissolved solids, electrical conductivity), chemical (pH, alkalinity, Cl^-, NO_3^-, NO_2^-, Br^-, PO_4^{3-}, SO_4^{2-}, Al, As, Cd, Ca, Cr, Cu, Fe, K, Na) and microbiological (*Escherichia coli* and total coliform) water quality parameters through the process of catchment-to-consumer. Samples were collected from 13 locations covering the catchment, different stages of the water purification process and purified piped water from two areas, weekly for a period of three weeks during June 2019 for analysis. Results showed that the water quality of the catchment was exceeding the standards of National Environmental (Ambient Water Quality) Regulations and treated water was exceeding the WHO standards for drinking water quality particularly in physical and microbiological aspects. High turbidity values (6.75 NTU - 10.4 NTU), which is an indication of the presence of contaminants, were recorded in all the locations. All samples collected before and after the purification process were positive for *Escherichia coli,* and high total Coliform counts (78 - 408/100 mL) indicated the faecal contamination of water, posing a severe health risk to the community. Further, the results showed that the effectiveness of the Water Treatment Plant (WTP) is not satisfactory in particular to reduce turbidity and coliform count. Several major pollution sources were identified including agricultural and farming sites besides the catchment. It shows that the present WTP should be improved to remove entomopathogenic *E. coli* and turbidity in particular. There is an urgent need for undertaking a catchment protection and a suitable catchment management in connection with the operations and maintenance of the existing WTP.

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Keywords: Catchment, Microbial pollution, Rural water supply, Treatment, Water quality

Abstract No: 275 **Earth and Environmental Sciences**

MAJOR ELEMENT GEOCHEMISTRY OF CHARNOCKITIC ROCKS IN HIGHLAND AND WANNI COMPLEXES OF SRI LANKA

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Wanni Complex (WC) contains upper amphibolite to granulite-facies meta-igneous rocks and minor meta-sedimentary rocks whereas Highland Complex (HC) contains both meta-sedimentary and meta-igneous rocks formed under granulite-facies conditions. Charnockitic rocks are orthopyroxene-bearing gneisses having a characteristic greenish colour and greasy appearance ranging in composition from granitic to mafic and making–up one of the important components of the lower continental crust in many high-grade terrains including Highland and Wanni Complexes of Sri Lanka. Whole-rock geochemical analysis of major elements is helpful to understand basic geochemical characteristics related to their source rocks, tectonic environment and petrogenetic process. The aim of the present study was to resolve these aspects of HC and WC charnockitic rocks for a better understanding of their petrogenesis. Thirty eight (38) charnockitic rock samples covering both HC and WC were analyzed for major elements by X-Ray Fluorescence (XRF) spectrometry on fused glass discs using a PANalytical AXIOS Minerals instrument at the Rock-Mineral Preparation and Analysis Lab at the Institute of Geology and Geophysics, Chinese Academy of Sciences (IGGCAS). Harker diagrams and discrimination plots were prepared for geochemical interpretation of the analytical data. As shown by K_2O/Al_2O_3 vs. Na_2O/Al_2O_3 and MgO vs. Al_2O_3 diagrams, all the WC charnockitic rocks and a majority of the HC charnockitic rocks are orthogenesis. The TiO_2, total Fe_2O_3, MnO, CaO, P_2O_5 and MgO contents in charnockitic orthogneisses display a negative correlation with increasing SiO_2 composition with little scatter suggesting fractional crystallization of the protolith magma. Negative correlation of CaO, MgO and total Fe_2O_3 vs. increasing SiO_2 the formation of biotite and plagioclase during fractional crystallization. AFM and SiO_2 vs. Na_2O+K_2O-CaO diagrams represent the calc-alkaline nature in source magma of majority of both HC and WC charnockitic rocks. SiO_2 vs. Na_2O+K_2O diagram indicates that most of the samples have granitic and granodioritic protoliths of sub-alkaline affinity in both complexes. As depicted by K_2O, CaO and Na_2O ternary diagram, majority of the WC charnockitic rocks have had granodioritic to tonalitic protoliths. P_2O_5 and TiO_2 oxide saturation temperature in the WC is about 800 °C, and in the HC it is 800 - 950 °C as shown by the thermometric observations.

Financial Assistant provided by the University of Peradeniya (Grant No. URG/18/42) and Ministry of Science, Technology and Research (Grant No. MTR/TRD/AGR/3/2/20) is acknowledged.

Keywords: Charnockitic rocks, Highland Complex, Major Elements, Wanni Complex, XRF Analysis

Abstract No: 276 ***Earth and Environmental Sciences***

TEXTURAL CHARACTERISTICS OF SAND GRAINS IN RED EARTH DEPOSIT IN NORTH AND NORTHWESTERN SRI LANKA: IMPLICATIONS ON ORIGIN

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Red Earth (RE) deposit in Northwestern Sri Lanka is a distinctive sedimentary formation that belongs to the Quaternary Period. The deposit extends from Puttalam to Mullaitivu District, parallel to the North and Northwestern coastal belt. Although some hypotheses already exist on the formation of the RE deposit, a detailed study on quantitative textural characterization can provide useful information on its mode of origin. The aim of the present study was to analyze the size and shape of sand size particles of the RE deposit quantitatively to understand its provenance. Undisturbed RE samples were collected from four different locations of the deposit *viz.* Puttalam (southern part of the deposit), Mannar (mid part of the deposit), Kilinochchi (Northwestern northwestern part of the deposit) and Mullaitivu (Northeastern part of the deposit). The sand fraction (250 - 500 μm size) separated by dry sieving was rinsed with deionized water and observed through a stereo microscope. Monochromatic photomicrographs (15×) were taken for all the samples (>100 grains from each location), and post processed for the digital segmentation using "FIJI-ImageJ" open source software (Life-Line version) tool. Segmented and scaled images were analyzed with the same software tool to obtain two dimensional (2D) parameters such as area (A), perimeter (P), major and minor axes of best-fit ellipse (a and b, respectively), Freet's length (L) and Freet's width (S) of each grain. These parameters were used to calculate the grain size and shape indexes such as diameter of equal area circle ($D_{equ} = 2\sqrt{(A/\pi)}$), aspect ratio ($R = a/b$), solidity ($A/A_{convex\ hull}$), shape factor 1 ($SF_1$) or smoothness ($P/P_{equ}$; $P_{equ}=\pi*D_{equ}$) and shape factor 2 (SF_2) (A/A_{equ}; $A_{equ} = \pi*(D_{equ}/2)^2$). Sieve analysis data showed a uni-modal grain distribution pattern in all the locations. The highest and the lowest degrees of sorting were observed in samples from Puttalam ($\sigma = 0.8$) and Mannar ($\sigma = 1.3$), respectively. The average aspect ratio of grains of all four locations showed similar values (~1.5), indicating more spherical grains. However, the high standard deviation of Puttalam samples may indicate the variation in grain shape locally. The average SF_1 and SF_2 were similar for all the locations implying comparable smoothness and circularity of grains. No statistically significant difference was observed in any of the particle parameters obtained for sands from studied locations. This potentially indicates the influence of similar depositional or post-depositional environmental conditions in all regions of the RE deposit. A similar analysis should be performed for other size fractions of the deposit to confirm the above statement.

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Keywords: Microscopic analysis, Red earth, Sand, Shape descriptors

Abstract No: 289 **Earth and Environmental Sciences**

GEOLOGICAL AND GEOCHEMICAL CHARACTERISTICS OF CALCITE DEPOSITS AT BALANGODA, SRI LANKA: IMPLICATIONS FOR ORIGIN

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Economically important, unique calcite deposits occur in high-grade marbles near the litho-tectonic boundary between the Highland Complex (HC) and Vijayan Complex (VC) around Balangoda. The aim of the present study was to characterize trace element geochemistry of the differently colored calcite of these deposits to postulate their possible origin. Combined field, structural, geological, mineralogical, and geochemical investigations were carried out during the research. The mineralogical analysis was carried out primarily on petrographic microscope with further refinements using X-ray diffractometer (XRD). Chemical analysis was carried out with wavelength dispersive X-ray fluorescence spectrometer and inductively coupled plasma mass spectrometer. The calcite deposits occur as bands and isolated pockets with variably coloured coarse-grained calcite crystals in the high-grade marbles, adjacent to angular-shaped mafic and calc-silicate enclaves. Among the colored calcites, the most common are yellow and white, while blue, green, and rose coloured varieties are intermittently found. The yellow, white, and rose-colored varieties usually occur closer to the enclaves whereas blue colored calcite occurs away from those. The contact between enclaves and calcites is sharp and coloured calcite bands and enclaves show subparallel alignment to the foliation of the marble. The length of a single calcite band extends from 0.3 - 30 m and the width varies from few centimeters to several decimeters. The surficial distribution of the calcite bands is irregular; however, they may appear as concordant vein-like structures in the host marble. The XRD data revealed that all calcite occurrences are monomineralic. The commonest mineral assemblage of the host marble is dolomite+calcite+forsterite±phlogopite± apatite±graphite±pyrite with a high dolomite (85% modal) content. The major constituents of the calcite deposits are Ca (39.11 wt.%) with subordinate Mg (0.36 wt.%) and the common trace elements are V, Co, Ni, Zn, Sr, Y, Zr, Ba, Ti, and Mn. The concentrations of Mg, Al, and Si as well as trace elements of colored calcites do not show significant variation. However, Fe and Mn concentrations in rose and yellow calcites are higher than that of other coloured calcites. The Rare Earth Element (REE) concentrations of coloured calcites are much lower than those of carbonatites in Sri Lanka and the chondrite normalized REE pattern of colored calcites is more similar to that of the host marble. It indicates that the calcite deposits may have been derived from partial melting of the host marble with fluid activities along the thrust zone between HC and VC. Moreover, the concordant vein-like occurrence of calcite supports the hypothesis of syntectonic crystallization of coarse-grained calcite possibly during the thrusting of the HC over the VC.

Keywords: Balangoda calcite deposit, Coloured calcite, Enclaves, Trace elements

Abstract No: 301 ***Earth and Environmental Sciences***

A STUDY OF THE IMPACT OF RAJAGIRIYA FLYOVER ON NEIGHBOURING COMMUNITIES

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Industrial development and expansion of businesses to the districts might have caused such traffic congestion along with enhancement of affordability for use of private vehicles. Therefore, the traffic congestion has increased due to lack of proper and efficient traffic management systems. At present, the road junction in Rajagiriya is experiencing traffic congestion during the daytime. The main objective of this study was to identify the impact of Rajagiriya flyover on neighboring communities. Hence to achieve the target, 50 commuters, 25 traders, both permanent and mobile, surrounding the flyover and 25 householders were selected through purposive sampling method. Focus-group discussion and questionnaire surveying (2019.05.18 - 2019.12.18, inclusive of weekends excluding Poya Days) techniques were used to collect primary data from the surroundings of the Rajagiriya junction, while other secondary data sources were traffic data and land use data. Descriptive statistics including percentage and mean score measures were used to analyze the data, and Inferential Statistic Methods such as Paired Two sample for Means was used to identify the peak time. The study identified that there was heavy traffic congestion along the Sri Jayawardenapura Mawatha in the morning peak time between 07:30 - 09:00 h and in the evening between 16:30 - 19:45 h. Majority of the sample was daily routers. Half of fixed merchant's sample had mentioned that the construction of flyover as an existing issue. Also, all fixed merchants undertook business in pre-construction period of flyover and after. The present study found that the number of vehicles is higher than earlier after the construction of flyover. For that reason, the traffic congestion had also increased. Moreover, the results of the present study demonstrated that the construction of the flyover is a failure due to insufficient feasibility study.

Keywords: Commuters, Flyover, Peak Time, Roundabout, Traffic Congestion

Abstract No: 313 ***Earth and Environmental Sciences***

OPEN SOLID WASTE DISPOSAL AND ITS EFFECTS ON WATER QUALITY IN CENTRAL PROVINCE AREA OF MAHAWELI RIVER DUE TO PREVAILING URBAN AREA MANAGEMENT SYSTEMS

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Open dumping is the most common method of solid waste disposal in Sri Lanka. Majority of the dumping sites are located on the river basins causing water pollution. The objective of the ongoing project is to identify the effects on water quality of Mahaweli River due to prevailing urban systems. The entire study area is located in the Central Province area of Mahaweli River representing Study Site 1 at Ginigathhena in Nuwara Eliya District, Study Site 2 and 3, respectively, at Peradeniya and Gohagoda in Kandy District, and Study Site 4 at Wariyapolawatta in Matale District. The two open dumping sites at Gohagoda in Kandy and Wariyapolawatta in Matale were selected, respectively, to identify the point and non-point sources of pollution, composition of wastes collected, the effects of pollution and to identify the associated stakeholder groups. Dissolved oxygen (DO), chemical oxygen demand (COD), Biological Oxygen Demand (BOD), nitrates, phosphates, pH, conductivity, total dissolved solids (TDS), total suspended solids (TSS) and turbidity of water samples collected were analyzed in the Analytical Research Laboratory, University of Peradeniya following the standard methods from November 2019 to February 2020. Study Site 4 showed a significant difference in pH from other sites, being more alkaline. TDS values of the current study varied between 89.7 mg L^{-1} and 246.3 mg L^{-1}. Highest conductivity and TDS values were associated with the open dumping site in Wariyapolawatta, Matale, which indicated the mixing of leachate with river waters, while the lowest at Ginigathhena, where pollution was minimal. Highest mean COD value was recorded as 115.7 mg L^{-1} in Study Site 4. The highest average nitrate concentration observed in Study Site 2 may be due to the grey and black water discharges from Meda-Ela. Study Sites 3 and 4 also had considerably higher average values of nitrates because of the gully discharges in Gohagoda and the household waste water in Wariyapolawatta area. Each of the selected study sites did not record phosphates. However, results indicate that changes in measured water quality parameters had occurred due to solid wastes, urban waste water discharges, etc.

Keywords: Central province, Mahaweli River, Open solid waste disposal, Urban area management, Water Quality

Abstract No: 318 ***Earth and Environmental Sciences***

PARTICULATE MATTER ANALYSIS IN AIR OF A HIGH DENSITY CHRYSOTILE ASBESTOS RELATED PRODUCTION FACTORY IN SRI LANKA

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Particulate matter (PM) is the generic term to classify air pollutants comprising of suspended particles in air. PM_{10} and $PM_{2.5}$ are mostly considered because of their possible respiratory toxicity. The most serious health hazard of an asbestos related production factory (ARPF) is asbestos fibers, because they can cause asbestosis. PM of the air of an ARPF consist of not only asbestos fibers but also other atmospheric particles. The aim of the present study was to determine the PM in air of an ARPF. One of the largest ARPF in Sri Lanka, with two production facilities (PF) was selected for this study. Seven sampling sites were selected from PF1(Admin complex (AC), Loading area (LA), Sheets cutting area (SC), Sheets removing area (SR), Cement silo (CS), Broken sheets dumping area (DA), near the pulverizing machine (PL) and five sampling sites were selected from PF2 [near the stores (ST), (LA), (SC), DA), (PL)]. APM 550 Fine particulate air sampler was used for sample collection. Six samplings were done from both PFs. Control samples were collected from the National Institute of Fundamental Studies (NIFS). Initial weight (W1) and final weight (W2) of the filters were measured using analytical balance and sampling duration was 30 minutes. The highest $PM_{2.5}$ value was observed from PL of PF2 (258 μ gm^{-3}) while the lowest value was observed from AC in PF1 (37 μ gm^{-3}). The highest and the lowest PM_{10} values were observed from the same sites as $PM_{2.5}$ (387 μ gm^{-3}, 67 μ gm^{-3}). Control sample PM_{10} and $PM_{2.5}$ values were 46 μ gm^{-3} and 23 μ gm^{-3}. WHO maximum limit for PM_{10} and $PM_{2.5}$ are 50 μ gm^{-3} and 25 μ gm^{-3}. The PM values were higher at PL due to continuous breakage of waste roofing sheets, while the PM values were lower at AC due to the concealed conditions. Therefore, the risk of PM inhalation is higher for ARPF workers and proper precautions should be taken to mitigate the risk.

Financial assistance from the Ministry of Science, Technology and Research, and the National Research Council (*Grant No. 19-002) is acknowledged.*

Keywords: APM 550, Asbestos, Occupational health, Particulate matter (PM)

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TREND ANALYSIS ON SOUTHWEST MONSOON RAINFALL IN SRI LANKA USING DROUGHT INDICES

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Sri Lanka is an agrarian country where the monsoon rainfall variation influences all agro-meteorological elements. Therefore, analyzing the trend of monsoon rainfall will be useful in different social and economic aspects. Even though trend analysis on rainfall in Sri Lanka has been conducted, drought indices have not been considered for trend analysis. Therefore, the main objective of this research study is to analyze the trend of Southwest monsoon rainfall in Sri Lanka using drought indices. Trend analysis on Standardized Precipitation Index (SPI) and Rainfall Anomaly Index (RAI) was carried out station-wise using Mann Kendall test (MK test) and Sen's slope estimator. The daily precipitation data for the Southwest monsoon season during 1981 - 2010 at 13 rain gauge stations located in the Southwest part of Sri Lanka were utilized to calculate the RAI and the SPI. The RAI was calculated using negative and positive anomalies and the SPI was calculated considering the data distribution. Trend analysis on both indices indicated that 10 rain gauge stations showed decreasing trends in Southwest monsoon rainfall according to normalized MK statistics. However, trend analysis on the RAI indicated significant decreasing trends in Southwest monsoon rainfall only at four rain gauge stations: Ambewela, Hatton, Katugastota and Nuwara Eliya while trend analysis on the SPI indicated significant decreasing trends in Southwest monsoon rainfall at three rain gauge stations: Ambewela, Katugastota and Nuwara Eliya. Furthermore, all those stations are located in the hill country. If this decreasing trend continues, it may cause negative impacts on agriculture, transportation, tourism, etc. and would ultimately affect the economy of the country and livelihood of the people. Therefore, results gained from this research study can be supportive to local decision makers in order to make decisions and manage risks.

Keywords: RAI, Southwest monsoon rainfall, SPI, Trend analysis

Abstract No: 18 ***ICT, Mathematics and Statistics***

STATISTICAL APPROACH ON U-Pb ZIRCON GEOCHORONOLOGY WITHIN THE HIGH - GRADE BASEMENT OF SRI LANKA

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Geochronology is the field of determining ages of rocks using precise mass spectrometric procedures. Sri Lanka represents a fundamental part of the center of East Gondwana, and hence is an important constituent of the world geochronology. Yet, the statistical approach on Geochronology in Precambrian basement of Sri Lanka is still elusive. The main objective of this study was to mark the initial step of statistical involvement in U-Pb zircon geochronology of meta-igneous meta-sedimentary rocks in Sri Lanka. Three lithotectonic units, namely, Highland, Vijayan and Wanni Complexes (HC, VC, WC) of Sri Lanka, have been compared using Welch's ANOVA and Welch's *t*-test. Games-Howell test was performed as a post hoc test for multiple pairwise comparisons. Geochronological features of the HC and WC showed possible correlations between previously adjoined Gondwana terranes in Southern India and East Antarctica. This study allowed a statistical comparison between Sri Lanka and adjacent parts of Southern India [Trivandrum Block (TB)] and Eastern Antarctica [Lützow-Holm Complex (LHC)]. Considering Welch's ANOVA test, results obtained between three complexes, the *p*-value was $2.2e^{-16}$, which is less than $\alpha = 0.001$. As the ANOVA test was significant, Games-Howell test was performed to examine the significantly different complexes. The *p*-values for HC - VC pair and HC – WC pair were less than the significance level, but the WC - VC pair was 0.0087. Hence, HC showed a significant difference from the other two complexes. This justifies the geochronological hypothesis, that HC consists of the oldest rock base in Sri Lanka. Welch's *t*-test conducted between igneous and sedimentary rocks for all three complexes indicated that the *p*-value for WC was 0.0516557, which is higher than $\alpha = 0.05$. This shows that igneous and sedimentary rock bases in WC are not significantly different. This explains the geochronological reading that, parent rock genesis of sedimentary rock type in WC may be igneous. The high-grade basement of Sri Lanka can be divided into three clusters according to their similar characteristics in age distribution. According to Welch's ANOVA test conducted between HC, TB and LHC, *p*-value was 0.913, which is higher than the significance level 0.001. As the result was not significant, it can be concluded that there is a statistical relationship between those three units. Therefore, it's it is conceivable that the three regions might have initiated under similar convergent tectonics. Metasedimentary constituents of LHC and the HC might be adjacent and continue to the Trivandrum Block. To conclude the results, it was observable that, adequate amount of geochronological results based on Precambrian high-grade basement of Sri Lanka can be confirmed through statistical explanations. Continuation of a statistical approach on geochronology will lead to a statistical involvement in geochronology of Sri Lanka.

Keywords: Cluster analysis, Geochronology, Gondwana terranes, Welch's ANOVA, Welch's *t*-test

Abstract No: 19 ***ICT, Mathematics and Statistics***

MODELLING AND RISK ASSESSMENT OF EXTREME FIRE CLAIMS

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Day by day, lives and properties are exposed to unpredictable circumstances, causing huge losses to the entire world, which compels people to look for insurance for financial security. In contrast, extreme claims from the insured undermine insurer's profit and its sustainability. Modelling and risk assessment of extreme claims are essential for profitable business, which is an emerging topic in research. The objectives of this study are to model the extreme fire claims and thereby to assess the largest risk exposure for the future. The daily fire claims from 15th August, 2017 to 20th September, 2019 were obtained from an insurance company in Sri Lanka. The Peak Over Threshold (POT) approach of the Extreme Value Theory was employed to model the extreme fire claims. Initially, the Mean Residual Life Plot was drawn to identify the range of tentative thresholds with the POT approach to each of the tentative threshold, and the Mean Square Errors (MSEs) of fitted Generalized Pareto Distributions (GPDs) were calculated. The threshold with minimum MSE was selected as the optimum. The parameters of the GPD were estimated through the Unbiased Probability Weighted Method and the Bootstrap Goodness of Fit Test was applied to validate the GPD. Finally, the Value-At-Risk was calculated at 95% level of confidence. It was revealed that, the fire insurance claims were positively skewed with a skewness of 4.042. Then the MSEs of the GPDs, fitted to the 45 tentative thresholds between LKR 100,000 and LKR 550,000, were obtained. The optimal threshold of LKR 340,000 was exceeded by 56 claims. These exceedances can be best described by GPD (ξ = 3.343e-01, σ = 7.291e+05). Moreover, the largest claim expected in a day has not exceeded LKR 3,756,123. This information enables the insurer to take precautionary measures in designing the risk management strategies to assure a sustainable business.

Keywords: Claims, Generalized pareto distribution, Insurance, Threshold

A GENERALIZED ELLIPTIC CURVE ELGAMAL CRYPTOSYSTEM

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Over the years, Elliptic Curves have been an active area of research. Around the mid-1980s, Koblitz, Lenstra Jr., and Miller independently developed the theory of Elliptic Curve cryptosystems whose significance is apparent from the statement made by the latter: "It is my intent to show that elliptic curves have a rich enough arithmetic structure so that they will provide a fertile ground for planting the seeds of cryptography". To withstand cryptanalysis over faster computers that also have higher processing capacities, classical cryptosystems have been forced to use larger keys for a secured communication. Thus, the future of Cryptography is most likely to be based on Elliptic Curve Cryptography (ECC), which provides an equivalent or higher security with smaller keys compared to that of the well-known cryptosystems. The heart of ECC lies within the Elliptic Curve Discrete Logarithm Problem (ECDLP), which is believed to be computationally infeasible and hence, provides a higher level of security for Elliptic Curve cryptosystems. Elliptic Curve Diffie-Hellman and Elliptic Curve ElGamal algorithms are couple of renowned members of the family of ECC. We have introduced a Generalized ElGamal algorithm that uses the prime factorization of the plaintext and is proven to be secure against the Chosen Plaintext Attack. The Elliptic Curve version of our Generalized ElGamal algorithm also follows the prime factorization. If the plaintext is the power of a single prime, the proposed scheme is similar to the Elliptic Curve ElGamal cryptosystem. The security of the new method is guaranteed by the ECDLP.

Keywords: Chosen plaintext attack, ElGamal cryptosystem, Elliptic curves, Elliptic curve discrete logarithm problem

A MATHEMATICAL MODEL FOR STOCK PRICES IN THE COLOMBO STOCK EXCHANGE

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This empirical study attempts to examine whether the stock prices of companies listed on the Colombo Stock Exchange (CSE) follow Random Walk Hypothesis (RWH) and presents a mathematical model of stock prices using a Fractional Brownian Motion Process with Adaptive Parameters (FBMAP) compared with Auto-Regressive Integrated Moving Average (ARIMA) time series model. The research was motivated by the fact that investors are interested in knowing whether past stock prices have a propensity to forecast future stock prices. The period covered by the research was January 2012 to June 2018. The main objective of the study was to investigate whether stock prices follow the RWH and to compare two major forecasting methods. In order to check RWH, we used Chi-square Test, the Runs Test and the Auto-correlation Test. The Augmented Dickey-Fuller Test (ADF Test) was used to verify the stationarity of the data set. In the first phase, best fitted ARIMA model was found using Akaike Information Criteria (AIC), Least Root Mean Squared Error (RMSE) and Mean Absolute Percentage Error (MAPE). In the second phase, proposed FBMAP was used to predict future stock prices. The findings showed that changes in stock prices on the CSE refute the RWH. The study concluded that stock price shifts follow some pattern or trend and that historical price changes can be used to predict future price movements in short-term. The simulation results showed that the FBMAP model is more suitable for forecasting daily closing price than ARIMA model.

Keywords: Augmented Dickey-Fuller Test, Auto-Regressive Integrated Moving Average, Chi-square Test, Runs Test, Fractional Brownian Motion with Adaptive Parameters, Random Walk Hypothesis

Abstract No: 31 ***ICT, Mathematics and Statistics***

PERFORMANCE OF VARIOUS LOCATION-BASED LINDLEY FAMILY DISTRIBUTIONS BASED ON AKAIKE INFORMATION CRITERION

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In statistical literature, several modifications of the Lindley distribution (LD) have been introduced in terms of having the flexibility of LD's failure rate criteria. These modifications have been applied to several heterogeneous lifetime data sets and used to model the heterogeneous Poisson parameter. Herein, it is needed to examine the performance of these modifications for various datasets that may have various characteristics such as horizontal symmetry, measured by skewness (SK); tail-heaviness measured by excess kurtosis (EK); and dispersion, measured by Fano factor (mean-variance ratio). In this study, we compare the performance of various location-based Lindley family distributions based on the Akaike information criterion. To generate various characteristics of data sets, and accommodate most of the Lindly family distributions, we propose a new location-based generalized Lindley distribution (NLGLD). This is a two-component mixture of exponential (θ, β) and gamma (γ, θ, β) with mixing proportion, $p = \frac{\delta\alpha}{\delta\alpha+\eta}$. Here, α, δ, η are shape parameters, and θ, β are scale and location parameters, respectively. Several possible sub-models of NLGLD are fitted for various characteristic simulated data sets. It was found that sub-models with the mixing proportion, $p = \frac{\alpha^3}{\alpha^3+1}$ perform well for all different settings of γ and β. However, the inclusion of the location parameter β, in these types of distributions resists the flexibility to cover the higher Fano factor (FF) values. Further, among the location-based sub-models of NLGLD, the model at $\gamma = 2$ is recommended for a data set with higher horizontal symmetry (around $SK > 0.85$), tail-heaviness (around $EK > 1.32$), and various ranges of dispersions when compared with the location-based model at $\gamma = 3$. Below this range of SK and EK values, and around $FF \leq 8$, the location-based model at $\gamma = 3$ can perform well. However, the location-based models with $\gamma \geq 4$ are not suitable to fit for various characteristics of the data sets since they have converging issues for the unknown parameter estimation β, and poor performance when compared with simple models without having a location parameter.

Keywords: Finite mixture models, Failure rate, Fano factor, Lindley distribution

EFFECT OF ADDING A NEW EDGE TO A NON-TRIVIAL GRAPH, ON $R_{-1}(G)$ AND HARMONIC INDEX $H(G)$

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Given a graph G, the general Randić index $R_\alpha(G)$, is defined as the sum of the weights $(d(u)d(v))^\alpha$ over all edges uv of G, where $d(u)$ denotes the degree of the vertex u and α is an arbitrary real number. When $\alpha = {}^{-1}/_{2}$, it is defined as the Randić index which was proposed by the Chemist Milan Randić, in 1975. In particular, $R_{-1}(G)$ is one of the most important topological indices investigated by researchers. Another remarkable variant of the Randić index is the Harmonic index, defined as $H(G) = \sum_{uv \in E(G)} \frac{2}{d(u)+d(v)}$, where uv is an edge connecting the vertices u and v. These indices were extensively studied by mathematicians, and several results have been established. Among the studies, it is noticeable that most of the researchers have encountered the effect that edge deletion has on $R_{-1}(G)$ and $H(G)$. In 1998, Bollobás and Erdös first identified the effect of deleting an edge with maximum weight on $R(G)$. In 2013, Mike Cave studied the effect of deleting a non-leaf edge on $R_{-1}(G)$. In a similar manner, many researchers have focused on studying the effect of deleting certain types of vertices and edges on $H(G)$, so that the mathematical background of those indices are well elaborated. In this study, the effect of adding a new edge to a non-trivial graph on $R_{-1}(G)$ and $H(G)$ has been investigated. Also, after adding the new edge, only simple graphs are considered as the resulting graph. Novel upper and lower bounds for$R_{-1}(G+e)$ and $H(G+e)$ have been provided in terms of $R_{-1}(G)$ and $H(G)$ under two main cases, where $G+e$ is the new graph obtained by adding an edge to any non-trivial graph G.

Keywords: Harmonic index, Non-trivial graph, Randić index

A NOVEL EXPRESSWAY TICKETING SYSTEM FOR SRI LANKA USING ARTIFICIAL INTELLIGENCE

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All E-Grade expressways (commonly called highways) in Sri Lanka are levying a user charge depending on the type of vehicle and currently the fee-levying operation is totally manually handled. When a vehicle enters an expressway, an electronic ticket is issued at the entrance interchange mentioning the type of vehicle and the name of the interchange entered. When the vehicle reaches the exit point, the ticket received at the point of entry is handed over to the exit toll gate and the user charge based on the vehicle type is informed. The user has to make the payment only in cash to the toll gate and a receipt is issued for the payment. After finishing the payment, the barrier gate is opened and the vehicle can pass through the lane. The current system of operation has led to wastages of time both at the entry and exit points of the expressways. The intent of this research is to propose an automated expressway fee-levy system using Computer Vision and Artificial Intelligence concepts. According to the proposed fee-levy system, the vehicle registration number is detected and recognized using a digital camera and Automatic License Plate Recognition (ALPR) software at the entrance, and the date, time and point of entry are saved securely in a database. The payment can be made using a credit/debit card and mobile cash while in transit. At the exit point, the registration number of the vehicle is again recognized and the relevant entry details are traced. Exit toll gate barriers open automatically for those vehicles that made the relevant payments while in transit. This mode of operation will reduce waiting time at the entry and exit points particularly during weekends, long holidays and festive seasons. For other non-regular vehicles, once the user fee is paid at the exit, the toll gate barriers open automatically. The system was implemented using MATLAB, OpenCV library and NewSQL. Experimental results have shown that the system is capable of recognizing vehicle registration number plates, in all standard formats provided by Department of Motor Traffic Sri Lanka, even in noisy images. The system works satisfactorily even under wide variations of illumination in real-time situations.

Keywords: Automated expressway ticketing system, Artificial Intelligence, Automatic license plate recognition, Computer Vision

Abstract No: 44 ***ICT, Mathematics and Statistics***

WIKIDATA BASED PERSON NAME DISAMBIGUATION FOR USER PROFILING IN NEWS RECOMMENDATION

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Entity linking (EL) is a process of extracting entity mentions in documents and linking them to their corresponding actual entities in a Knowledge Base (KB), such as Wikipedia or Wikidata. This task is challenging due to name variations, incompleteness of the KB and high ambiguity of entity mentions. News articles generally contain mentions of entities, such as persons, organizations and locations, which are an excellent resource for understanding readers' news interest. However, an entity mention can refer to different real-world entities. Furthermore, person entities are generally more ambiguous and critically important to understand the readers' news interest. This paper aims to design an EL system for disambiguating person mentions in news articles that can be used for user profiling in news recommendation. Current EL methods do not focus on improving EL performance of person entity mentions. Wikidata KB is chosen based on accessibility, completeness of the relations and timeliness of the data. The proposed method includes three main steps. In the first step, a new approach is proposed to generate candidate entities based on name dictionary-based technique. Partial string-matching technique is adopted when person names are referred as part of their full names. In the second step, top *N* candidates are selected using features from previous studies: entity popularity, textual similarity and the contextual similarity between a mention and the KB entity. In the last step, the best-matched entity is chosen from the top *N* candidates based on the semantic relatedness between the entities in a news article. The performance of the proposed methods is evaluated over a manually annotated AIDA-CoNLL news dataset. Experimental results show that the proposed candidate entity generation algorithm achieves the highest precision, and the recall of 98.91% on AIDA-CoNLL testb dataset. The best overall performance is achieved by correctly linking 90.05% of mentions in testb corpus. The results show that the proposed approach to generate candidate entities leads to achieve the highest precision at best matched entity selection stage. Thus, it can significantly benefit the user interest profiling in news recommendation.

Keywords: Entity linking, News recommendation, Person name disambiguation, User profiling, Wikidata

Abstract No: 48 ***ICT, Mathematics and Statistics***

NON-LINEAR DISPERSION OF A CHEMICAL POLLUTANT INTO A RIVER WITH NON-LINEAR INITIAL FLOW

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The boundary value problem has developed into an important area of research of fluid dynamics. It is a system of ordinary or partial differential equations with the solution and derivative values specified at the boundaries. In this study, we generalized the boundary value problem derived by Van Gorder considering non-linear initial flow with an added chemical pollutant to ascertain the velocity profile's behaviour and the pollutant concentration. By introducing a new parameter *m*, we were able to present a general formula for the initial velocity when a particle is released into water. Here, we considered the system of partial differential equations using both concentration equation and Navier-Stokes equation, important for effectively predicting the outcome of river pollution. By introducing dimensionless parameters, the system has been converted into a dimensionless form. Then, we converted the governing system into systems of non-linear ordinary differential equations via similarity transformation and obtained solution curves numerically by the Runge-Kutta method. For a given set of parameters, numerical results were obtained using Maple software. These results differ from those in literature, as the non-linear variable initial flow has not been considered for this model. It could be analysed that the values of *m* did not affect the concentration function. But when *m* was increased, the graph of the velocity function decreased. The gradient of the curve supplies the velocity at each point of the motion. Physically, this model is applicable while spreading a chemical pollutant into a river when a spill is in progress. Further, present results form an inspiring study of a pollutant problem, and hence, results are relevant to those working in the field of environmental engineering.

Keywords: Analytical solutions, Nonlinear partial differential equations, Pollutant dispersion, Runge-Kutta Method

STUDY ON MUTATION MECHANISMS OF HUMAN BREAST CANCER IN SRI LANKA

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Breast cancer is a genetic disease that has become a major health problem in developing countries like Sri Lanka. The incidence rate of breast cancer in Sri Lanka continues to rise. Therefore, this study was conducted to analyze the breast cancer data descriptively, compare age-specific incidence rate patterns for gender, and investigate the mutation mechanisms to determine how many mutations are needed for breast cancer. The breast cancer data was obtained from the National Cancer Control Programme in Sri Lanka. Preliminary data analysis was done to identify the age, gender, district, and province wise prevalence of breast cancer, and the age-specific incidence rate of breast cancer was calculated. The multistage stochastic model was built and parameters were estimated. Then the system of differential equations in the model was numerically solved to obtain the value of the hazard function. The chi-square goodness of fit test was used to examine the optimal fitting stage model. The results show that a high number of breast cancer incidence was evident among women in Sri Lanka. The incidence of female breast cancer was high in postmenopausal women. The results further indicated that the incidence of breast cancer depends on the morphology types of breast carcinoma (Infiltrating duct carcinoma 79.04%, Neoplasm malignant 10.64%, etc.). When considering the percentage of women having breast cancer to the districts' population, an increased rate of incidences of female breast cancer was observed in highly populated urban districts in Sri Lanka. According to the result of the model, there should be at least two to three mutations in the genome of breast stem cells for them to become a malignant cell. It is evident from the result that three gene mutations ($p = 0.06$) with estimated parameters fit very well in Sri Lankas' data on female breast cancer.

Keywords: Breast cancer, Gene mutation, Stochastic model

Abstract No: 52 ***ICT, Mathematics and Statistics***

A METHOD OF DIRECTLY DEFINING THE INVERSE MAPPING FOR PARTIAL DIFFERENTIAL EQUATIONS

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In the early nineteenth century, J.H. He proposed the Homotopy perturbation technique, which has been widely used to obtain analytic solutions to non-linear differential equations. If the operator of the non-linear differential equation contains a linear part and non-linear part with a small parameter, then the original non-linear problem can be transferred into an infinite number of linear sub problems. Under this situation, there is no freedom to choose the linear operator. Moreover, the inverse of the linear operator should be calculated to find unknown functions, and it is computationally expensive. To overcome this obstacle, Liao introduced the Method of Directly Defining inverse Mapping (MDDiM) with the freedom of choosing the inverse linear mapping. Therefore, most of the barriers faced when solving the problems can finally be overcome. Recently, Vajravelu *et al*. extended the MDDiM to solve coupled systems of non-linear ordinary differential equations that have been previously used to solve single non-linear ordinary differential equations. In this study, this novel method was further extended to solve systems of non-linear partial differential equations. The results obtained through this method are well in agreement with those obtained with numerical methods in previous studies. As a result of the extended MDDiM, the novel method is able to save computational time. Further, this method can be used to analyze more complicated models in Science and Engineering.

Keywords: Analytical methods, Coupled nonlinear systems, Directly defining the inverse mapping, Homotopy analysis method

Abstract No: 56 ***ICT, Mathematics and Statistics***

ON A QUESTION OF CONSTRUCTING MÖBIUS TRANSFORMATIONS VIA SPHERES AND RIGID MOTIONS

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A Möbius transformation is a complex-valued function that maps points in the extended complex plane into itself either by translations, dilations, inversions, or rotations or even as a combination of the four mappings. Such a transformation can be constructed by a stereographic projection of the complex plane on to a sphere, followed by a rigid motion of the sphere, and a projection back onto the plane. In 2008, Arnold and Rogness created, and posted on YouTube, the video *Möbius Transformation Revealed* which became an instant hit. Their question, "*In how many different ways can the transformation be constructed using a sphere?*", which appeared in the follow-up paper was answered in 2012 by Siliciano, who showed that for any given Möbius transformation and an admissible sphere, there is exactly one rigid motion of the sphere with which the transformation can be constructed. The purpose of the present work is to work on a suggestion posted by Siliciano in characterizing rigid motions in constructing a specific Möbius transformation. Here our work shows that different admissible spheres under a unique Möbius transformation would require different rigid motions. In stereographic projections, the angle between lines on the surface of the sphere is equal to the angle between the projections of those lines and the circles on the surface of the sphere project as circles on the plane of projection. These are two most important existing results on stereographic projections and in the present work we have proved that under a unique Möbius transformation f, there exists different rigid motions (T, $\hat{T}$) for different admissible spheres (S, $\hat{S}$). Throughout the present work, Möbius transformations are written in the form $f = P_{T(S)} \circ T \circ P_S^{-1}$, where P_S is the stereographic motion before the rigid motion and $P_{T(S)}$ is the stereographic projection after the rigid motion. All these results can be combined and used in related applications, such as map making.

Keywords: Admissible sphere, Möbius transformation, Rigid motion, Stereographic projection

Abstract No: 60 ***ICT, Mathematics and Statistics***

SOME PROPERTIES OF THE UNITARIES REPRESENTING MINIMAL INNER TORAL POLYNOMIALS

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An inner toral polynomial is a polynomial in two complex variables z and w such that its zero set is a subset of $\mathbb{D}^2 \cup \mathbb{T}^2 \cup \mathbb{E}^2$, where $\mathbb{D}$, $\mathbb{T}$, and $\mathbb{E}$ are the open unit disk, unit circle, and the exterior of the closed unit disk, respectively. A minimal inner toral polynomial is one that divides all the other inner toral polynomials with the same zero set as itself. In 2005, Jim Agler and John E. McCarthy proved that, for a given minimal inner toral polynomial $\mathfrak{p}(z,w)$ of degree n and m in z and w, respectively, there exists a unitary matrix, written in block form as $\begin{pmatrix} A & B \\ C & D \end{pmatrix}$, such that $\det \begin{pmatrix} A - wI_m & zB \\ C & zD - I_n \end{pmatrix}$ is a constant multiple of $\mathfrak{p}(z,w)$. Moreover, the block matrix D in such unitaries has no unimodular eigenvalues. Greg Knese in 2010 gave an alternative proof to the same result. Following their work, we prove the following results on the block matrix D. If $\mathfrak{p}$ does not have the zw^m term, then the trace of the block matrix D is zero. Likewise, if $\mathfrak{p}$ does not have $z^n w^m$ term, then the determinant of the block matrix D is zero. Consequently, if $\mathfrak{p}$ does not have the $z^k w^m$ terms for all $k = 1,2,\dots,n$, then D has zero eigenvalues. Further, if $\mathfrak{p}$ does not have the $z^k w^m$ terms for all $k = 1,2,\dots,n-1$, then the determinant of D is not unimodular.

Keywords: Distinguished varieties, Inner toral polynomials, Unitary matrices

TRANSPORTATION PROBLEM WITH VARYING DEMANDS AND SUPPLIES ARISING IN TEA DISTRIBUTION

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This study is motivated by a real-world tea distribution problem. Transportation problem with varying demands and supplies (TPVDS) can be modelled as a variant of the interval transportation problem (ITP). In ITP, the demands and capacities of a homogeneous product may not be known precisely but vary within an interval. Due to these variations, the total cost of the transportation can also be varied within an interval, and thus the cost bounds can be obtained. Determination of an exact upper bound on the minimal total transportation cost to this ITP is an NP-hard problem. This study develops an alternative efficient heuristic technique to find the better near optimal upper bound to a tea-distribution problem. We consider a special case of ITP where the sum of the lower bounds for all supplies is equal to the sum of the lower bounds for all demands, and the sum of the upper bounds for all supplies is equal to the sum of the upper bounds for all demands. The proposed method is formulated using the idea of convex combination in which the points on the supply-demand interval ranges are expressed as a convex combination of their respective lower and upper bound values. The performance of this new heuristic is evaluated on available small-sized benchmark instances and a real-world case study. The proposed method, as a heuristic, provides near-optimal upper bounds of the minimal total costs.

Keywords: NP-hard problem, Tea-distribution problem, Upper bound

Abstract No: 76 ***ICT, Mathematics and Statistics***

TURNING GUI INTO HTML SOURCE CODE WITH IMAGE PROCESSING AND DEEP LEARNING

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Web development is one of the top emerging fields in the IT industry. It is the process of developing web-based content, hosting them and accessing via internet or intranet based on the requirement. Drafting and prototyping the design mock-up of a webpage is an important step in web development procedure. The User Interface (UI) design of a website plays an essential role in attracting new users and engaging them on the web pages helps businesses in boosting up sales and revenue. A unique design template will help to increase the user interaction among the visitors of the page and also assure value for the time and resources spent on a page. Web designers design the websites either by using an existing template or by creating the design from scratch. Once the UI design of a website has been created, it is given to a developer to implement in code. This process is challenging and time consuming since the design and implementation are carried out by different teams and therefore costly. The overall outcome of the design template of a website almost depends on the design skills of the web designer and there are differences between two source codes even implemented in the same UI by two different developers. What if there is a mechanism or system to identify the HTML components on GUI image and generate source code automatically. If this system or tool can generate the source code that way, developers can be more focused on functionalities instead of wasting time on front-end development, in an efficient manner. Therefore, this research introduces an approach which automatically turns UI design of a website into HTML source code, end to end with image processing and deep learning. This research was conducted in an experimental approach to achieve two separate scenarios which are implemented as image processing module and deep learning module. Image processing module is to extract the HTML components from a UI design of a website, and deep learning module is to train a convolutional neural network (CNN) which generates the source code according to the constructed HTML tag tree hierarchy. For the evaluation process, the tag tree created from image processing was compared with the original HTML tag tree, and original source code implemented for particular GUI was compared with generated code lines. The system was implemented using MATLAB, Image Processing Toolbox, TensorFlow and Python.

Keywords: Deep learning, Image processing, Source code generation, Web designing

Abstract No: 89 ***ICT, Mathematics and Statistics***

BEHAVIOUR OF PURE ALGEBRAIC ISOPAIRS AT NON-REGULAR POINTS

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A polynomial in z and w is called inner toral if its zero set is a subset of $\mathbb{D}^2 \cup \mathbb{T}^2 \cup \mathbb{E}^2$, where $\mathbb{D}$ is the open unit disk, $\mathbb{T}$ is the unit circle, and $\mathbb{E}$ is the exterior of the closed unit disk. An inner toral polynomial is called a minimal inner toral polynomial if it divides any polynomial with the same zero set as itself. A zero of a polynomial $p(z,w)$ is called a regular point for p, if the gradient of p at that point is non-zero. An isometry defined on a Hilbert space is called a pure isometry if it behaves like a shift operator. The bimultiplicity of a pair (S,T) of pure isometries S and T is given by $(\dim(\ker(S^*), \dim(\ker(T^*))$, where * denotes the adjoint of an operator. Given a minimal inner toral polynomial $\mathfrak{p}$, a pair of pure isometries (S,T) satisfying the algebraic relationship $\mathfrak{p}(S,T) = 0$ is called a pure $\mathfrak{p}$-isopair. In 2018, it was proved that, for a pure $\mathfrak{p}$-isopair (S,T) with finite bimultiplicity, $\dim[\ker(S-\lambda I)^* \cap \ker(T-\mu I)^*] = 1$ whenever $(\lambda,\mu) \in \mathbb{D}^2$ is a regular point for $\mathfrak{p}$. In this paper, we show that the converse of this result does not hold. The pair (M_z, M_w), is a pure $\mathfrak{p}$-isopair with finite bimultiplicity $(2,2)$, where $\mathfrak{p}$ is taken to be as the minimal inner toral polynomial $z^2 - w^2$, and M_z and M_w are multiplication by z and w, respectively. We show that the dimension of $[\ker(M_z-\lambda I)^* \cap \ker(M_w-\mu I)^*]$ is 1 at the point $(\lambda,\mu) = (0,0)$, which is a non-regular point for $\mathfrak{p}$.

Keywords: Algebraic isopairs, Inner toral polynomial, Isometries

Abstract No: 91 ***ICT, Mathematics and Statistics***

A MACHINE LEARNING APPROACH FOR UNIVERSITY STUDENT AND COURSE PROFILING WITH RESULT PREDICTION: A CASE STUDY

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A wide variety of courses is offered at state universities in Sri Lanka, and students have the freedom of selecting subjects and courses they prefer under the selected study programme. In the first two years in the Faculty of Science, University of Peradeniya, Sri Lanka, students have to register for many compulsory courses; but in the next two years, they have a freedom of selecting optional courses. Even though students have three major subjects in the first year, they are given the opportunity to register for courses from many other disciplines to fulfil the credit requirement within the academic year. A proper mechanism for a student to select the best elective courses according his or her capabilities is imperative to elevate the student's academic performance. Thus, the aim of this research is to find an effective way of identifying best elective courses suitable for a student to improve the academic performance. The proposed method consists of two approaches to solve this problem. In the first approach, using the results of past students for various courses, the grade a new student might obtain for a course is predicted. A dataset of 208,985 records is considered for this study from the year 2005 up to 2012 which was received from the Faculty of Science, University of Peradeniya. Pre-processing this dataset was carried out by removing non-processable values and representing values in one standard format and adding new attributes such as the Grade Point value corresponding to each grade for different analyses. Machine learning techniques, such as the K-nearest neighbour method, neural networks, decision trees and the random forest method were used for the prediction of results. Neural networks is identified to be the best machine learning technique which gives the highest and the most reliable accuracy of 99.69% when using the accuracy score function for results prediction. Using this method, students can predict their results before attempting any course. The second approach of this research was to identify various course profiles/groups of similar courses offered at the Faculty. Using the K means algorithm, keywords from course descriptions and pre-requisite courses, the courses were categorized into ten clusters. With the help of these course profiles/groups as a base, student profiles/groups were identified. If a student performs well for a particular course, its course group can be identified, and the student can select any other course from this group as elective courses. These selected elective courses are predicted to give similar results as the former course. Thus, the proposed method in this study is recommended to identify and select the best elective courses according to the student's capabilities.

Keywords: Course clusters, Machine learning approach, Results Prediction, Student profiles

Abstract No: 93 ***ICT, Mathematics and Statistics***

PRIME LABELLING OF CENTRELESS DOUBLE WHEEL GRAPHS (CDW_{2n})

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Graph labelling is a prominent research area in Graph theory and a considerable amount of open problems are available in the literature for various types of graphs. Prime labelling is one of the most interesting categories of graph labelling. A graph $G = (V(G), E(G))$ with $|V(G)|$ number of vertices is said to have *prime labelling* if there exists a bijective mapping $f : V(G) \rightarrow \{1, 2, 3, \dots, |V(G)|\}$ such that for each edge $e = uv \in E(G)$, the greatest common divisor of $f(u)$ and $f(v)$ is 1. In our previous work, the prime labelling of the Tripartite graph, Roach graph, Crab graph, and Scorpion graph have been discussed, and we found the cases where each of the graphs have prime labelling. In the present work, the prime labelling method has been introduced for the Centreless double wheel graph CDW_{2n} with $2n$ vertices when n is even. The graph obtained from cyclic graph C_{n-1} by joining each vertex to a new vertex v is the *wheel* on n number of vertices, denoted by W_n. The Centreless double wheel graph is obtained by using Cartesian product of C_n with n vertices and complete graph of the form K_2 and is denoted by CDW_{2n} (i.e $C_n \times K_2 = CDW_{2n}$). This is also isomorphic to the graph obtained by joining the end vertices by two edges of the Ladder graph. We proved that CDW_{2n} is a prime graph for two special cases when n is an even integer and $n + 1$ is prime, and when n is an even integer and $2n + 1$ is prime. In addition, the cyclic vertex labelling method in the clockwise direction and anti-clockwise direction have been introduced. Moreover, proofs of the two theorems related to the above two cases are given. We used the theorem on ladder graphs in the work by A.H. Berlineer et al in this proof. Furthermore, as future work we are interested in considering prime labelling of centreless n-wheel graphs and to apply the prime labelling method when n is odd.

Keywords: Centerless double wheel graph, Greatest common divisor, Prime labelling

Abstract No: 95 ***ICT, Mathematics and Statistics***

PRIME LABELLING OF NEWLY CONSTRUCTED GRAPHS OBTAINED BY REPLACING EACH EDGE OF A STAR GRAPH BY A COMPLETE TRIPARTITE GRAPH

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The study of relatively prime numbers connecting with graphs is an active research area in Graph Theory. Prime labelling is a special case of graph labelling and our present work is focused on the prime labelling of newly constructed graphs obtained by replacing each edge of a star graph by a complete tripartite graph. A *prime labelling* of a simple graph G with n vertices is a labelling of vertices of G with distinct integers from the set $\{1, 2, \cdots, n\}$ in such a way that the labels of any two adjacent vertices are said to be relatively prime. If the greatest common divisor (gcd) of two integers is equal to 1, then those integers are relatively prime. A complete tripartite graph is a simple tripartite graph in which each vertex in one partite set is adjacent to all the vertices in the other two partite sets. In our work, we have proved that the graphs obtained by replacing every edge of a star graph $K_{1,n}$ by $K_{1,m,1}$ is a prime graph, where $n \geq 1$ and $m = 2,3$. These results are illustrated for some particular values of n and m. In future, we are planning to implement a computer program to generalize our present results to the graphs obtained by replacing each edge of a star graph $K_{1,n}$ by the tripartite graph $K_{1,m,1}$ ($n \geq 1$, $m \geq 4$), to the more generalized tripartite graphs of the form $K_{p,q,r}$ (for $p, q, r \in \mathbb{Z}^+$), and also to the multipartite graphs.

Keywords: Complete tripartite graph, Greatest common divisor, Prime labelling, Star graph

Abstract No: 98 ***ICT, Mathematics and Statistics***

THREE-PHASED HEURISTIC ALGORITHM BASED ON INTEGER LINEAR PROGRAMMING FOR CAPACITATED VEHICLE ROUTING PROBLEM

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The Capacitated Vehicle Routing Problem (CVRP) is a special variant of the Vehicle Routing Problem (VRP) which is extensively addressed in the literature because of its vast applicability. Since the problem is NP-hard, only heuristic algorithms are capable to find satisfactory approximate solutions for relatively large problems within a reasonable CPU time. Therefore, the objective of this study is to develop a novel heuristic algorithm to find comparatively better solutions for CVRP. The first phase of the proposed heuristic algorithm is to form a pool of unique clusters that do not exceed the vehicle capacity. In the second phase, an Integer Linear Programming (ILP) model is used to construct five sets of clusters by selecting clusters from the pool. To construct five sets of clusters, five different parameters are used as the objective function of the ILP. The parameters are derived based on the area of convex hull, number of customers, total demand of customers and mean distance from the centroid of the clusters. The constraint that visits every customer exactly once by exactly one vehicle is incorporated to ensure the sets of clusters provide feasible solutions for the CVRP. Subsequently, Traveling Salesman Problems (TSPs) of unique best sets of clusters (≤ 5) are separately solved in the third phase. To solve the TSPs optimally, the Miller-Tucker-Zemlin ILP formulation is used. Statistical analysis with one-way ANOVA and the Tukey's pairwise comparison tests is used to compare the solutions of the proposed algorithm against three prominent heuristics found in the literature: the efficient two-phased heuristic algorithm, savings algorithm and genetic algorithm, using 30 well-known benchmarked instances. In the comparison, the degree of satisfaction of optimal solutions and the consumed CPU times are compared. The comparison revealed that the three-phased Heuristic algorithm reaches better near-optimal solutions by consuming competitive CPU times.

Keywords: CVRP, Heuristic algorithms, Three-phased heuristic algorithm

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INTEGER PARTITIONS AND THEIR GRAPHICAL REPRESENTATIONS

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An integer partition is a way of writing a given positive integer *n* as a sum of positive integers less than or equal to n. The study of partitions of an integer has been carried on with great interest since the time of Euler. Many mathematicians have studied and searched about integer partitions and have developed graphical representations for the integer partitions. Integer partitions can be graphically interpreted with Young diagrams or Ferrers diagrams which are both pictorial representations. The partition function $p(n)$ has been introduced to represent the number of possible partitions of a non-negative integer n. According to Handshaking Lemma, if a graph exists, then total degree should be even. Therefore, even integer partitions have been used for our work. In the graphical representation, positive integer n is the total degree of the corresponding graph. In this study, it was shown that the number of terms of the partition of an even integer n is equal to the number of vertices of the corresponding graph and the total degree of the graph is equal to n. Further, the degree of each vertex is the value of the positive integer corresponding to that vertex. Hence, partitions of every even positive integer can be represented as connected graphs or disconnected graphs.

Keywords: Graphical representation, Handshaking Lemma, Integer partitions

Abstract No: 119 ***ICT, Mathematics and Statistics***

COMPUTING BUMP-FUNCTION LANDSCAPE IN TOPOLOGICAL DATA ANALYSIS

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Topological Data Analysis (TDA) is a modern field that emerged from various work in computational geometry and applied topology. Persistent homology is a tool that is used extensively in TDA to analyse the shape of data. To find the persistent homology, data must be first represented as a simplicial complex, then the geometric properties of the data are computed using a tool called homology that appears in algebraic topology. The process of constructing a simplicial complex using raw data uses a parameter, the radius r that is used to draw a ball around each point. Changing this parameter, one can obtain the persistence homology of the dataset, and a signature that tells about the persisting topological features of the dataset. Persistent homology can be summarized in a variety of ways; the most prominent ones being the barcode, persistence diagrams and persistent landscape. Although barcodes contain all the information, it is difficult to do statistical analysis using them. Persistence landscape, introduced by Peter Bubenik, solves this problem by mapping the summary into an L^p space. The function used in the construction of persistence landscape is a piecewise linear function. In this study, a new topological summary for data called the bump landscape is proposed. A bump function is a smooth function which has a compact support. The advantages of using a bump function over a piecewise linear function is that most properties of the function are preserved under the sum, product, average and the convolution. The topological summary given by the bump landscape retains all the properties of persistence landscape. The smoothness of the bump function may give additional geometric features of data. In addition, a code was written to generate the bump landscape for synthetic data using ripser, scikit-TDA and java script.

Keywords: Barcodes, Bump functions, Persistence homology, Persistence landscape, Topological data analysis

MONITORING SURGICAL PERFORMANCE USING RISK-ADJUSTED MULTIVARIATE CUMULATIVE SUM CHARTS

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Cumulative Sum (CUSUM) chart is a statistical process control technique that is used in detecting small changes or variations in data monitored over time. The use of CUSUM charts in monitoring and improving quality in the healthcare industry has replaced the use of standard control charts during the past years. Applications of CUSUM charts used in the medical field include monitoring of rates of congenital malformations, monitoring of adverse reactions to drug treatments, and assessing trainee competencies. This study is mainly based on an application of Risk-Adjusted Multivariate CUSUM (RA-MCUSUM) charts in monitoring surgical performance taking into consideration several risk factors associated with cardiac surgery mortality. The main objective of this study was to identify the effect of the surgeons and the type of surgical procedure on the mortality rate. Factors considered under this study include patient's pre-operative characteristics, also defined under the Parsonnet score, heterogeneity of surgeons, type and extent of the surgical procedure. Since each patient has a different level of risk, a vector of weights for every attribute is assigned for each patient. A novel scoring method based on the mortality rates associated with each surgeon was proposed. Similarly, depending on the failure rates of each procedure, scores were assigned to each type of procedure. A logistic regression model was fitted to estimate the mortality rates, and the RA-MCUSUM charts were then plotted to obtain the relevant results. It was noted that RA-MCUSUM control charts are much more stable in performance compared to the standard MCUSUM charts, as they are sensitive to different risk levels. Furthermore, results obtained show that there is a visible difference in the overall outcome and mortality rates if factors such as surgeons and the type of surgical procedure are not taken into consideration during risk-adjustment.

Keywords: Control charts, CUSUM, RA-MCUSUM, Surgical performance

Abstract No: 121 ***ICT, Mathematics and Statistics***

SURVIVAL ANALYSIS OF *BETA*-THALASSEMIA MAJOR PATIENTS

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Thalassemia is one of the most widely spread genetic diseases in the world. Among the types of Thalassemia, *Beta*-Thalassemia Major has become the deadliest disorder. Though there are survival modelling studies based on Thalassemia, most have proposed the popular Cox Proportional Hazard model (CPH). Nonetheless, due to the violation of the proportional hazards (PH) assumption, the CPH model may often not be accurate, and the findings interpreted may remain uncertain. Thus, alternative realistic models for analyzing survival data of *Beta*-Thalassemia Major patients are in need. Hence, the current research was conducted to select the best model through comparison of survival models. The analysis was performed using data from 1998-2006 on 578 *Beta*-Thalassemia Major patients at Zahedan Thalassemia Center, Iran. The research was focused primarily on implementing and comparing survival models. Modeling was performed under the Semi-parametric model: CPH and Parametric models: Accelerated Failure Time (AFT) models. The Akaike Information Criterion (AIC) and log-likelihood values were used for the model comparison. R statistical software was used for the analyses. As per the findings of the current research, the CPH model implemented for the survival of *Beta*-Thalassemia Major patients does not satisfy the PH assumption. The model with the lowest AIC (502.22) and the highest log-likelihood value (-245.1) was selected as the best model after the comparison of four parametric AFT models (Exponential, Weibull, Log-logistic and Log-normal). It was concluded that the survival time of *Beta*-Thalassemia Major patients in the southeast of Iran was distributed Weibull (scale parameter 0.487 and shape parameter 2.054) with significant factors; kind of transfused blood [Hazard Ratio $(HR) = 3.35 > 1$], haemoglobin level ($HR = 0.67 < 1$), the annual number of transfusions ($HR = 0.85 < 1$), and the accompanying diseases ($HR = 1.19 > 1$). According to *HR*, it was found that the patients with no other accompanying diseases, a higher haemoglobin level (> 9 g dL^{-1}) who had received more than 12 transfusions with filtrated blood have higher survival than the counterparts. Both the Extended and Stratified Cox models will be considered for comparison as future work.

Keywords: Accelerated failure time models, *Beta*-Thalassemia major, Cox proportional hazard model, Survival analysis

Abstract No: 138 ***ICT, Mathematics and Statistics***

A VARIANT OF RSA ALGORITHM WITH USE OF FERMAT'S LITTLE THEOREM

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In cryptography, symmetric and asymmetric cryptosystems are the two basic types. Although an asymmetric cryptosystem has two keys, namely public and private, a symmetric cryptosystem has only one key. One of the well-celebrated asymmetric cryptosystems is the RSA cryptosystem, founded in 1976 by Ron Rivest, Adi Shamir, and Leonard Adleman. Considering the variants of RSA, the use of multi-prime numbers increases the strength of security because it makes the factorization of the modulus more difficult. So, the multi-power RSA system is more secure than the original RSA. Hybrid cryptography is one which combines the asymmetric key cryptosystem and the symmetric key cryptosystem. It combines the benefits of both algorithms. In this study, we introduce a hybrid cryptosystem based on multi-power RSA system and Fermat's Little Theorem. We have used a symmetric key which is generated by the sender and an asymmetric key which is generated by the receiver. Hence, the key generation of the proposed algorithm is performed by both parties, and the security of the new method is guaranteed by the multi-power modulus and key generation.

Keywords: Fermat's Little Theorem, Hybrid cryptosystem, Multi power RSA cryptosystem, RSA cryptosystem

Abstract No: 145 ***ICT, Mathematics and Statistics***

A STUDY ON PRODUCT OF COMPLETE BIPARTITE GRAPHS OF THE FORM $K_{n,n}; n \in \mathbb{Z}^+$

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The study of graphs with number theory is a flourishing research area in graph theory. In graph theory, new graphs can be generated from existing graphs using a well-defined set of rules. One such way of defining a combination graph is via a binary operation. Graphs generated in such manner can have applications in Mathematics, Communication theory and Network analysis. In current literature, it can be found methods to translate arithmetic operations for the natural number system into complete graphs. This study focuses on the multiplication of complete bipartite graphs of the form $K_{1,1}$ and $K_{2,2}$, which is defined using a bijection between complete bipartite graphs and the set of natural numbers. A simple graph is called a complete bipartite graph, if its vertices can be partitioned into two disjoint subsets in such a way that no edge joins two vertices in the same set, and if its every vertex in one partite set is adjacent to all the vertices in the other set. If the two partite sets have cardinalities s and t, then the complete bipartite graph is denoted by $K_{s,t}$ where $s, t \geq 1$. In this study, it was proved that by incorporating multiplication operation of the natural number system into the complete bipartite graph of the form $K_{n,n}$, where $n \geq 1$, a higher-order degree of complete bipartite graph can be constructed. The multiplication operation was defined for the complete bipartite graphs $K_{n,n}$, where n is the number of vertices in one partite set. The results $(K_{1,1})^n = K_{2^{n-1},2^{n-1}}$ and $(K_{2,2})^n = K_{2^{2n-1},2^{2n-1}}$ for $n \in \mathbb{Z}^+$, were established for the product of the complete bipartite graphs $K_{1,1}$ and $K_{2,2}$ respectively. Furthermore, the result $(K_{1,1})^{2k} = (K_{2,2})^k$ was obtained.

Keywords: Complete bipartite graphs, Generating graphs, Natural numbers

Abstract No: 156 ***ICT, Mathematics and Statistics***

A COMPARISON BETWEEN GENETIC ALGORITHM AND LOGISTIC REGRESSION ON VARIABLE SELECTION: A CASE STUDY

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Identifying a combination of variables causing infections or infectious diseases is one of the main tasks in clinical models in medicine. Logistic Regression (LR) has been widely used to identify such variable under the assumptions of linearity of independent variables and absence of multi-collinearity. Experimental data which has a large number of variables may not meet these assumptions. Thus, the method of LR may fail to identify variables that cause infections or infectious diseases. Hence, the Genetic Algorithm (GA), which does not depend on pre-defined assumptions, can be applied under such circumstances. By evaluating the prediction rates of LR and GA techniques, this studys' objective was to perform binary LR and GA on a sample of clinical data and compare the goodness of fit statistics to identify the best variable reduction method. Two models were built for 40 independent variables (3 non-categorical and 37 categorical) for a sample of 497 observations collected from a suspected Respiratory Syncytial Virus (RSV) infected children under five years of age, who were hospitalized in the Kegalle Base Hospital from May 2016 to July 2018. The goodness of fit on the two models was compared using statistical methods: 2log-likelihood, Cox & Snell R-square, Nagelkerke R square, correctly classified percentage, specificity, and sensitivity. A total of 162 children were tested RSV positive by an RSV antigen detection method. Except for specificity, GA shows better goodness of fit measurements compared to all other considered statistical methods. However, GA performs better in predictions when sensitivity and specificity were taken together. Moreover, the GA method filtered 17 independent variables to predict RSV infection status, while the LR method filtered 9 independent variables. This case study suggests that GA shows better performance in analysis when the predefined assumptions were not satisfied and solving high dimensional classification problems in a large or complex searching space in the background of the study.

Keywords: Clinical Data, Fitness Function, Genetic Algorithm, Logistic Regression, Sensitivity

Abstract No: 160 ***ICT, Mathematics and Statistics***

THREE NEW HIGHER ORDER ITERATIVE SCHEMES FOR SOLVING NON-LINEAR EQUATIONS

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Three new higher order iterative schemes have been developed for solving non-linear equations of one variable. Initial two-step iterative scheme has been derived by combining the Newton-Raphson method and Simpson's Rule. Based on this initial scheme, the first two-step scheme has been developed using the second order Taylor's expansion and the improved Newton-Raphson method. Combining the Predictor-Corrector method with above schemes, the second scheme with three steps has been derived. The third three-step scheme was derived by combining the second scheme with the third order polynomial interpolation approximation of the second derivative. Convergence analysis of proposed schemes have been carried out, and it has been proved that first, second and third iterative schemes have order of convergence four, five and five, respectively. Hence, we have established that the new schemes have higher orders of convergence than that of the Newton-Raphson method. The performance of proposed schemes has been simulated, for a set of highly non-linear equations for a different set of initial guesses. The number of iterations taken by each scheme to converge the approximate solution with 10^{-10} accuracy has been calculated, and new schemes converge rapidly as compared to the Newton-Raphson method. The number of iterations taken by each scheme decreases with the rise of order of convergence. In some cases, when the initial guesses are far away from the actual solution, the Newton-Raphson method runs into an infinite-loop and fails to converge. However, proposed schemes converge to the solution of these problems without falling into infinite-loops. Absolute errors in approximate solutions in the iterative processes are compared graphically, and they are in accordance with the derived orders of convergence of schemes and the Newton-Raphson method. Further, the computational orders of convergence of the schemes are compared with the Newton-Raphson method. The values are in accordance with the orders of convergence analysed.

Keywords: Computational order, Convergence analysis, Higher order iterative method, Non-linear equations, Predictor-Corrector method

A MATHEMATICAL MODEL FOR COVID-19 TRANSMISSION IN SRI LANKA

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In this study, the SEIR epidemiology model for the spread of COVID 19, introduced by Wickramaarachchi et al, was extended. The model was continued with a special focus on asymptomatic and symptomatic infected individuals, infected individuals in Intensive Care Units of hospitals, and patients who are assumed to be recovered, but not fully recovered (falsely tested). We have derived the system of ordinary differential equations and the basic reproduction number for the system to observe the transmission potential of the disease. Numerical simulations for the mathematical model were done for a period of one month by estimating parameters using MATLAB for the real-world data. The results indicate that the exposed and infected cases reach a maximum with a peak and decrease with time due to various prevention methods followed by society. Further, the basic reproduction number was calculated and discussed for the system along with numerical simulations.

Keywords: Asymptomatic individuals, Basic reproduction number, COVID-19 disease, Numerical simulations, Symptomatic individuals

Abstract No: 186 ***ICT, Mathematics and Statistics***

FIRST ORDER KARUSH-KUHN-TUCKER CONDITIONS FOR QUADRATIC PROGRAMMING PROBLEMS WITH CONTINUOUS AND DISCRETE VARIABLES

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In classical optimization, method of Lagrange multiplier provides first order necessary conditions for optimization problems with equality constraints. Celebrated Karush-Kuhn-Tucker (KKT) conditions, published in 1951, generalize the Lagrange multiplier approach to Mathematical Programming problems with both equality and inequality constraints. In this research, a useful first order optimality conditions are provided for the following nonlinear quadratic programming model problem with continuous and discrete mixed bounded variables:

Model Problem (MP)

$$\min_{x\in\mathbb{R}^n} f_0(x) = \min_{x\in\mathbb{R}^n} \frac{1}{2}x^T A_0 x + a_0^T x + c_0$$

$$\text{subject to } f_j(x) = \frac{1}{2}x^T A_j x + a_j^T x + c_j \leq 0, \quad \forall j \in \{1,2,\dots\dots\dots,m\}$$

$$x_i \in [u_i, v_i], \qquad i \in I \text{ – continuous variable,}$$

$$x_i \in \{u_i, v_i\}, \qquad i \in J \text{ – discrete variable,}$$

where $I \cap J = \emptyset, I \cup J = \{1,2,\dots\dots\dots,n\}$. $A_j=\left(a_{st}^{(j)}\right)$ is an order n symmetric matrix, for all $j\epsilon\{0,1,..,m\}$. $a_j=\left(a_r^j\right)\epsilon\mathbb{R}^n$, $c_j\epsilon\mathbb{R}$ and $u_i,v_i\epsilon\mathbb{R}$ with $u_i < v_i$ for all $i\epsilon\{1,2,..,n\}$.

As MP admits discrete variables, available KKT type local necessary optimality conditions are not readily applicable to this problem**.** A new necessary optimality condition is derived as follows: If $\bar{x}\ \epsilon\ \widetilde{D}$ is a local minimizer of (MP), then

$X_i(\bar{x})\sum_{j=0}^{m}\lambda_j\left(A_j\bar{x} + a_j\right)_i \leq 0$, $\forall\ i\ \epsilon\ I$; where $\lambda_j\epsilon\mathbb{R}^+$; $j = 1,2,\dots,m$ are the Lagrangian multipliers associated with $\bar{x}\epsilon\ \widetilde{D}$, λ_0=1 and $X_i(\bar{x}) = -1$ if $\bar{x}_i = u_i$, 1 if $\bar{x}_i = v_i$, $\nabla L(\bar{x},\lambda)_i$ if $\bar{x}_i\epsilon(u_i, v_i)$. The newly derived necessary condition is provided in terms of the data/coefficients of MP and easily verifiable without long computation. Further it can be useful to develop a numerical scheme to locate the local minimizers of MP.

Keywords: Karush-Kuhn-Tucker conditions, Mixed variables, Quadratic programming problem

Abstract No: 192 ***ICT, Mathematics and Statistics***

DETERMINING A SHORTEST PATH FOR TRAVELLING SALESMAN PROBLEM USING IMPROVED NODE SELECTION CRITERION

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Shortest Path Problem is a highly regarded problem in science and engineering. It is represented using a network, and usually, the weight of each edge of the network represents the distance between two adjacent points. In the real world, distances between two locations are not fixed due to the availability of alternative routes between the points. In 2017, Sumarni Abu Bakar and Milbah Ibrahim developed an algorithm to find the optimal solution to Travelling Salesman Problem with imprecise arc lengths. In this study, this algorithm was extended and improved with a new node selection criterion. Our extensive numerical study shows that the proposed algorithm has provided an improved solution with a reasonable computational time. The strength of the proposed algorithm was tested with a real-world problem, and the findings were compared with the existing algorithm. It can be concluded that the proposed algorithm is proven to be better with respect to objective value as well as computational time.

Keywords: Deterministic algorithm, Heuristic algorithm, Imprecise arc lengths, Shortest path problem, Traveling salesman problem

Abstract No: 195 ***ICT, Mathematics and Statistics***

REDUCED DIFFERENTIAL TRANSFORM METHOD FOR APPROXIMATING SOLUTIONS FOR LINEAR AND NON-LINEAR PARTIAL DIFFERENTIAL EQUATIONS

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In the literature, linear or non-linear partial differential equations, such as the heat equation and the wave equation which describe physical phenomena, are encountered. However, the non-linear models of real-life problems are still difficult to solve numerically or analytically. Much attention has recently been devoted to numerical methods that neither require discretization of space-time variables nor linearization of non-linear equations; for example, Adomian Decomposition Method (ADM) and Variational Iterative Method (VIM). The numerical methods can provide approximate solutions rather than analytic solutions to the problem. The Differential Transform Method (DTM) for solving differential equations has recently renewed interest due to many important applications, such as solving the pantograph equation. In 2009, the Reduced Differential Transform Method (RDTM), which is an alternative approach to DTM, was first proposed by Keskin, a Turkish mathematician, to overcome the demerit of complex calculation of DTM. In this research, three types of non-linear partial differential equations, namely Reaction-Convection-Diffusion equation, Brusselator system of equations (with $A = 1$, $B = 0$, $\alpha = 0.25$) and Volterra integral equations were solved using RDTM and DTM. For this process, CPU times have been calculated using MATLAB software. Present results show that the RDTM is an efficient and accurate numerical method to obtain an approximate solution for linear and non-linear partial differential equations and integral partial differential equations than DTM. Finally, the RDTM was used to find the approximate solutions of different partial differential equations, such as the Diffusion-Advection Equation and Brusselator system of equations with unknown exact solutions.

Keywords: Differential transform method, Iterative techniques, Linear and non-linear equations, Partial differential equations, Reduced differential transform method

Abstract No: 197 ***ICT, Mathematics and Statistics***

A REVIEW OF PERFORMANCE OF FEATURE SELECTION METHODS FOR MACHINE LEARNING ALGORITHMS FOR TWITTER SENTIMENT ANALYSIS

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Twitter sentiment analysis is an area of study with numerous applications. Hybrid approach which combines lexicon and machine learning models are proven to be the best methodology for social media sentiment analysis in previous researches. There are many popular machine learning models suitable for sentiment analysis and their performance varies according to the set of features fed for training. This research aims to review and compare few existing feature selection methods and machine learning models for Twitter sentiment analysis. As the data set for this study 3,378 tweets were collected from Twitter Standard Application Program Interface using the name of a popular mobile phone brand as the search keyword. The initial data set was reduced to 1,709 tweets after the preprocessing step. Then, SentiwordNet lexicon was used to classify tweets as positive, negative and neutral. Features were selected using Recursive feature elimination, Chi-square, Mutual information and F-classification and fed to machine learning models; Multinomial Naïve Bayes, Logistic Regression, K Nearest Neighbors, Decision tree and Random forest. The experiment was repeated 20 times with bootstrap samples to generalize the results. Each sample used for training consisted of 80% of the total tweets and test data set was created using the out of sample tweets. Final results were calculated by averaging the results from all bootstrap samples. The results show that Chi-square, Mutual Information and F-classification methods are accurate and Root Mean Squared Error (RMSE) scores are only slightly different from each other for each machine learning model. Recursive feature elimination shows lower accuracy and higher RMSE score than other methods. Logistic Regression and Multinomial Naïve Bayes have generated the highest accuracies (72.35% and 71.95%) and lowest RMSE scores (0.69 and 0.71). K Nearest Neighbors was the model that generated the lowest accuracy (35.39%) and highest RMSE score (0.85). In conclusion, this study suggests Chi-Square, Mutual Information and F-classification methods are better feature selection techniques than Recursive Feature Elimination for Twitter Sentiment Analysis. Multinomial Naïve Bayes and Logistic Regression were shown to be better classifiers and K Nearest Neighbors was shown to be least suitable classifier for Twitter Sentiment Analysis.

Keywords: Feature selection, Hybrid approach, Machine learning models, Twitter sentiment analysis

Abstract No: 198 ***ICT, Mathematics and Statistics***

A SHARING ECONOMY BUSINESS MODEL FOR SRI LANKAN ACCOMMODATION INDUSTRY

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Sharing Economy is an economic system used to facilitate the communication between the supply and demand sides without conveying suppliers' ownership of under-utilized assets for free or for a fee. Tourism industry, the third largest in the Sri Lankan economy, has embraced the sharing economy concept, especially related to the accommodation industry. While the Sri Lankan rural population accounts for more than four times the urban population, potential benefits associated with accommodation business are yet to be reaped by these communities, whereas the industry can be successfully transformed to deliver significant benefits through proper ICT integration. Therefore, this study aims to propose a business model and a set of guidelines and recommendations for policy adoption, for implementing sharing-based accommodation business by Sri Lankan rural communities. Inspired by the well-known Business Canvas Model and the major types of sharing economy-specific business models, *e.g.*, access-based, marketplace/platform economy, and on-demand service provider, the study attempts to propose a business model focusing on the rural accommodation sector. The study is complemented by a questionnaire survey carried out centering Dickwella town in the Matara District which is having a huge foreign tourist base. Stakeholder groups, including hosts, tourists and relevant government institutions were employed in the survey. Limited ICT literacy, accessibility issues and lack of expertise in digital marketing communications were among the major barriers that hinder the wider adoption of ICT and digital marketing communications. Models adopted by successful digital platforms, including Airbnb, Booking.com, and Tripadvisor, were also reviewed during the study. Moreover, the study has generated a set of SWOT factors making the competitive environmental analysis easier for any potential business. The outcomes of the study would help to implement sustainable accommodation sharing businesses in rural areas in Sri Lanka, and thereby contribute immensely towards national economic development.

Keywords: Accommodation Sector, Business Model, Sharing Economy, Sri Lanka, Tourism Industry

Abstract No: 200 ***ICT, Mathematics and Statistics***

GENERALIZED HADAMARD MATRICES AND 2-FACTORIZATION OF COMPLETE GRAPHS

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Graph factorization plays a major role in graph theory and it shares common ideas in important problems such as edge coloring and Hamiltonian cycles. A factor F of a graph G is a spanning subgraph of G which is not totally disconnected. An n- factor is an n- regular spanning subgraph of G and G is n-factorable if there are edge-disjoint n-factors $F_1, F_2, \dots, F_k$ such that $G = F_1 \cup F_2 \cup \dots \cup F_k$. We shall refer $\{F_1, F_2, \dots, F_k\}$ as an *n-factorization* of a graph G. In this research we consider 2-factorization of complete graph. A graph with n vertices is called a complete graph if every pair of distinct vertices is joined by an edge and it is denoted by K_n. We look into the possibility of factorizing K_n with added limitations coming in relation to the rows of generalized Hadamard matrix over a cyclic group. Over a cyclic group C_p of prime order p, a square matrix $H(p, v)$ of order v all of whose elements are the p^{th} root of unity is called a generalized Hadamard matrix if $HH^* = vI_v$, where H^* is the conjugate transpose of matrix H and I_v is the identity matrix of order v. In the present work, generalized Hadamard matrices $GH(3, 3^m)$ over a cyclic group C_3 have been considered. We prove that the factorization is possible for K_{3^m} in the case of the limitation 1, namely, if an edge $\{i, j\}$ belongs to the factor F_k, then i^{th} and j^{th} entries of the corresponding generalized Hadamard matrix should be different in the k^{th} row. In Particular, $\frac{(n-1)}{2}$ number of rows in the generalized Hadamard matrices is used to form 2-factorization of complete graphs. We discuss some illustrative examples that might be used for studying the factorization of complete graphs.

Keywords: Factor, Factorization, Generalized Hadamard matrices, Kronecker product

Abstract No: 205 ***ICT, Mathematics and Statistics***

AN AFFECTIVE ENGINEERING APPROACH FOR ENHANCED USER INTERFACE DESIGNING: A CASE STUDY OF WEBSITES OF SRI LANKAN HIGHER EDUCATIONAL INSTITUTES

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Organizations always seek ways to attract and retain customers by providing the best user experience. In this regard, enhanced user interface (UI) designing of web sites is crucial. Apart from improved usability, emotional arousal and aesthetic appeal of UIs must be well considered during designing. Kansei Engineering (KE) is an affective engineering approach which aims to transform consumer affect into design elements. Recent review of literature reveals that KE is frequently explored for tangible products while its potential in UI designing remains to be explored. Further, the existing studies heavily focus on e-commerce web sites while institutional websites require further attention. Therefore, the aim of the study is to introduce KE for UI designing of institutional websites, specifically of Sri Lankan higher educational institutions. Employing ten specimen websites, a questionnaire survey was carried out as the subjects being Sri Lankan undergraduates. For each specimen, the product property space was documented including colour, layout, lines/shapes and typography. As the semantic space, a Kansei word database was developed referring to related research articles, magazines and similar evaluation metrics. Survey questionnaire comprised 12 bipolar adjective pairs each on a five-point semantic differential scale, derived from the above database. Moreover, the preference for each specimen was obtained on a five-point scale, and no intermediate labels were used. For statistical analysis, Principal Component Analysis was employed through the findings of which the design guidelines were to be established. The study is limited by the inclusion of a homogeneous study population whereas age, culture, and occupation-based differences are important to be explored. Design elements which require in-depth analyses are also to be identified through this preliminary study. It is believed that the study would contribute in bringing out a KE-based design model which helps revamp the Sri Lankan higher educational websites.

Keywords: Affective engineering, Higher educational institutions, Kansei engineering, Semantic space, User interface designing

DEEP LEARNING APPROACH FOR ELEPHANT INTRUSION DETECTION SYSTEM FOR REDUCING HUMAN ELEPHANT CONFLICT

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Due to the growth of the population, humans are extending to forest border areas and fulfill their needs. It has become a huge problem for wild animals. Human-Elephant Conflict (HEC) has been a major issue in forest border areas and properties, and human lives are destroyed by elephants. This makes HEC a major real-time environment-based research problem. Hence, large scale monitoring is required for real-time detection and warning of elephant intrusion into human habitats. The major aim of this research study is to identify elephant intrusion with a trained model of better accuracy. Deep learning has proved an effective way for elephant detection in recent days. Therefore, the study uses a methodology based on Convolutional Neural Networks (CNN). The method, that is robust to the diverse noise sources present in the field, is proposed for automated detection of elephant vocalizations. This method was evaluated on a dataset recorded under natural field conditions to simulate a real-world scenario. It is believed that the proposed method is able to detect elephants more accurately than existing methods. The dataset includes 15,000 images of elephants with various postures and 30,000 non-elephant images, respectively. The trained CNN-based model achieved the highest accuracy of 90%. Furthermore, this study can be useful for scientists in bioacoustics to investigate wildlife recordings. Findings of this research further prove that the use of the deep learning concept to easily categorize images with increased accuracy of the Elephant Intrusion Detection System.

Keywords: Convolutional neural networks, Forest border area, Human-elephant conflict

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STUDY OF SOLAR RADIATION VARIATION IN SRI LANKA

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Solar radiation is the electromagnetic radiation emitted by the Sun which can be captured and turned into useful forms of energy, such as heat and electricity. It has been increasingly valued due to its application for useful purposes. However, clinical studies have shown that there are negative effects of solar radiation on the human skin. Therefore, the knowledge of the variation of solar radiation in Sri Lanka is crucial for industries as well as policymakers. The study aims to identify the type and behaviour of surface net solar radiation (SSR) and other relevant factors such as convective precipitation (CP), instantaneous moisture flux (IE), surface pressure (SP), sea surface temperature (SST), sunshine duration (SD), 10 m U wind component (U10) and 10 m V wind component (V10). Daily data on above parameters for 39 years were obtained from the European Centre for Medium-Range Weather Forecasts website. The geographical area (4.50^o to 10.50^o latitude and 78.00^o to 83.25^o longitude) which covers Sri Lanka was considered in the study. The behaviour of each variable, when moving across the land area, was studied and it is found that the median values and variations of SST, CP, SP, and IE are comparatively very low in the central region of the country than in the coastal area. The median values of SSR are higher in the East than in the West of the country. Median values and variation of SD are significantly higher in the East than in the West. The area was divided into 72 small grids and a regression model was fitted for each grid. All models were significant at 5% level with an adjusted-R2 greater than 85%. The relative importance of independent variables on SSR for each grid area was obtained. The SD was the highest contributing factor to solar radiation in the region while CP had the least relative importance on the West coast and the central region of the country. The wind components have the least relative importance in the southwest area while the SP have higher relative importance in the northwest region. Moreover, the highest relative importance of the IE on SSR was found in the land area. Overall, the analysis revealed that there is a variability of the relative importance of the independent variables studied on solar radiation in the region. Furthermore, multiple time series analysis was conducted to predict the SSR of 6 grids representing different locations in the country. Augment Dicky Fuller Test revealed that all variables were stationary at 5% level of significance. As the Johansen cointegration test indicated the existence of eight cointegration relationships, the Vector Error Correction model was fitted. The adequacy of each model was evaluated using cross-validation. Findings revealed that the forecasted SSR values are decreasing gradually along with its variability.

Keywords: Regression, Relative importance, Solar radiation, Vector Error Correction Model

IMPACT OF INFORMATION SYSTEMS STRATEGY IN ACHIEVING BUSINESS SUCCESS: A CASE STUDY IN SRI LANKA

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Information systems (ISs) play a vital role in business organizations all over the world. With the recent experiences presented by COVID-19 pandemic to many of the nations including Sri Lanka, the demand for ISs has increased more than ever before. However, to reap the countless benefits of employing ISs, an organization's IS strategy should be well aligned with its business strategy and the organizational strategy. Strategic planning and management of ISs involve the IS decisions relating architecture and other resource considerations on key IS components, namely hardware, software, networking and data. However, our recent review of literature revealed that the awareness of business organizations on strategic planning and management of ISs as well as its impact on achieving business success require further research. This study aims to investigate the impact of IS strategy on business success, taking into account the Sri Lankan context. The study is supplemented by a systematic review of literature on the existing frameworks on the strategic management of ISs. Further, the study focuses on identification of limitations and barriers in strategic planning and management of ISs in Sri Lankan business organizations. In assessing the awareness and impact of IS strategy on business success, a questionnaire survey was conducted employing study samples representing tourism, apparel and textile, and retail and consumer industries in Sri Lanka. The questionnaire was designed to evaluate the business success based on the four major perspectives in the balanced scorecard, namely, financial, learning and growth, customers, and internal business processes. Through correlation analysis, significant relationships between various IS strategy components and the above performance perspectives are to be discovered. Further, the study would contribute to the existing knowledge base by presenting a generic framework for strategic planning and management of ISs within business organizations.

Keywords: Business and IS alignment, Business strategy, Information systems strategy, Organizational strategy, Strategic planning and management

Abstract No: 227 ***ICT, Mathematics and Statistics***

ITERATIVE METHODS FOR SOLVING NONLINEAR EQUATIONS

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In this work, four new iterative methods were developed to solve a nonlinear equation of one variable. The initial two-step iterative method based on Cubic Spline functions has been derived, and it has been improved to a four-step iterative method using the predictor-corrector method. The Newton Raphson method is combined with second-order Taylor expansion of the nonlinear function is used as the predictor, and the initial iterative scheme using Cubic Spline functions is used as the corrector. The order of convergence of two iterative schemes is analyzed, and it has been proved that the two-step iterative method has a third-order convergence, and the four-step iterative method has a twelfth order convergence. The methods have been tested for various highly nonlinear equations, and the results have been compared with the well-known Newton Raphson method. The third and fourth four-step iterative schemes are derived based on decomposition techniques. Two iterative methods have tenth and nineteenth order of convergence, respectively, which both are higher than the order of convergence of the Newton Raphson method. The iterative methods are implemented by using MATLAB for some highly nonlinear problems with the accuracy of 10^{-15}. The number of iterations to converge to the approximate solutions with the same initial conditions have been compared. It has been proved that all proposed iterative methods are applicable for the nonlinear equation that occurs in the theory of single-slit diffraction, which fails to converge when the Newton Raphson method is used. According to the results, all proposed iterative schemes are better than the Newton Raphson method in terms of efficiency and the order of convergence.

Keywords: Convergence analysis, Decomposition techniques, Iterative methods, Nonlinear equations, Spline functions

Abstract No: 232 ***ICT, Mathematics and Statistics***

AN ALTERNATIVE APPROACH FOR GOLD GRABBING GAME

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Initial idea of the Gold Grabbing Game introduced by Moshe Rosenfeld in 2009 is defined as follows: A fixed tree T has some non-negative integer amount of gold g(v) at each vertex v. The game can be played with any number of players by taking turns removing leaves one by one from the tree and collecting the gold from those leaves and deleting the relevant vertex v. After removing the leaves, graph T remains as a tree. When the tree is empty, the game should end, and the player who has collected the most amount of gold is the winner. The problem is to find the winning probability of each player. A software was developed to simulate the gold grabbing game and to find the winning probabilities of each player. Furthermore, we conjecture that, when the greedy method is used to choose the vertices by players, the first player can get at least half of the gold of any tree with an even number of vertices in a two-player game. That is, the winning probability of the first player is higher (at least 50%) than the winning probability of the second player. Moreover, when there are three players, the winning probability of the first player is higher than the winning probabilities of the other two players. It seems that the winning probabilities of second and third players are nearly equal. There is the need to implement the software for higher number of players and to reduce the computational time to calculate the winning probabilities.

Keywords: Connected Graphs, Gold Grabbing Game, Tree, Two-player game

REDUCED ORDER MODELLING FOR RADIATION DETECTION

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Radiation detection plays an important role in many fields, such as nuclear physics, radiation transport and medical radiation physics. There are several types of instruments, such as radiation portal monitors (RPM), currently available to detect and identify radioactive materials. RPMs are currently used at ports for screening vehicles. These instruments analyse the gamma-ray spectrum and/or the neutron flux emitted by passing vehicles to detect radioactive materials. One of the biggest challenges with these monitors and/or methods is managing false alarm rates. In this work, a reduced order model is developed in such a way that the location of radioactive sources to be identified from the noisy sparse sensor data. Reduced order models are computationally inexpensive numerical techniques, which can be used to simulate stochastic problems rapidly. The fundamental idea of this work is to develop a ROM that estimates an entire radiation spatial field (including the source location and the emission spectrum) given the measurements from a few sensors. The ROM approach consists of an 'offline' and 'online' procedure. In the 'offline' step, detailed Monte Carlo (MC) simulations are performed to generate a radiation field. The "online step" is used to localize and detect energy spectra of radiation sources given sparse trial data, obtained from a Monte Carlo simulation at a few sensors. Bayesian parameter estimation with a Gaussian prior is used to estimate the latent variables associated with noisy sparse data. Thereafter, a noise-free estimate for the measured data is obtained and radiation sources are identified. The results are validated using a terrestrial radiation detection scenario. The approach developed in this research is shown to be a promising method for radiation detection problems.

Keywords: Bayesian parameter estimation, Monte Carlo simulation, Noisy sparse data, Radiation source detection, Reduced order model

Abstract No: 237 ***ICT, Mathematics and Statistics***

MATHEMATICAL ANALYSIS OF A DISEASED PREY- PREDATOR SYSTEM WITH HARVESTING OF PREY

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Susceptible prey modelling is important to understand the transmission of infectious diseases, such as COVID-19, SARS, ebola, and dengue, among populations of organisms. Studying the dynamics and the behaviour of the ecological interactions among the species of susceptible prey-predator system assists in decision-making by making projections regarding important issues such as intervention induced changes in the spread of disease. In this study, a continuous-time prey-predator system with susceptible prey, infected prey, and predator populations is considered assuming that the predator is not acquiring infections. An existing mathematical model has been modified in order to study the dynamics of a diseased prey-predator system with the harvesting of the prey. The existence and uniqueness of the solutions to the modified model have been proved. Locally, asymptotic stability of the vanishing equilibrium point, disease and predator-free equilibrium point, predator-free equilibrium point, and the co-existent equilibrium point is proved under some conditions. Those conditions are $c > 1$ for vanishing equilibrium point, $c < 1$ and $ak(1-c) < e$ for disease and predator-free equilibrium point, $f\hat{y} < d$ and $k(1-c) < (2\hat{x} + ak\hat{y})$ for predator-free equilibrium point, and $k(1-c) < (2x^* + aky^*)$ and $ax^* < (bz^* + e)$ for co-existent equilibrium point. Here a, b, c, d, e, f, and k are constants and x,y and z are variables in the system. Moreover, it is shown that the prey and predator populations can survive in the ecological system even if the disease still exists in the populations.

Keywords: Ecological system, Equilibrium, Prey-Predator, Susceptible Prey Modelling, Stability

Abstract No: 242 ***ICT, Mathematics and Statistics***

COMPARISON BETWEEN *r-k* AND *r-d* CLASS ESTIMATORS IN THE PRESENCE OF AUTOCORRELATED ERRORS IN LINEAR REGRESSION MODEL

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Multicollinearity and autocorrelated errors have adverse effects on the properties of the least-squares estimator in linear regression. Several bias estimators were suggested by the researchers to reduce the effect of multicollinearity in place of the best linear unbiased estimator and Ordinary Least Square (OLS) Estimator. The intension of this study was to compare the performance of such two bias estimators, *r-d* class and *r-k* class estimators, using a Monte-Carlo simulation, when the problem of multicollinearity and autocorrelated errors occur simultaneously. Four different values for the autocorrelation parameter ρ (0.1, 0.3, 0.7 and 0.9), and eight different levels for noise parameter σ (0.01, 0.1, 0.25, 0.5, 1, 4, 9 and 20), were selected. Nine different values (0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8 and 0.9) were selected for the bias parameters of the two estimators (k/d) with the sample size of 30. Results show that the *r-k* class estimator performs better than the *r-d* class estimator in the sense of Mean Square Error (MSE) when ρ, σ and k/d are not substantial. Considering the effect of ρ, it was the same for the two estimators considered when the error variance $\sigma \geq 0.5$. On the other hand, the $r-d$ class estimator is superior to *r-k* class estimator when $k/d \leq 0.4$, and the $r-k$ class estimator is superior to the other estimator when $k/d > 0.4$ for large values of σ and ρ. Simulation results indicate that no estimator is always superior to the other estimator when the multicollinearity and autocorrelation occur simultaneously.

Keywords: Autocorrelation, Mean Square Error, Multicollinearity, *r-d* class estimator, *r-k* class estimator

RESTORATION UNIQUE FACTORIZATION USING ROOTS OF QUARTIC POLYNOMIALS

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Unique Factorization Domains (UFD) are important mathematical structures that arise in all areas of abstract algebra. An integral domain is called a Unique Factorization Domain if every non-zero non-unit element can be written as a product of irreducible elements uniquely up to order and multiplication by units. In this research, the concepts of loss and restoration of the Unique Factorization property were explored. For example, $\mathbb{Z}$ is a unique factorization domain, however, if the element $\sqrt{-3}$ is used in extending the ring to$\mathbb{Z}[\sqrt{-3}]$, the Unique Factorization property is lost. Unique Factorization can be restored by extending $\mathbb{Z}[\sqrt{-3}]$ by $\left[\frac{1+\sqrt{-3}}{2}\right]$. Restoring Unique Factorization is subject to extensive research as a general method of doing restoration is yet to be found. In this project, it is looked in to restoring Unique Factorization by extending the integral domain using a radical, which is a root of a polynomial of a certain degree, called the degree of Unique Factorization Restoration Extension (UFRE). Literature reports indicate that all UFREs of degree 2 have been classified for an extension by a radical of the form $\sqrt{-a} : a > 0$. In this research, it is explicitly shown that the loss of unique factorization of $\mathbb{Z}[\sqrt{-5}]$ cannot be restored by a UFRE of degree 2; but using an argument based on Minkowski's estimate, a UFRE of degree 4 can be found.

Keywords: Minkowski's estimate, Restoration of unique factorization.

Abstract No: 254 ***ICT, Mathematics and Statistics***

STATISTICAL APPROACH FOR MULTI-CLASS WEATHER CLASSIFICATION

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Weather is an unexplainable state of the atmosphere around our environment. Therefore, processing information related to weather conditions at a given time and space is necessary for scene awareness, which helps to organize and take actions on human behaviour. Though several studies have been conducted using deep learning and computer vision to detect the multi-class of weather and visual conditions, a limited number of studies have considered the use of statistical features of such weather images. In this study, multi-class statistical classification techniques that use statistical features of an image were introduced to detect the given weather condition. A set of statistical features of an image, such as skewness and kurtosis along with the standard statistical features like mean and standard deviation, was used on 1,115 JPEG compressed (RGB) and uncompressed (YUV) domain from four different weather scenes (cloudy, rain, shine and sunrise). Several classification techniques, namely, Support Vector Machine (SVM), Random Forest and Gradient Boosting method, were used to train a model based on 70% of the image database, and the remaining 30% was used to evaluate the model accuracy. Among these models, the linear SVM and the SVM based on radial basis functions showed the highest classification accuracy of 90%, while that of the random forest model was 89%. All models showed a higher F1-score and the false positive rate was less than 4%. The findings of the study can be used but not limited to drive-assistance systems, climate-related research, or to understand weather conditions through images.

Keywords: Gradient boosting, Random forest models, Support vector machines, Weather classification

Abstract No: 268 ***ICT, Mathematics and Statistics***

QUASI-COMPACT FOURTH ORDER APPROXIMATIONS FOR FRACTIONAL DERIVATIVES AND APPLICATIONS

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Fractional derivatives (FDs) have recently been used in numerous applications in many branches of science and engineering, including fractal phenomena, anomalous diffusion, viscoelasticity and biological population models. Different types of definitions for FDs have been presented in the literature, of which Riemann-Liouville (R-L) FDs are used in fractional diffusion equations (FDEs). FDs, including R-L FDs, are non-local operators, meaning that an FD at a point involves discrete function values spread throughout the domain. Thus, numerical computation of FDs has become an involved task. Grünwald approximation (GA) derived from Grunwald-Letnikov FDs, equivalent to R-L FDs, is a common approximation for R-L FDs. However, the GA is known to have two main limitations: 1) It is of the first order accuracy and when applied to space-FDEs without shift displays unstable numerical solutions for implicit Euler and Crank-Nicolson(C-N) methods; 2) The shifted form of GA with shift $r = 1$ recovers the stability in these methods but retains the first order accuracy. Therefore, higher order approximations for R-L FDs are of great importance. Recently, extending the notion of GA, a second order Grünwald type approximation with non-zero shift (GA_2), theoretically established as reliable for stability and consistency, was developed for R-L FDs. Then, a third order approximation was constructed using the GA_2. In this study, a quasi-compact operator involving a convex combination of two shifted operators with integer shifts p and q of the GA_2 is defined. Then, for the shift parameters $(p, q) = (1, 0)$ and $(1, -1)$, two fourth order quasi-compact approximations are obtained for R-L FDs. Both the approximations were applied in C-N schemes to solve the one-dimensional space FDE. Numerical results obtained for the preceding schemes confirm the order of accuracy and the convergence of each scheme. However, stability and convergence of the schemes are not theoretically analysed and left for future work.

Keywords: Crank-Nicolson scheme, Fractional derivatives, Fractional diffusion equations Generating functions, Grünwald approximation

FORECASTING STOCK PRICE INDEX IN SRI LANKA: A COMPARATIVE STUDY OF UNIVARIATE TIME SERIES MODELS

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Construction of financial frameworks comprised of micro and macro-economic correlation factors are known to be a challenging task for researchers, and the importance of anticipating such financial changes in a country has driven the recent technologies to pursue better models, algorithms, and innovations. This study attempts to compare and contrast different statistical and soft computing methods by exploiting the volatility of All Share Price Index: Colombo Stock Exchanges' overall market movement index, by modelling and capturing the monthly closing market movement throughout the period from January 2000 to September 2019. The analysis is conducted with the application of Auto-Regressive Integrated Moving Average (ARIMA), Generalized Auto Regressive Conditional Heteroskedasticity (ARCH/GARCH), Stochastic Volatility (SV), Neural Network – Auto-Regressive (NNAR) models and Long Short-Term Memory (LSTM) models primarily focusing on the volatility of the stock market. Each utilized model is carefully crafted. Therefore, the selected models are best suited for the dataset according to a myriad of statistical tests. The concluded models were thereafter evaluated based on their predictive ability for the period from September to December, 2019 using Root Mean Square Error (RMSE), Mean Absolute Error (MAE), and Mean Absolute Percentage Error (MAPE) criteria. The results revealed the Neural Network methods utilized; NNAR and LSTM yielded better, consistent results and surpassed other models' performance by a higher degree. Yet the SV and ARCH/GARCH models managed to capture the volatility, whereas the conventional ARIMA models failed to do so. Coherent with the previous revelations, skewed and tailed conditional distributions served well for ARCH/GARCH modelling and depicted improved results. This study stands as evidence to stress with confidence that aged statistical tests perform poorly in the face of high volatilities, whereas SV models with high Markov Chain Monte Carlo (MCMC) iterations and soft computing methods yield exceptional results.

Keywords: Artificial Neural Network, Colombo Stock Exchange, Generalized Auto Regressive Conditional Heteroskedasticity, Long Short-Term Memory, Volatility

Abstract No: 279 ***ICT, Mathematics and Statistics***

THE (G'/G)-EXPANSION METHOD TO THE GENERALISED DERIVATIVE NON-LINEAR SCHRODINGER'S EQUATION

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(G'/G)-expansion method is a straightforward and reliable mathematical tool for constructing traveling wave solutions of non-linear evolutionary equations that occur in engineering and mathematical physics. The derivative non-linear Schrodinger's equation (DNLS) equation is a canonical dispersive equation that can be obtained in a long-wave. It is shown that a physical system described by a DNLS equation without a dissipative term may support the propagation of shockwaves. In this work, exact traveling wave solutions to the generalised DNLS equation were obtained using the (G'/G)-expansion method. The travelling wave solutions were expressed by the hyperbolic functions, the trigonometric functions and the rational functions. For some specific choice of parameters, the solitary wave solutions were also derived from the traveling waves solution. Further, the solution obtained was compared with the solution derived by other existing method.

Keywords: (G'/G)-expansion method, Generalised derivative non-linear Schrodinger's equation, Travelling wave solutions

Abstract No: 280 ***ICT, Mathematics and Statistics***

EFFECTIVE DECISION MAKING IN FRESHWATER PRAWN EXPORT INDUSTRY IN SRI LANKA

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During the last decade, Sri Lanka has taken many steps to improve the quality and quantity of export merchandise. Among many exports, edible fish is a rapidly growing industry as well as a major contributor to the national economy of Sri Lanka. In this study, we specifically focus on the edible prawns exporting industry with the hope of developing a Logistic Regression model to predict the likelihood of exporting a given prawn batch based on several human and naturally controlled matters. Currently, the exporting decision made by the exporters is based on their personal experience, and statistical techniques are hardly in use. The model developed in this study will help both farmers and prawn exporters to predict the exporting likelihood based on the available data, and thus save a significant amount of money and time. The study reveals that the dissolved oxygen level, water pH, ammonia, nitrate, alkalinity, saltinity and small prawn density per hectare of a prawn farm play a vital role in achieving export quality prawn harvest. Based on the *P*-value, water temperature is not a significant factor for the export decision, and the fitted logistic model predicts response with 87% accuracy. The same accuracy can be achieved under Support Vector Machine and Random Forest techniques. Moreover, the model was extended with the Bayesian approach and the parameters were updated accordingly. Only for alkalinity and small prawn density, converged parameter values were very close to zero. Actual data collected from the field in the future would be revised to improve the predictability of the model. All the statistical analyses in the study were carried out using RStudio and WinBugs.

Keywords: Bayesian approach, Edible prawns, Logistic regression, RStudio, WinBugs

Abstract No: 286 ***ICT, Mathematics and Statistics***

AN AGENT-BASED MODEL TO CAPTURE THE DYNAMICS OF FISH POPULATION IN THE KAUDULLA RESERVOIR, SRI LANKA

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Agent-based modelling is a new approach to modelling systems with interacting, autonomous agents. NetLogo is a powerful agent-based modelling platform that can be used to observe the dynamics of populations. In this study, an agent-based model (ABM) was developed to capture the dynamics of the fish population in the Kaudulla Reservoir, Sri Lanka, and the sustainability of the fish population with fishing was studied. This reservoir has two zones; Open access fishery zone and a smaller region where fish is grown. To maintain the sustainability of the reservoir, fries (5-6 days old fish) were grown in the fish growing area, and after 30 days, fingerlings were released to the reservoir. Fishing is permitted only in the fishery zone and the fish growing area is of negligible size. As the government is unable to fund the required number of fingerlings to the reservoir at one time, the fishery management system adds fingerlings to the reservoir about three times a year. In this study, a restricted fishing area was introduced, and three zones were considered, namely; a fishing zone, a reserved zone where fishing is strictly prohibited, and a fish growing area where small fish is grown to release into the reservoir. The control setup of the common practice of the reservoir was built to compare the dynamics of the fish population with the restricted fishing area. The results indicate that the fish population reaches the carrying capacity and extinct faster when fingerlings are not released to the reservoir. Also, if the fingerlings are released to the reservoir (real-world situation), or a restricted fishing area is introduced without releasing fingerlings, the fish population sustains longer. Further, releasing fingerlings to the reservoir with a restricted area leads the fish population to survive for a longer period than the above three cases. Since, even with these controls, the fish population can go extinct, the management would have to release fingerlings to the reservoir more than once in a year. The optimal time intervals would be found to add fish populations to maintain a sustainable fish population over the years.

Keywords: Agent-based modelling, Carrying capacity, Fishing reservoir, NetLogo, Sustainability

Abstract No: 296 ***ICT, Mathematics and Statistics***

ENCRYPTION ALGORITHMS USING GRAPH THEORY IN SYMMETRIC CRYPTOGRAPHY FOR PROVIDING BETTER DATA SECURITY

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Web and network technologies are growing rapidly; hence, the most common challenge is to protect the information exchanged over the web or other types of media. Cryptography is one of the focused areas of cyber security which converts information from its natural form to an incomprehensible form. Symmetric and asymmetric cryptography are the two main branches of cryptography. Since the graphs can be represented by matrices, and can be converted into images, graph theory is widely applied in cryptographic algorithms. Throughout this research, an algorithm is proposed to build an important relationship between graph theory and symmetric cryptography, and to develop a code for the proposed algorithm, to store and transmit data in a particular form so that only for those whom it is intended can read and process it. In these proposed methodologies, the original texts are converted into graphs and then represented those as matrices. All proposed algorithms produce ciphertexts which are larger than the plaintext size. Also, these algorithms perform n^3number of operations if the plaintext is of size n. Time complexity is computed using Big-Oh notation. Further, some additional edges are added to the graphs generated by the third algorithm which it performs an equal number of operations as in the other two proposed algorithms. Therefore, when security is considered, the third proposed algorithm is more powerful than the other two. However, when storage is considered, the second proposed algorithm is better than the other two as it produces a single matrix as the ciphertext.

Keywords: Decryption, Encryption, Graph theory, Symmetric key cryptography

Abstract No: 297 (Oral) ***ICT, Mathematics and Statistics***

A STUDY OF DNA SIMILARITY ANALYSIS IN EVOLUTIONARY RELATIONSHIPS USING GRAPH THEORY

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Since DNA sequences are rapidly increasing in the DNA database, its similarity analysis is one of the major challenges for bio-scientists. During the evolutionary history, there are different kinds of species with a common ancestor, and DNA sequence rearrangements and DNA mutations occur over time. Therefore, it is very important to analyse similarities between DNA sequences. This research work focuses on one of the mathematical structures of DNA sequence to analyse similarities between DNA sequences of evolutionary close species. These species evolved from a common ancestor, and some features, such as conserved regions in DNA sequences, remain from generation to generation. In this study, the graph-based method for DNA similarity analysis was modified. The studied based method with weighted directed graph has an adjacency matrix and representative vector which is applicable for only the conserved regions and DNA variations in considered genomes. The study also checks whether the molecular similarity coefficients are applicable as distance measurements to calculate the similarity between vector representations of DNA sequences. Then the graph spectrum is used as the vector representation of DNA and compare the results of these two vector representations. As an application, the modified method is tested using the 0.9 kb-mitochondrial DNA of evolutionary closed three species: human, gorilla, and orang-utan, by considering different areas in their genomes. The results predict that human and gorilla are very similar in evolution history. The modified method gives the same result with that of based method when the number of nucleotides in the DNA fragments is increased.

Keywords: DNA, Evolutionary, Similarity, Spectrum, Weighted directed graph

Abstract No: 300 ***ICT, Mathematics and Statistics***

MATHEMATICAL MODELLING OF SPREAD OF COVID-19 IN SRI LANKA

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COVID-19 is caused by a new strain of coronavirus, Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2). In this study, a Susceptible-Infected-Recovered (SIR) model, that describes the dynamics of COVID-19 in Sri Lanka, was developed. For the model development, the human population (N) was divided into five compartments, as Susceptible (S), Asymptomatic infectious (I_A), Symptomatic infectious (I_S), Recovered (R) and Dead (D). The transmission rates of I_S and I_A were taken to be β_S and β_A respectively. Using the available parameter estimates in the literature, β_S and β_A were calculated from the recorded COVID-19 data for Italy, and Florida in USA in 2020. The data were collected starting from the day of the first recorded patient until the day of lockdown of Italy and Florida. Then, the transmission rates β_S and β_A were estimated using Python to best fit the available COVID-19 data in Italy and Florida. Next, the model was simulated for a possible epidemic in Sri Lanka using these estimated parameters. Secondly, the model developed was modified to check the dynamics of disease transmission when the symptomatic individuals are hospitalized and isolated and/or under lockdown. The second model developed was further modified to check the dynamics of disease transmission with random PCR tests to identify the asymptomatic individuals. According to the simulation results, without any control methods, the epidemic could reach the peak within 91 days with a total of 14,387,598 cases throughout the epidemic in Sri Lanka. Further, from the results, it is clear that the infected individuals decrease under the control methods, such as hospitalization, isolation, lockdown and PCR testing, and could prevent having an epidemic.

Keywords: Asymptomatic, COVID-19, PCR tests, SIR model, Symptomatic

Abstract No: 303 ***ICT, Mathematics and Statistics***

IMPACT OF GOVERNMENT FOREIGN DEBT ON GROSS DOMESTIC PRODUCT OF SRI LANKA

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Sri Lanka is often portrayed as a country that fell into debt traps as a result of public investment projects financed by foreign governments and agencies. The Government Foreign Debt (GFD) of any country will be increased when new external debt is borrowed. Particularly for Sri Lanka, foreign debt is also severely affected by the depreciation of the exchange rate of the Sri Lankan rupees against other foreign currencies. In this study, the relationship between the Gross Domestic Product (GDP) and the Government Foreign Debt of Sri Lanka has been investigated. Data from annual reports of the Central bank of Sri Lanka for the period from 1950 to 2017 have been used in the study. The results show that there are positive trends in both GFD and GDP variables even after converting them into logarithmic values. According to Augmented Dicky Fuller (ADF) test both variables have been stationary at first difference and variables are cointegrated based on the results of Johansen co-integrated test. Vector Error Correction Mechanism (VECM) was used since Johansen co-integration test has shown co-integration relationships. The co-integrated term became negative and significant as expected. The residuals of the resulted error correction model satisfy the tests for homoscedasticity and stationary. The residuals are also normally distributed. Around 52% of the variation of Gross domestic product (GDP) is explained by the model.

Keywords: Co-integrated relationships, Government Foreign Debt, Gross Domestic Product, Vector Error Correction Mechanism

Abstract No: 305 ***ICT, Mathematics and Statistics***

VOLUMETRIC FLOW RATE OF PARTICLE SUSPENSION FLOW OVER POROUS MEDIA

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Transport of particles in suspension over porous media occurs in many industrial and environmental processes such as filtering and sedimentation. For instance, sedimentation is used in industry for separation of dust particles from air streams, and filtering is used during the process of water treatment and food processing. In this study, the fundamental physics of suspension of particles is presented at various suspension concentrations over porous layers. Here, the flow of mono-disperse, non-colloidal suspensions over a porous medium has been quantitatively examined by developing an analytical framework to model the flow in a channel, where the lower surface is replaced by various porous media. The diffusive flux model is used to model the suspensions over the porous media. Darcy-Brinkman equation is used to solve the velocity and shear stress distribution of the porous media. The velocity profile, shear stress profile, and the concentration profiles in the channel were obtained for a steady-state, fully developed flow. The model has been validated by comparing the predictions of the flow at low suspension concentrations with the flow of pure Newtonian fluid over a porous layer. It is shown that the volumetric flow rate induced by the presence of the porous media depends on the values of the permeability parameter, the thickness ratio, and the concentration of the suspension in the flow.

Keywords: Darcy-Brinkman equations, Permeability, Porous media, Suspension, Volumetric flow rate

Abstract No: 306 ***ICT, Mathematics and Statistics***

A SELF SIMILARITY SOLUTION FOR A COUPLED CHANNEL FLOW

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Coupled free-flow and porous medium flow systems arise routinely in environmental settings and industrial applications such as overland flow interactions with groundwater aquifers, evaporation from soil influenced by wind, fluid-flow through filters, and water-gas management in fuel cells. Due to the wide range of applications, researchers have given considerable attention to study flow over porous media. This study aims to get physical insight to the applications of coupled flow at different values of permeability parameters. A channel is considered where the bottom of the channel is occupied by a porous media and the top of the channel is occupied by a free flow region. The flow between the channels is assumed to be steady-state, incompressible, and Newtonian. Thus, the flow in the free region is described by the fully developed Navier-Stokes equation at small Reynolds number. Darcy/Brinkman equation is used to obtain a meaningful insight into the physics of flow in porous media. Coupled boundary conditions are used to describe the interphase flow. The goal here is to find similarity solutions of the governing equations for the flow between the channel. Similarity solutions can be obtained by reducing, at least to one, the number of independent variables that describe a problem. The velocity and the shear stress distribution have been investigated for different values of permeability parameter and thickness ratio. Moreover, the similarity results are compared with the analytical solutions of the governing equations.

Keywords: Brinkman/Dracy Equation, Coupled Flow, Navier-Stokes Equations, Porous Media, Similarity solution.

Abstract No: 308 ***ICT, Mathematics and Statistics***

A NEW REDUCED SYSTEM OF MICHAELIS-MENTEN ENZYME REACTION MODEL

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Michaelis-Menten enzyme reaction model is a system consisting of four non-linear, simultaneous, ordinary, differential equations that model catalytic activities of reaction mechanisms of various enzymes. The four differential equations connect concentrations of substrate, enzyme, intermediate complex made by enzyme and substrate, and product with rates of changes of all former measures as a function of time. It has many applications in biology and biochemistry in understanding fundamental tasks in cells. Since it cannot be solved analytically, there are many numerical methods developed to solve such systems. Recently, Van Gorder et al. obtained a series approximation to the enzyme reaction model by transforming the non-linear coupled ordinary differential equations into one equation with the use of a transformation. Based on this work, the original Michaelis-Menten enzyme reaction model has been reduced into three new non-linear differential equations, each depending on only one dependent variable with respect to time. Finally, the spread of the concentrations was investigated numerically using Mathematica, and the results were illustrated graphically. Since the newly derived system has individual equations for concentrations of enzyme, intermediate complex made by enzyme and substrate, and the product distinctly, it is beneficial in studying each measure as a function of time separately.

Keywords: Autonomous differential equations, Michaelis-Menten enzyme reaction model, Non-linear differential equations

Abstract No: 309 ***ICT, Mathematics and Statistics***

WEATHER FORECASTING USING DYNAMIC MODE DECOMPOSITION

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Weather forecasting is one of the most scientifically and technologically challenging problems around the world. Historical weather data is rich with important information, which can be used for weather prediction. In this paper, a method based on dynamic mode decomposition (DMD) was used for weather forecasting. DMD is a data-driven, matrix decomposition technique, which is developed using a linear Koopman operator concept. It is basically a modal decomposition algorithm that gives insight into the underlying dynamics of the system. The DMD algorithm can extract both spatial and temporal patterns of the weather data where existing methods are restricted to either of the patterns. This paper utilizes the capability of DMD to forecast the future response by learning the available historical weather data. The technique is illustrated considering daily temperature at seven sensor stations in Sri Lanka. The temperature values at sensor locations are reproduced using dynamic modes at dominant eigenvalues of the observation matrix. Root mean square error is calculated to measure the accuracy of the results. It was shown in this study that the error of the reproduced data at Kurunegala sensor station for 10 consecutive days is only 6%. Further, the DMD approach is a good candidate for weather forecasting and to find out natural disasters in advance.

Keywords: Dynamic mode decomposition, Koopman operator theory, Non-linear dynamical system, Numerical analysis, Weather forecasting

Abstract No: 312 ***ICT, Mathematics and Statistics***

EFFECTIVE MACHINE LEARNING ALGORITHMS FOR ANOMALY INTRUSION DETECTION SYSTEM

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Cyber security is an important and highly considerable area in the technology due to increment of various kinds of security attacks. Network intrusion detection system is a software tool which monitors malicious activities of the network traffic combining with hardware components of the network. Mainly, there are two types of network intrusion detection approaches which are signature-based detection and anomaly-based detection. The signature-based detection method attempts to detect attack patterns, while the anomaly-based detection method classifies network traffic into "attack" or "normal" using techniques like machine learning. This study is designed to compare five discrete machine learning algorithms for the anomaly-based detection, and further to identify the most effective algorithm. The dataset NSL-KDD which contains 125,973 records for training and 22,544 records for testing was used for the study. Initially, pre-processing was carried out for the training and testing data and during the pre-processing, data were encoded first, in order to convert categorical variables to numerical values. Then features were reduced up to 27, using Principal Component Analysis (PCA) dimensionality reduction technique. Finally, they were normalized in order to change feature values to specific range. After the pre-processing step, 10-Fold cross validation was carried out on the training data. The mean values of 10-Folds cross validation for Decision Tree, Random Forest, K-Nearest Neighbours, Logistic Regression and Support Vector Machine are 99.70%, 99.84%, 99.67%, 96.81% and 99.47%, respectively. Among these results, Random Forest algorithm was observed with the best score. Therefore, hyperparameters were tuned of this algorithm and fit the model. Thereafter, it obtained the best score as 99.84%. Finally, it was validated with the test data and scored 99.99% against test data. Logistic Regression provides the lowest performance and Random Forest provides the highest performance while other three algorithms also provide satisfactory performances.

Keywords: Anomaly based detection, Classification, Cyber security, Network intrusion detection, Random forest

Abstract No: 3 ***Life Sciences***

EFFECT OF EXCESSIVE CONCENTRATION OF ANTICOAGULANT DIPOTASSIUM ETHYLENE DIAMINE TETRAACETIC ACID ON COMPLETE BLOOD COUNT

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The Complete Blood Count (CBC) is a laboratory test routinely carried out as one of the first steps in diagnosis. Proper specimen collection is the first step in ensuring accurate and reliable results from a clinical laboratory. Incorrect procedures in mixing blood with the anticoagulant EDTA result in incorrect blood: anticoagulant ratio. This study analyzed the effect of excessive amount of dipotassiumethylenediaminetetraacetic acid (K_2EDTA) anticoagulant on CBC. This was a descriptive cross-sectional study, using 100 healthy volunteers. A total volume of 4 mL of blood was drawn from each subject. Different volumes of blood, *i.e.* 2.0 mL, 1.0 mL and 0.5 mL, were dispensed into separate blood collection tubes containing 3 mg of K_2EDTA in each tube. Tube containing 2 mL of blood in 3 mg anticoagulant was considered as standard. Then CBC test was carried out for 300 blood samples using Haematology Analyzer within 4 hours. Statistical analysis was conducted using Statistical Package for the Social Sciences (SPSS). The tested CBC parameters of the tubes containing 0.5 mL and 1.0 mL blood volumes showed significant difference ($p < 0.05$) compared to the CBC parameters of the standard blood sample. Some parameters were significantly increased and some were significantly decreased compared to the standard sample. Decreased parameters were Total White Blood Cell (WBC), percentage of Eosinophil, Monocyte, Haemoglobin concentration, Total Red Blood Cell (RBC), Haematocrit (HCT), Mean Corpuscular Haemoglobin (MCH), Mean Corpuscular Haemoglobin Concentration (MCHC), Platelet, and Plateletcrit (PCT) while the increased parameter was Mean Corpuscular Volume (MCV). However, percentage of Lymphocytes, Neutrophils, Basophils, Red Cell Disrtibution Width-Coefficient Variation (RDW-CV), Red Cell Distribution Width-Standard Deviation (RDW-SD), and Platelet Distribution Width (PDW) showed no significant variance of the CBC parameters. It is preferable to perform total WBC, Haemoglobin, total RBC, HCT, MCV, MCH, MCHC, Platelet, PCT, percentage of Eosinophil and Monocyte on blood specimen with correct blood volume and anticoagulant (1.5 ± 0.25 mg of K_2EDTA/mL of blood). When analyzing Percentage of Lymphocytes, Neutrophils, Basophils, RDW-CV, RDW-SD and PDW parameters 0.5 mL (0.5 mL blood in 3 mg K_2EDTA) can also be used. Medical laboratory technologist should have good knowledge on which parameters of CBC should be analyzed with which blood and anticoagulant ratio.

Keywords: Blood anticoagulant ratio, Complete Blood Count, Under filling vacutainers

Abstract No: 06 ***Life Sciences***

DEVELOPMENT AND EVALUATION OF SET YOGHURT INCORPORATED WITH ALOE VERA GEL AS BIO-PRESERVATIVE

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Food safety and food security play a continual challenge in the dairy industry. In commercial yoghurt production, chemical preservatives are added to enhance the shelf life of the product. But present-day consumers are health conscious and find foods with functional properties additional to their nutritional requirement. The objective of this study was to evaluate the effect of *Aloe vera* gel as a bio preservative on physicochemical, microbiological and sensory properties of set yoghurt. For this, a yoghurt sample was prepared with 5% of *Aloe vera* gel and yoghurt incorporated with potassium sorbate was used as the control. All physicochemical, microbial and organoleptic properties were evaluated at weekly intervals. Parametric data were statistically analyzed using SPSS program and organoleptic data were analyzed through MINITAB. There were no significant differences in the titratable acidity, pH and organoleptic properties between bio preservative added yoghurt sample and the control. Coliform was not detected and yeast (< 1,000 cfu g^{-1}) and mold (< 1 cfu g^{-1}) counts were within the acceptable limits over the storage period of 28 days. This study concluded that all the physicochemical, microbial and sensory quality of the bio-preservative added new yoghurt product was not significantly different from the commercially available yoghurt products. Therefore, *Aloe vera* gel can be used as a bio-preservative instead of the chemical preservative (potassium sorbate) in commercial yoghurt production.

Keywords: *Aloe vera*, Bio-preservative, Yoghurt

Abstract No: 8 ***Life Sciences***

DETECTING TRENDS IN FOREST DISTURBANCE AND RECOVERY USING LANDSAT TIME SERIES OF HORTON PLAIN NATIONAL PARK, SRI LANKA

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Changes of vegetation cover over a landscape are important for sustainable management of forest landscapes. Remote sensing is a powerful tool for investigating variation in forest cover beyond traditional field surveys. This study aims to examine gradual changes occurring throughout a range of natural ecosystems (tropical montane cloud forest and *wet patana* grassland) in Horton Plains National Park (HPNP) using thirty years of Landsat Thematic Mapper (LTM), Enhanced Thematic Mapper Plus (ETM+) and Operational Land Imager (OLI) time series data. Normalized Difference Vegetation Index (NDVI) time series data stack was generated using the Landsat images from 1988 to 2019 for the HPNP. Through analyses of time series data, the results of this study indicated that gradual systematic change in forest and grassland communities in the HPNP. The greenness of montane forest areas (by means of NDVI) in the HPNP is showing slow changes after the sever canopy dieback, but very few forest patches are showing evidence of improvement at a high rate or increased greenness. During the period from 2005 to 2019, forest covered area (collectively both disturbed and undisturbed) in the HPNP showed progressive increase from 2,285.4 ha (73.7%) to 2,493.4 ha (80.2%). *Wet Patana* grassland covered area showed decrease from 653.4 ha (21%) to 481.2 ha (15.4%) due to colonization of early successional tree species. The change in marshland land cover area highly fluctuates and depends on seasonal and climatic conditions. Analyses of time series data using many scenes and covering multiple years are required to develop better impressions and representations of the changing ecosystem patterns and trends that are occurring in the HPNP. This information and maps will be very valuable for forest managers and other decision-makers at different levels, providing early warning on potential risk areas.

Financial assistance from the Sri Lanka Council for Agricultural Research Policy (SLCARP Grant No. NARP/16/UWU/SCT/01) *is acknowledged.*

Keywords: Forest disturbance, Horton Plains, Landsat, Remote sensing, Vegetation cover

Abstract No: 9 ***Life Sciences***

BIOLOGICAL ACTIVITY OF *Exacum trinervium*

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Sri Lankan endemic plant *Exacum trinervium* (Trimen) Cramer, locally known as "Binara", belonging to the family Gentianaceae, is an annual herb which grows in the wet zone highlands and is used to treat fever and dysentery in indigenous medicine. As this plant is poorly investigated, the present study was aimed to determine the biological activity of *E. trinervium* which involved two samples of the plant: leaves, flowers and buds (L); stem and roots (S). These samples were sequentially extracted by the bottle shaker method using hexane (HX-L, HX-S), ethyl acetate (EA-L, EA-S) and methanol (MT-L, MT-S) to obtain six crude extracts. Antioxidant activity, toxicity, antimicrobial activity, total polyphenolic content (TPC) and alkaloid content were evaluated using 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay, brine shrimp lethality assay, agar well diffusion assay, Folin-Ciocalteu method and acid-base method, respectively, for all six extracts. All extracts except HX-L exhibited a moderate antioxidant activity with the highest shown by EA-S with an IC_{50} value of 171.8 (±13.7) mg L^{-1}. The HX-S, HX-L and EA-S extracts were detected with high toxicity with LC_{50} values of 4.12 (±1.21) mg L^{-1}, 50.95 (±3.83) mg L^{-1} and 93.77 (5.13) mg L^{-1}, respectively. Most importantly, the toxicity of HX-S was twelve-fold higher than the positive control, $K_2Cr_2O_7$. The TPC and the alkaloid content were the highest for the polar extracts. The TPC was two times higher for MT-S than MT-L, whereas the alkaloid content was approximately equal for these two extracts with values of 17.41% and 17.32%, respectively. Moderate antifungal activity was shown against *Candida albicans* by all the extracts, however, only a slight antibacterial activity was displayed against gram-positive *Staphylococcus aureus* and gram-negative *Escherichia coli*. Accordingly, an unequal distribution of phytoconstituents was observed in *E. trinervium* and greater activity was displayed by the stem and root sample except for antimicrobial activity. Very high toxicity was observed for HX-S extract, may be due to possible presence of highly toxic nonpolar alkaloids, flavanoids and/or terpenoids which will be investigated through further analysis.

Keywords: Alkaloids, DPPH assay, *Exacum trinervium*, Indigenous medicine, Toxicity

Abstract No: 10 ***Life Sciences***

ASSESSING VARIATION OF BIOACTIVITY OF *Dendrophthoe falcata* ON THE HOST *Limonia acidissima* IN DIFFERENT ENVIRONMENTAL REGIONS OF SRI LANKA

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Dendrophthoe falcata (L.f) Ettingsh, locally known as "Pilila" (Family Loranthaceae) is a hemiparasitic plant grown on a variety of hosts with many medicinal applications. The bioactivity of the hemiparasite has proven to be heavily dependenant on the host on which it grows. It shows high antioxidant activity coupled with high toxicity when it grows on the host, *Limonia ascidissima* (L.) (Woodapple, Family Rutaceae). The aim of the present study was to investigate the impact of environmental conditions on the bioactivity of the hemiparasite grown on host *Limonia ascidissima*, as the environmental conditions may play a role in determining the secondary metabolites produced in a plant. The hemiparasite grown in Hambantota (Hamb-Arid zone), Kurunegala (Kuru-Intermediate zone) and Ambalantota (Amba-Arid zone) were selected for the study. Sequential extracts of hexane (Hamb-HE, Kuru-HE, Amba-HE), ethyl acetate (Hamb-EAE, Kuru-EAE, Amba-EAE) and methanol (Hamb-ME, Kuru-ME, Amba-ME) were studied to compare the antioxidant activity, toxicity, polyphenolic content and alkaloid content. Antioxidant activity, determined by 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay was 13% higher for Hamb-EAE compared to Kuru-EAE. Brine shrimp lethality assay was used to determine the toxicity and it revealed that *Dendrophthoe falcata* collected from Hambantota showed the highest toxicity for the three extracts. The toxicity was 38% higher for Hamb-HE than Kuru-HE. Out of the ethyl acetate extracts Hamb-EAE is almost 50% more toxic than Kuru-EAE. A significant three-fold difference was observed in total polyphenolic content of Hamb-ME compared to the other two locations which were investigated by Folin-Ciocalteu method. Hamb-ME showed the highest alkaloid percentage which was 21.9%. On average among the three locations, extracts of Ambalantota showed intermediate bioactivities, and the least bioactivitives were observed for extracts of Kurunegala, which experience intermediate and least stressed environmental conditions, respectively. Extracts of plants collected from Hambantota, the location having the most stressed environmental conditions, showed the highest bioactivity compared to the other two locations. Hence, it is clear that environmental conditions have an impact in governing the production of secondary metabolites produced, which in turn affects the bioactivity exhibited by *Dendrophthoe falcata*.

Keywords: Antioxidant activity, *Dendrophthoe falcate*, Environmental impact, Secondary metabolite production, Toxicity

Abstract No: 16 ***Life Sciences***

EFFECT OF PROCESSING ON BIOAVAILABILITY OF TOTAL PHENOL, TOTAL FLAVANOID AND ANTIOXIDANT CAPACITY OF COMMONLY CONSUMED LEGUMES IN SRI LANKA

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Different processing methods and gastrointestinal digestion are known to modulate the bio-accessibility and bioavailability of bioactive compounds in food. Even though legumes are consumed all over the world, data related to effects of processing and *in-vitro* digestion on bioavailability of bioactive compounds are limited. The aim of this study is to investigate the effect of boiling and *in-vitro* digestion on total phenol (TP), total flavonoid (TF) and antioxidant capacity of chickpea, mung (MI6), cowpea (Waruni), cowpea (Dawala) and horse gram (Kollu). Raw and boiled legume samples were digested using dialysis and synthetic enzymes (pepsin, pancreatin and bile extract). TP and TF contents were assessed using Folin-ciocalteu method and Aluminium chloride colorimetric method, respectively. The antioxidant capacities were determined using ABTS (3-ethylbenzothiazoline-6-sulphonic acid) and FRAP (Ferric reducing power) methods. All the experiments were carried out in triplicate, and one-way ANOVA model was used to analyze the data. According to results, TP and TF contents of tested legumes have reduced ($p < 0.05$) upon boiling. However, *in-vitro* digestion has increased ($p < 0.05$) the TP and TF contents of both raw and boiled legumes. TP bioavailability ranged from 5.20 - 20.66%, and TF bioavailability ranged from 0.32 - 1.34%. Cowpea (Waruni), horse gram (Kollu) and chickpea showed an increase ($p < 0.05$) in TP bioavailability upon boiling in the range of 9.60 - 30.00%, while mung (MI6) and cowpea (Dawala) showed a decrease in the range of 3.70 - 32.17%. However, TF bioavailability of tested legumes reduced ($p < 0.05$) in the range of 17.82 - 77.0% upon boiling. Further *in-vitro* digestion has increased ($p < 0.05$) the antioxidant capacity of legumes. ABTS radical scavenging capacity has increased between 1.8-11.6 folds, and ferric iron reducing ability has increased between 3.7-44.7 folds after digestion. The highest increase of ferric iron reducing ability and ABTS radical scavenging capacity in dialysate was observed for boiled chickpea which correlated with the increase in TP bioavailability of chickpea after boiling. Hence, the overall results reveal that processing and simulated digestion modulate the bioavailability of TF, TP and the antioxidant capacity of above five selected legumes.

Financial assistance provided by the National Institute of Fundamental Studies is acknowledged.

Keywords: Antioxidant capacity, Bioavailability, Flavonoids, *In-vitro* digestion, Phenol

Abstract No: 17 ***Life Sciences***

SPATIAL ARRANGEMENT OF TERRESTRIAL PEST GASTROPODS IN AGRICULTURAL LANDS IN THE NUWARA ELIYA DISTRICT, SRI LANKA

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Eighteen exotic terrestrial pest gastropods have been inadvertently introduced to Sri Lanka. Most of them are confined to the central highlands, especially in Nuwara Eliya (NE) District. Only a few studies have been carried out to investigate their distribution in Sri Lanka. This study was conducted to map the pest gastropods in agricultural lands in NE District. Eighty vegetable, fruit and ornamental flower fields in NE District were sampled from 2017 to 2019 twice a year. Each location was surveyed for gastropods by establishing ten 1 m^2 sampling plots, and sampling for gastropods was done for a maximum of 15 minutes/plot from 18:30 to 02:00 h. The species density was calculated and distribution maps were prepared for each species using Arc Map 10.4. The distribution of a total of 14 gastropods were documented during this survey, which included five natives (*Macrochlamys indica*, *Cryptozona bistrialis*, *C. chenui*, *Euplecta emiliana* and *Ratnadvipia irradians*) and four exotic snails (*Bradybaena similaris*, *Allopeas gracile*, *Lissachatina fulica* and *Subulina octona*) and five exotic slug species (*Deroceras laeve*, *D. reticulatum*, *Milax gagates*, *Mariella dussumieri* and *Leavicaulis alte*). *D. reticulatum* (9,000 ha^{-1}) and *B. similaris* (5,000 ha^{-1}) were the most dominant species while *M. gagates* was the least dense species (20 ha^{-1}). The densities of sampled pest gastropods were significantly different (one-way ANOVA test; $F = 3.17$, $p < 0.05$). The density of the slugs (2,907 ha^{-1}) was higher compared to the sampled snail (1,842 ha^{-1}) densities. Majority of the exotics were widely distributed throughout the agricultural fields in NE, and most of the exotic snails and slugs were highly abundant around Diagama, Agarapathana, Labukele, Kudaoya, Bogawanthalawa and Ragala. Furthermore, among the pest snails, *A. gracile*, *S. octona*, *L. fulica* and *L. alte* were the dominant species in the dryer parts of NE including Hanguranketha, Walapane and some parts of the Kothmale Divisional Secretariats. The European invaders, *B. similaris*, *D. laeve* and *D. reticulatum*, were common throughout the wet areas of NE District including Ambagamuwa and Nuwara Eliya. Non-endemic native species were found mainly along the margins of the fields and these species were abundant around Bogawanthalawa, Hatton, Nallathanniya and Norwood while the endemics were recorded near Keenagolla, Walapane, Udagama and Palagolla areas. In contrast to the exotic gastropods, the endemic and non-endemic natives showed narrow range distributions especially in dry parts of the district including Hanguranketha and Walapane. Altered environments, such as agricultural lands, provide opportunities of passive dispersal of the exotic terrestrial pest gastropods. This spatial arrangement information can therefore be used to formulate monitoring programmes and strategies to control and prevent the spread of these pests in NE District and thereby minimize the economic damage to agriculture.

Financial assistance provided by the National Science Foundation, Sri Lanka (Grant No. RG/2017/EB/05), is acknowledged.

Keywords: Agricultural lands, Nuwara Eliya, Pest, Spatial arrangement, Terrestrial gastropod

Abstract No: 21 ***Life Sciences***

ENHANCEMENT OF CHEMICAL DEFENSE AGAINST TWO POSTHARVEST FUNGAL PATHOGENS IN 'EMBUL' BANANA BY SOLUBLE SILICA TREATMENT

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Postharvest treatment with soluble silica is known to inhibit fungal growth and induce disease resistance in many fruits. Dipping in 1,500 µg mL^{-1} silica solution for 20 min extended the shelf life of 'Embul' banana (*Musa* sp. Mysore group AAB) significantly. The aim of this study was to investigate the possible role of antifungal compounds in silica-enhanced resistance to anthracnose and crown rot (CR) disease in banana. 'Embul' banana 'fingers' (15 replicates) and 'hands' (08 replicates) were exposed to silica treatment (Si+), as above, and those treated with distilled water for 20 min served as controls (Si-). Twenty-four hours after treatment, banana fingers and hands were inoculated with 1×10^8 conidia mL^{-1} suspension of *Colletotrichum* sp. (anthracnose pathogen) and mycelial segments of *Lasiodiplodia* sp. (a CR pathogen), respectively, and incubated at 27 ± 3 °C and 95-100% relative humidity. Anthracnose lesion diameters were taken daily while CR development was assessed and expressed as CR Index (CRI) 14 days after inoculation. *Cladosporium* bioassay coupled with Thin Layer Chromatography was performed to assess antifungal activity in ethyl acetate extracts of Si+ and Si- peel tissues. Methanol extracts of Si+ and Si- peels were subjected to Folin Ciocalteu (FC) assay for Total Phenolic (TP) content. Significant delay (by 04 days) in rot initiation, lower anthracnose lesion diameter (0.5 cm) and CRI (3) were observed in Si+ fruits versus controls (1.4 cm and 5, respectively). In bioassay plates, three antifungal zones (R_f = 0.14, 0.48, 0.79) were visible in both Si+ and Si- extracts, indicating them to be pre-formed antifungal compounds (phytoanticipins). Significantly larger antifungal areas and TP levels were detected with Si+ extracts. Si-enhanced resistance to fungal rots in 'Embul' banana may at least be partly attributed to enhanced phytoanticipin levels, including phenolic compounds.

Financial assistance from the National Science Foundation (*Grant No - NSF/RG/2016/AG/03*) *is acknowledged.*

Keywords: Anthracnose, Banana, Crown rot, Disease resistance, Silica

Abstract No: 28 ***Life Sciences***

MOF-199 IN CONTROLLED RELEASE OF DRUGS

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MOFs (Metal organic frameworks) are porous materials still under investigation as controlled drug delivery systems. MOF-199/HKUST-1 consisting of Cu(II) nodes and trimesate linkers is a widely exploited MOF in the areas of catalysis and gas storage. In this study, its ability was tested to perform as a controlled drug delivery system. Aspirin and nicotinamide were encapsulated to the MOF-199 structure via direct adsorption using water and 95% ethanol as solvents and drug release studies were conducted under pH 5, 7 and 8 at 37 ^{o}C. However, the powder X-ray diffraction analysis of MOF samples placed in water revealed that MOF-199 was unstable in water. Hence, 95% ethanol was selected as the better solvent for encapsulation. Good loading capacities were observed for nicotinamide and aspirin with comparison to the reported results for MOF-199 with other drugs. The average drug encapsulations were 44.84 mg g^{-1}, 51.28 mg g^{-1} and 62.88 mg g^{-1} for nicotinamide encapsulated in water, nicotinamide encapsulated in ethanol and aspirin encapsulated in ethanol, respectively. The highest drug release, after 24 h, for nicotinamide was observed at pH 8, while it was pH 5 for aspirin. Overall, the results show that MOF-199 can be developed as a controlled drug delivery system for nicotinamide and aspirin.

Keywords: Aspirin, Controlled drug release, MOF-199, Nicotinamide

Abstract No: 38 ***Life Sciences***

FRUIT CHARACTERISTICS AND SEED GERMINATION BEHAVIOR OF *Dillenia indica* (DILLENIACEAE)

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Dillenia indica is an important medicinal plant native to Sri Lanka having comparatively large fruit containing seeds covered with sticky hyaline mucilage. However, published data are not available on the effect of fruit characteristics and mucilage on the seed germination behavior of *D. indica*. Thus, the present study was conducted to determine the significance of fruit characteristics of *D. indica* on its germination behaviour. Seed germination assay was conducted with and without seed mucilage. Seed storage behavior was identified using the 100 seed test. Antibiotic, antifungal, antioxidant, and allelopathic activities of fruit extracts (with mucilage) were tested using standard biochemical assays. *D. indica* seeds took approximately 70 days to germinate to 95% indicating the presence of seed dormancy. Germination rate increased when seeds were treated with GA_3 or when they were stored dry for one month, suggesting the presence of physiological dormancy in seeds. Seeds are comprised of an underdeveloped embryo that grows inside the seed before the germination. Thus, seeds of *D. indica* have morphophysiological dormancy which clearly differs from previous studies on seed dormancy of *D. indica*. The seed moisture content of *D. indica* was 12.5% and seeds continued to be viable after dry-storage revealing their orthodox storage behavior. Seed mucilage does not affect seed germination. The floating time of seeds with mucilage was at least five times higher than that without mucilage. Fruit-extracts exhibited a significant antibacterial, antifungal, and antioxidant activity. No allelopathic activity of fruit extracts was shown towards the seed germination of *Brassica juncea* and *Vigna radiata*. Seed mucilage appears to be assisting seeds to float on the water during dispersal. Further, antifungal, antibacterial and antioxidant properties of fruit wall and mucilage seem to protect seeds from fungal and bacterial pathogens and other stress conditions during dispersal and stay in the soil seed bank.

Keywords: Antibacterial activity, Antifungal activity, Antioxidant activity, Seed dispersal, Seed dormancy

Abstract No: 39 ***Life Sciences***

IDENTIFICATION OF FUNGAL PATHOGENS ASSOCIATED WITH FINGER MILLET (*Eleusine coracana*) IN SRI LANKA

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Finger millet is a 'security crop' and a 'climatic-smart' crop due to its high nutritional value and low input requirement. This study aims to isolate the foliar fungal pathogens in finger millet and to characterize those using morphological, pathological and molecular data. Diseased samples were collected from farmer fields and research fields in Kurunegala, Anamaduwa and Gannoruwa. Causative fungi were isolated following standard protocols, and pathogenicity was established by adopting Koch's postulates. Methods for culturing, sporulation induction, morphological characterization of the isolates and re-inoculation to host plants were optimized. The fungal isolates were PCR amplified using primers in the Internal Transcribed Spacer (ITS) region; ITS4 and ITS5. The amplified fragments were sequenced. Six distinct leaf disease symptoms and two sheath symptoms were identified and nine different fungi were isolated from diseased samples. Based on morphological and molecular data, three fungal isolates; *Pyricularia grisea*, *Epicoccum* sp., and *Nigrospora* sp. were identified. Inoculation of leaf *ex-plants* and potted plants confirmed the pathogenicity of these three isolates. *Pyricularia grisea*- anamorph causes blast, one of the most devastating diseases in finger millet worldwide. Economic losses due to blast disease are previously reported in Sri Lanka, but this is the first report of sequence data on local strains of *Pyricularia grisea* isolated from finger millet. Although not previously reported on finger millet, *Epicoccum* sp. is a pathogen in related cereals such as sorghum, wheat and maize and further studies and field inoculation will confirm the pathogenicity of this strain. Protocols that were optimized in this study for isolation, sporulation induction are useful in further research in finger millet cultivar screening for disease tolerance.

Financial assistance from National Research Council, Investigator Driven Grant (18-019) is acknowledged.

Keywords: Blast disease, *Epicoccum* sp., Finger millet, Pathogenicity, *Pyricularia grisea*

Abstract No: 47 ***Life Sciences***

ISOLATION AND CHARACTERIZATION OF *Lactobacillus* STRAINS FROM DOMESTIC CURD AND INVESTIGATION OF CURD FORMING ABILITY

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Curd is a popular fermented milk product in Sri Lanka. The main group of bacteria that contributes to the curdling of milk is the group of lactic acid bacteria (LAB). The curdling of milk is the result of protein coagulation due to acidity. These LAB produce either lactic acid alone or a mixture of end products where the main component is lactic acid. *Lactobacillus* species are one of the main members of LAB that cause the curdling of milk. The present study focused on isolating bacteria that contribute to curdling from domestically produced curd in Sri Lanka and evaluating their relative curdling ability individually. Using two curd samples, four strains were isolated on De Man, Rogosa, and Sharpe (MRS) agar containing L-cysteine (0.2%) which were labelled as A, C, D and G. All four cultures were tested on the *Lactobacillus* and *Streptococcus* differential agar and were found to be reddish and rhizoidal surrounded by an opaque zone. For the characterization, Gram's staining, Endospore staining, Motility test, Growth aerobically, Growth anaerobically, Catalase test, Oxidase test, Glucose acid/gas test, Oxidation-Fermentation test and Arginine hydrolysis test were done. All four isolates were *Lactobacillus* species. The isolates were tested for their ability to form good curd which was observed by the visual solidity, and the isolate G was found to be the best culture for the formation of curd. The isolate C was better than cultures A and D. Some liquid was left on curds when isolates A and D were used. A combination of cultures G and C can be investigated further as starter cultures. Culture A and D could also be used as starter cultures for the formation of less solid curd that may be suitable to make drinking curd, as drinking yoghurt.

Keywords: Curd, Fermented milk product, Lactic acid bacteria, *Lactobacillus* species, Starter culture

Abstract No: 54 ***Life Sciences***

GASTRO-INTESTINAL PARASITES OF WET AND DRY ZONE TOQUE MACAQUES *(Macaca sinica)* AND THEIR ZOONOTIC AND ANTHROPONOTIC POTENTIAL

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Gastrointestinal (GI) parasites in non-human primates have a greater potential to become zoonotic as well as anthroponotic. This study examined the GI parasites in two subspecies of toque macaque: *Macaca sinica sinica* in the dry zone and *Macaca sinica aurifrons* in the wet zone of Sri Lanka. Fresh faecal samples were collected from Polonnaruwa Archaeological Reserve and Peradeniya University premises, and were analysed following a modified Sheather's sucrose floatation method. Further identification and differentiation of *Entamoeba* sp. were conducted by PCR using species specific primers. Of the 98 macaques examined, 89 (90.8%) were infected with GI parasites. Overall, there was no difference in the prevalence of GI parasites between the two subspecies in the wet (95.9%) and dry zones (85.7% ; $\chi^2 = 3.059$, $p = 0.080$). A total of 16 parasite species were recorded including nine helminths and seven protozoans. Among the helminths observed, *Anatrichosoma* sp., *Ancylostoma* sp., *Capillaria* sp., *Oesophagostomum* sp., and *Physaloptera* sp. have been identified as zoonotic while *Ascaris* sp., *Enterobius* sp., *Strongyloides* sp., and *Trichuris* sp. have been identified as both zoonotic and anthroponotic. Among the protozoans, *Balantidium coli* and *Buxtonella* sp. have been reported to cause zoonoses while *Entamoeba* sp. and *Cryptosporidium* sp. have been reported to cause both anthroponoses and zoonoses. This study provides the first record of *Anatrichosoma* sp. and *Buxtonella* sp. in Sri Lanka and the first record of *Cryptosporidium* sp. in the wet zone macaques. The highest overall intensity of infection was eggs of *Oesophagostomum* sp. (EPG = 49.02 ± 40.30) in the wet zone macaques. The molecular data confirmed the presence of *E. nuttalli* and *E. coli*, that are known to be zoonotic and anthroponotic, respectively. Urban toque macaque populations and human monkey interactions are constantly increasing in Sri Lanka. Therefore, in-depth epidemiological studies of the zoonotic and anthroponotic pathogens in both monkeys and humans are important for better understanding of potential public health risks and implications for conservation of toque macaques.

Financial assistance from the University of Peradeniya (*Grant No. URG/2018/39/S) is acknowledged.*

Keywords: Anthroponotic, Gastrointestinal parasites, Toque macaques, Zoonotic

Abstract No: 55 (Oral) ***Life Sciences***

NUTRITIONAL AND HEALTH STATUS OF RURAL ELDERLY ATTENDING AYURVEDA MOBILE HEALTH CLINICS AT HANGURANKETHA AND MEDADUMBARA

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Sri Lanka has a fast-growing aging population, and health and nutritional status of elderly will affect the economy in the future. Although there are several studies on nutritional status of hospitalized and institutionalized elderly population in the country, studies on community dwelling elderly is not reported. The present study was conducted to evaluate the nutritional and health status of the rural community dwelling elderly cohort selected from two divisional secretariats of Kandy District of Central Province. Random sampling was used as every patient who met with the selection criteria was taken for the sample. Mini-nutritional assessment tool (MNA), selected anthropometric measurements and biomarkers were used to assess the nutritional and health status. Based on MNA score, 54.2% of the study population (valid n = 72) has normal nutritional status. Mean MNA score (23.7 ± 3.2) and BMI (20.3 ± 3.2) lies within the normal range for the age group. Percentage of population at risk of malnutrition is 41.1% despite their overall good health status. Only 4.1% was malnourished. Among the elderly subjects 28.8% were underweight, 64.3% had normal weight and 5.5% were overweight and 5.5% obese. Mean waist to hip ratio (WHR) for study population is 0.84 ± 0.06, for males 0.83 ± 0.06 and for females 0.84 ± 0.06 with a moderate health risk in 27.4% of subjects; 24.7% females. The mean fasting blood glucose for males was 101.7 ± 16.7 mg dL^{-1} and for females 106.3 ± 12.2 mg dL^{-1}. Majority of participants (68.7%) were normoglycaemic, 26.8% showed impaired glucose tolerance and 4.5% were hyperglycaemic. Prevalence of anaemia in the study population was 24.1% (6 men and 8 women). Mean serum total protein concentration for males was 7.1 ± 0.5 mg dL^{-1} and for females 7.6 ± 0.8 g $dL^{-1}$and mean albumin concentration was 3.7 ± 0.2 g dL^{-1} for males 3.8 ± 0.2 g dL^{-1} for females that lie within normal limits. Mean serum protein thiol concentration for the study population is 459.5 ± 98.2 µmol L^{-1}; 430.6 ± 64.0 µmol L^{-1} for males and 484.0 ± 115.1 µmol L^{-1} for females. Mean total antioxidant capacity (TAC) of the study population was 813.4 ± 143.2 µmol L^{-1}; 831.5 ± 133.8 µmol L^{-1} for males and 797.8 ± 150.9 µmol L^{-1} for females. Biomarkers are within the normal ranges though MNA has revealed significant percentage at risk of malnutrition. Correlation between biomarkers and the MNA was not significant and it may be due to small sample size. A large-scale screening in the community is suggested in order to revalidate the MNA tool in Sri Lankan elderly population and to arrive at a better conclusion.

Keywords: Elderly health, Mini nutritional assessment, Anthropometry, Serum antioxidant levels, Serum protein thiols

Abstract No: 65 ***Life Sciences***

EFFECTS OF LITHIUM ON CANONICAL WNT SIGNALING DURING THE EMBRYONIC DEVELOPMENT OF SIAMESE FIGHTER FISH, *Betta splendens*

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Canonical Wnt signaling pathway is one of the first cell-cell signaling pathways to be switched on during early embryonic development. Several studies in animals have shown that lithium upregulate Wnt signaling, which leads to the abnormal development of the embryo. The present study aimed to determine the effects of lithium on early development in a popular aquarium fish, the Siamese fighter fish, *Betta splendens*. Since the embryonic development of *B. splendens* is not well documented, its early and late development was examined using a Zeiss primo-star inverted microscope. The most effective lithium concentration for the treatment of *B. splendens* embryos was determined by exposing 20 cleavage and blastula stage embryos each to a series of lithium concentrations ranging from 0.15 - 0.45 mol L^{-1} and 0.15 - 0.35 mol L^{-1}, respectively. The lithium concentration which gave the most teratogenic effects was selected, its effects on external morphology was analyzed using live and whole mount preparations of the embryos, and the effects on internal anatomy was analyzed by preparation of histological sections. Embryogenesis of *B. splendens* started at 0:45 hours post fertilization (hpf), and the embryos hatched from the chorion at 48 hpf. Embryogenesis was categorized into periods of cleavage, blastula, gastrula, segmentation and pharyngula, and each of these periods was observed for 1.30, 5.30, 5.45, 14.15 and 20 hours, respectively. *Betta splendens* blastula stage embryos treated with 0.25 mol L^{-1} lithium showed the most abnormalities in development. During gastrulation, many lithium treated embryos showed exo-gastrulation. These lithium-treated embryos developed deformities in eye, nervous system, heart, gut, ear, somites and skeletal structures causing defects in body axes. Most embryos did not develop eyes and had curved tails. This study indicates that teratogenic effects of lithium during *B. splendens* embryonic development are possibly through its effects on the canonical Wnt signaling pathway.

Keywords: *Betta splendens*, Canonical Wnt signaling, Embryogenesis, Lithium

Abstract No. 68 ***Life Sciences***

PEDIGREE ANALYSIS OF TYPE 2 DIABETES MELLITUS INHERITANCE PATTERN IN PATIENTS ATTENDING DIABETIC CLINIC, NATIONAL HOSPITAL, KANDY, SRI LANKA

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Diabetes mellitus (DM) is a major cause of morbidity and mortality with approximately 422 million people living with DM worldwide and the prevalence of DM in Sri Lankan adults (20 - 79 years) is 10.3%. The objective of this study was to demonstrate the inheritance pattern of type 2 diabetes mellitus (T2DM) using pedigree analysis in a selected cohort of T2DM patients in Sri Lanka. This is a prospective cross-sectional study conducted from May – July 2016 at diabetic clinic, National Hospital, Kandy, Sri Lanka. Patients attending the Diabetic and Endocrinology unit, diagnosed with T2DM according to the World Health Organisation guidelines and volunteered to participate were enrolled in the study. Family history and demographic data were collected from 120 T2DM patients using a standardized questionnaire and pedigree was constructed for each proband. Forty-four (44) male patients and 76 female patients participated in the study. The DM history ranged from one month to 30 years and the DM onset age was found to be 24 - 76 years. Out of the 120 T2DM patients, 16 patients had both parents affected with DM and 44 patients showed that neither father nor mother was affected with DM. Of the 1523 family members of the 120 T2DM patients, 506 direct family members were found to have DM. In the study population, female progeny was more prone to have diabetic (χ^2 = 2.379, p = 0.0173) than male progeny when mother is diabetic. Though it is not statistically significant, we have also observed that female progeny is more prone to have diabetes when both the parents were diabetic (χ^2 = 0.9556, p = 0.3393). This study shows a multifactorial inheritance pattern of T2DM in our study population. As the number of T2DM patients increase in Sri Lanka, more studies are warranted in a large patient population to better understand the genetic linkage and influence of other environmental factors on the disease onset.

Keywords: Diabetes, Inheritance pattern, Pedigree analysis, T2DM

Abstract No: 71 ***Life Sciences***

DETERMINATION OF BIOACTIVITY AND ISOLATION OF GARCINOL IN *Garcinia quaesita*

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Garcinia quaesita (Family Clusiaceae) is a plant species endemic to Sri Lanka. This plant is commonly used in Ayurvedic medicine and in culinary. Determination of bioactivity and isolation of bioactive compounds from the bark and the fruit of *G. quaesita* have already been reported. However, there are no such reports on the leaves of *G. quaesita*. Therefore, determination of bioactivity was initiated by extracting a wide range of bioactive compounds to hexane, ethyl acetate and methanol solvants using sequential extraction. Determination of bioactivity for all three crude extracts was carried out using several assays; where antioxidant activity using DPPH assay, FRAP assay and total polyphenolic content using Foline-Ciocalteu assay, cytotoxicity using Brine shrimp lethality assay and anti-inflammatory activity using heat induced haemolysis. In determination of antioxidant activity, all three extracts showed IC_{50} values below 100 mg L^{-1} with respect to the control ascorbic acid demonstrating that the leaves of *G. quaesita* have a significant antioxidant activity. Among all the three crude extracts, hexane extract had the least IC_{50} value obtained from the DPPH assay. The ethyl acetate extract has the highest reducing capability according to the FRAP assay and the methanol extract has the highest total polyphenolic content according to the Folin-ciocalteu assay. The Brine shrimp lethality assay results showed that the toxicity of the hexane, ethyl acetate and methanol extracts were low, high and moderate, respectively, relying on the LC_{50} values obtained with respect to the control potassium dichromate. Heat induced haemolysis results showed that all three extracts exhibit significant anti-inflammatory properties with respect to the control (Aspirin). The hexane extract was selected for bio assay guided isolation of compounds since it has the highest antioxidant activity obtained from the DPPH assay and it also contains a higher number of antioxidant active compounds relative to the other two extracts. Vacuum-liquid chromatography, flash column chromatography and preparative thin-layer chromatography methods were applied to isolate the most prominent antioxidant active compound which is similar in R_f value to Garcinol. The co-TLC results confirmed that the isolated compound is Garcinol. Hence it could be concluded that Garcinol is also present in the leaves of *Garcinia quaesita.*

Keywords: Antioxidant, Bioactivity, *Garcinia quaesita*, Garcinol

Abstract No: 75 ***Life Sciences***

SYNTHESIS OF DERIVATIVES OF OLEANOLIC ACID AND THEIR CYTOTOXICITY STUDIES

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Natural products and their modified derivatives act as leading compounds for modern drug discovery due to their broad spectrum of biological activities. Oleanolic acid (3*β*-hydroxyolean-12-en-28-oic acid) is one of the most important pentacyclic triterpenoids known to process several biological activities including cytotoxicity, antibacterial, anti-inflammatory, antioxidant and antidiabetic. Even though several structural analogs of oleanolic acid have been reported, very few reports are found on the synthesis of fluoro analogs of the oleanolic acid. In the present study, the fluoro derivatives of oleanolic acid were synthesized via a new synthetic route and the cytotoxic potential of the synthesized compounds were evaluated using Brine Shrimp Lethality (BSL) assay and Sulforhodamine B (SRB) assay. Clean, air-dried and ground roots of *Lantana camara* were extracted into methanol by maceration. Oleanolic acid was isolated from the roots of *Lantana camara* using flash chromatography in 0.49% yield and the structure was confirmed using FTIR and mass spectroscopy analysis. Seven derivatives of oleanolic acid were synthesized by acetylation of C3-OH group followed by fluorination of C28-COOH, oxidation of C3-OH group followed by fluorination of C28-COOH, esterification of C28-COOH group followed by fluorination of C3-OH and esterification of C28-COOH group followed by oxidation of C3-OH. The synthesized compounds were characterized by using FTIR and ^{1}H-NMR spectroscopy. Cytotoxicity studies were carried out by using BSL assay, and LC_{50} values were calculated by probit analysis. The LC_{50} values of acetylated, oxidized and esterified products obtained indicate a higher cytotoxicity than oleanolic acid and the fluorinated compounds. This shows that the cytotoxicity has been decreased by fluorination at C28-COOH and C3-OH groups. Finally, the IC_{50} values were calculated from the SRB assay. It also showed that the cytotoxicity has been decreased with the fluorination. However, the oxidized product shows higher and lower cytotoxicity for NCI-H292 and MRC 5 cells, respectively, indicating better activity.

Keywords: Cytotoxicity, Fluoro derivatives, *Lantana camara,* Oleanolic acid

Abstract No: 79 ***Life Sciences***

COMPARISON OF WATER AND OIL ABSORPTION CAPACITIES OF PARTIALLY DEFATTED COCONUT TESTA FLOUR FROM SELECTED SRI LANKAN COCONUT CULTIVARS

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Coconut testa is the thin, brown outermost cover of the coconut endosperm. It is an under-utilized by-product of coconut processing industries. A partially defatted flour (CTF) was prepared using coconut testa with the aim of substituting wheat flour in baking. The aim of this study was to compare water (WAC) and oil absorption capacities (OAC) of coconut testa flour of four local cultivars namely San Raman (SR), Gon Thembili (GT), Ran Thembili (RT), TallxTall (TxT) against the Commercial hybrid (COM) grown in Sri Lanka. Fifty mature coconuts (12 months) from each cultivar were collected from Coconut Research Institute of Sri Lanka, Lunuwila during August to October 2018. Partially defatted coconut testa was dried and ground to obtain brown colour flour. Flour (1 g) was mixed with 10 mL of distilled water or soy bean oil and allowed to stand at ambient temperature for 30 min. Thereafter, it was centrifuged for 1 hr at 4,000 x g. The supernatant was discarded and the increase in weight of the flour was recorded. The WAC and OAC were recorded as % of water or oil bound per g of flour. The maximum WAC was recorded for SR (320.00 ± 6.08%) whereas minimum was reported for RT (194.33 ± 10.69%). The WAC of TXT and RT were statistically similar ($p > 0.05$), but significantly ($p < 0.05$) lower than those of SR, COM and GT. The highest OAC was recorded for COM (142.67 ± 2.52%) while lowest was noted for RT (85.67 ± 7.02%). The OAC of GT (127.33 ± 3.21%) and SR (124 ± 3%) was statistically similar ($p > 0.05$), but significantly ($p < 0.05$) higher than those of TXT (97.33 ± 3.21%) and RT (85.67 ± 7.02%). Statistically significant variations in WAC and OAC were observed among different cultivars of CTF suggesting the possible use in different food applications.

Keywords: Coconut testa, Flour, Functional properties, Oil absorption, Water absorption

Abstract No: 80 ***Life Sciences***

PREVALENCE OF DRUG RESISTANCE AMONG TUBERCULOSIS PATIENTS IN KANDY, SRI LANKA AND ASSOCIATED FACTORS

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Tuberculosis (TB), a bacterial infection caused by the bacterium *Mycobacterium tuberculosis* (MTB), has been responsible for millions of deaths worldwide. The major challenge in combating TB is the emergence of drug resistance. Diverse research is being carried out to identify factors that favor the emergence of drug resistance under various settings. Herein, we intended to identify the prevalence of drug resistance in Kandy, Sri Lanka, and to identify the associated socio-demographic factors. Ziehl-Neelsen positive sputa were collected from TB patients reported to the chest clinic, Kandy, from February 2018 to July 2019. Sputa were decontaminated using the modified Petroff's method, inoculated onto Lowenstein-Jensen media, and were incubated at 37 °C for 4-8 weeks. MTB isolates were tested for drug susceptibility (DST) to first-line drugs: Isoniazid (INH), Rifampin (RIF) and Ethambutol (EMB), using the two methods, agar proportion method and mycobacterium growth indicator tube. Demographic data were collected using an interviewer-administered questionnaire and were analyzed using EpiData and EpiStat software. Accordingly, 76 patients yielded culture positive MTB isolates and upon DST, 17 (22.4%) isolates showed phenotypic resistance to at least one drug tested; four were resistant to INH, five to EMB, four to RIF and EMB, three were RIF mono resistant and one was resistant to INH and EMB. The majority of drug resistant patients were males, associated with poor income ($p < 0.05$), smokers and alcohol consumers, and had a high sputum grade. A trend in acquiring drug resistance with increasing age was also observed (15-34 years: 14.8%, 35-64 years: 15.4% and 65 years and above (33.3%). Further studies on mutations that cause drug resistance and the associated clinical factors are being carried out.

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Keywords: Demography, Drug resistance, Drug susceptibility testing, Questionnaire, Tuberculosis

Abstract No: 101 ***Life Sciences***

POLLEN BIOLOGY AND STIGMA RECEPTIVITY OF *Osbeckia lanata* ALSTON. (MELASTOMATACEAE)

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Osbeckia lanata Alston. is an endemic, endangered shrub species found in few isolated populations in grasslands and montane forest edges at Horton Plains and Adam's Peak, Sri Lanka. Reproductive traits determine genetic diversity and population dynamics, thus playing a major role on the ecological status of a species. Therefore, understanding of these traits is a prerequisite to develop an effective conservation programme for a species. Reproductive characters of *O. lanata* were studied in order to identify the reproductive system of the species. Sampling was carried out at Thotupola Kanda mountain during the flowering season in 2019 between 09:00 and 12:00 h. Floral characters of developing flowers were recorded. Pollen viability was determined with 1% TTC staining, using *in vivo* and *in vitro* germination assays. Standard staining protocols were followed to assess stigma receptivity. Flowering was initiated in early November and continued till late February, 2020. Flowers were purple-red in colour, pentamerous and arranged solitary or in small clusters. Ten floral developmental stages (F_1 to F_{10}) from buds to fruit initiation were identified. In *O. lanata* fully developed flowers (F_8) had the optimum pollen germination, pollen viability and stigma receptivity. Also, 99 ± 0.2% of pollens were viable at F_8 stage. However, *in vitro* germination percentage was 62.0 ± 2.5. Stigmatic papillae were fully developed at F_8 stage and germinated pollens on stigmatic surfaces were observed through *in vivo* germination assays. Synchronized pollen maturity and stigma receptivity at F_8 stage indicates the possibility of self-pollination leading to inbreeding which may reduce the population vigor. Outcomes of the study generate essential information to develop further studies on pollination syndromes and recovery of *O. lanata* populations in Sri Lanka.

Financial assistance from the Royal Botanic Gardens, Peradeniya, and Ministry of Mahaweli Development and Environment are acknowledged.

Keywords: Endangered, Inbreeding, Pollination, Population dynamics, Reproductive biology

Abstract No: 103 ***Life Sciences***

CANINE BABESIOSIS: PREVALENCE, INTENSITY AND MOLECULAR IDENTIFICATION OF *Babesia* SPECIES IN DOGS BROUGHT TO VETERINARY TEACHING HOSPITAL, PERADENIYA

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Canine babesiosis is a globally distributed and clinically significant tick-borne disease caused by an intra-erythrocytic haemoprotozoan parasite belonging to the genus *Babesia*. Two species of *Babesia* infect dogs: *B. canis* and *B. gibsoni*. The present study determined the prevalence, intensity and phylogeny of *Babesia* species in dogs brought to the Veterinary Teaching Hospital (VTH) at the University of Peradeniya. The study compared the morphological and molecular methods of diagnosis and investigated the potential tick vectors of babesiosis. Blood samples from dogs brought to the VTH were collected from January to June 2019. Giemsa stained blood smears were examined under light microscopy. Blood samples from 42 dogs were collected and were subjected to PCR using genus-specific primers to amplify a 411-450 bp region in the *18S rRNA* gene. The DNA from 20 positive blood samples was sequenced and phylogenetic analysis was conducted using MEGA7 software. Results show that 19 (45.2%) and 33 (78.6%) dogs were positive for babesiosis from microscopic and molecular methods, respectively. This highlights a significant difference in the two methods of diagnosis (χ^2 = 9.462, p = 0.002) with 33.3% infected dogs diagnosed microscopically negative. All the parasites identified either through microscopy or genetically were confirmed as *B. gibsoni*. Nine dogs were infested with ticks (21.4%) and 17 ticks were collected from them. The tick species were identified as: *Rhipicephalus haemophysaloides, Haemophysalis bispinosa,* and *Rhipicephalus sanguineus*. Further studies are needed to confirm the vector capacity of these tick species and the presence of *Babesia* in ticks. The results of the study show a high prevalence of canine babesiosis among the dogs brought to the VTH and most of these infections may go undetected if only the microscopic method is used in the diagnosis. Moreover, since the infection is mostly asymptomatic, improved diagnostic method is needed to control and prevent the disease distribution, effectively.

Financial assistance from the National Science Foundation (*Grant No. RG/2019/BT/01*) *is acknowledged.*

Keywords: Asymptomatic cases, *Babesia gibsoni*, *18S rRNA* for *Babesia*, Ticks

Abstract No: 107 ***Life Sciences***

EFFECT OF EXOGENOUS APPLICATION OF SALICYLIC ACID ON ALLEVIATION OF DROUGHT STRESS OF IMMATURE TEA (*Camellia sinensis*) PLANTS

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Drought can be considered as one of the major limitations to improve tea yield in certain parts of Sri Lanka. In addition to adopting long-term drought mitigation strategies, it is necessary to take timely provisions to reduce short-term drought effects to improve plant vigor. Application of salicylic acid (SA) has resulted in positive impacts in improving the physiological and growth parameters under drought in other crops. Knowledge on plant hormonal regulation on tea is scanty but important especially under climate change. Therefore, potential of minimizing the drought effects on tea *via* exogenous application of SA was studied under a controlled environment (average temperature 28 °C, average relative humidity 50% and photosynthetically active radiation 1,200 µmoles m^{-2} s^{-1}) at the Tea Research Institute at Talawakelle, Sri Lanka, using one-year-old tea cultivars, namely, TRI 2025 (drought tolerant) and TRI 2023 (drought susceptible). Plants were exposed to a drying cycle while they were foliar sprayed with SA at various concentrations (0, 50, 100, 150 and 200 mg L^{-1}) along with well-watered and no-spray treatments arranged according to Randomized Complete Block Design (2 blocks, 24 replicate plants per cultivar per treatment). Data were collected at 18 hours and 3, 7, 14 and 21 days after applying the treatments from randomly selected plants. Physiological and biochemical parameters were measured (09:00 - 12:30 h) along with soil moisture content. Moisture stress resulted in declining of all gas exchange parameters, leaf relative water content and accumulated osmolytes (total soluble sugar and proline) in both tea cultivars compared with those under well-watered conditions. Foliar application of 150 and 200 mg L^{-1} SA were the best treatments that reduce drought impacts on the physiological parameters significantly in comparison to the no spray treatment. Considering the environmental impact and cost effectiveness, application of 150 mg L^{-1} SA may be considerably effective in reducing the drought impact on young tea. Further studies are necessary to determine the frequency of application to sustain the plant vigor during drought.

Financial assistance from the Tea Research Institute is acknowledged.

Keywords: Drought, Physiological responses, Plant hormones, Salicylic acid, Tea

Abstract No: 122 ***Life Sciences***

CANINE VECTOR BORNE DISEASES OF WORKING MILITARY DOGS OF SRI LANKA AIR FORCE, FREE-ROAMING AND PRIVATELY OWNED DOGS

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Canine Vector-Borne Diseases (CVBDs) are a major health problem among dogs, globally. An island-wide study examined the prevalence of CVBDs in military working dogs in the Sri Lanka Air Force (SLAF), in free-roaming and in privately owned dogs. Blood samples from 668 dogs were collected from the tip of the dog's ear from July 2016 to July 2019. Thin blood smears prepared and fixed in methanol were stained in Giemsa, and observed under light microscopy. Out of the sampled dogs, 173 were from 19 SLAF establishments (30 with clinical signs), 115 healthy free-roaming and 90 privately owned dogs living in close proximity to SLAF establishments, 90 free-roaming and 200 privately owned dogs that were taken to different veterinary clinics. Overall, 169 (25.3%) dogs were infected with blood parasites. Prevalence of CVBD in dogs from SLAF, free-roaming and privately owned dogs were 22.5%, 26.3% and 26.5%, respectively. There was no difference in the prevalence between male (23.6%) and female (26.4%) dogs or between SLAF dogs (22.5%) and other dogs (26.2% $\chi^2 = 0.93$, $p = 0.33$). However, fewer asymptomatic SLAF dogs (11.1%) were positive compared to asymptomatic dogs from other sources (18.4%; $\chi^2 = 4.06$, $p = 0.04$). Seven haemoparasites were identified microscopically: *Babesia gibsoni*, *B. canis, Ehrlichia canis, Anaplasma platys, Leishmania* sp., *Hepatozoon canis* and microfilariae. *Babesia gibsoni* was the most common vector borne parasite among the dogs. *Leishmania* sp. and *H. canis* were always single infections while microfilaria always occurred as mixed infections. There was no difference in the prevalence of *B. gibsoni* in SLAF dogs (8.6%) and the other dogs (13.3%; $\chi^2 = 2.61$, $p = 0.10$). However, the prevalence of *A. platys* was higher in SLAF dogs (4.6%) compared to the other dogs (1.2%; $\chi^2 = 7.27$, $p = 0.001$). The asymptomatic dogs, especially the free-roaming ones, possibly provide reservoirs of infection and investigation of the relationship between parasite load and clinical signs of infection need further study.

Financial assistance from the University of Peradeniya (Grant No. URG/2016/68/V) is acknowledged.

Keywords: Free-roaming dogs, Owned dogs, Vector borne diseases, Working dogs

Abstract No: 124 ***Life Sciences***

MITOCHONDRIAL DNA BASED PHYLOGENY OF SRI LANKAN SUNBIRDS (PASSERIFORMES: NECTARINIIDAE)

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Sunbirds are small nectar-feeding pollinators found throughout Africa, southern-Asia, and Australasia. Though over 125 species of sunbirds have been identified under 14 genera, phylogenetic relationships of most species within the family are poorly known. Sri Lankan biota includes three non-endemic sunbird species; Loten's sunbird (*Cinnyris lotenius*), Purple sunbird (*Cinnyris asiaticus*), and Purple-rumped sunbird (*Leptocoma zeylonica*), that also inhabit regions in Southern-Asia. As no phylogenetic hypothesis exists for sunbirds reported in Sri Lanka, this preliminary study was conducted to establish their molecular phylogeny using mitochondrial ATPase subunit 6 (ATPase 6) and NADH dehydrogenase subunit 3 (ND3) gene sequences. A concatenated data set with total of 900 bp (ATPase 6, 591 bp; ND3, 309 bp), including seven sequences of the three Sri Lankan species from Mannar and Bundala and 31 reference sequences (30 other sunbird species in the world and an outgroup; *Pycnonotus barbatus*), obtained from National Centre for Biotechnology Information was analysed. Phylogenetic trees were constructed using Maximum Likelihood and Bayesian Inference. The topologies of the resulting trees were 100% congruent. Results revealed that Purple-rumped sunbird forms a strongly-supported monophyletic basal lineage sister to all the other sunbirds included in this analysis, reinforcing the hypothesis of Asian (Indian subcontinent) origin of sunbirds. Purple sunbird and Loten's sunbird are found in a clade where majority are from Africa. Further, Purple sunbird is the most recently evolved Sri Lankan sunbird which shows a sister-group relationship with Loten's sunbird. Results also reaffirmed the polyphyletic nature of genus *Cinnyris*. This study concludes that in Sri Lanka, Purple-rumped sunbird is evolutionarily the oldest sunbird and perhaps could be one of the ancestral species remaining today. However, a detailed phylogenetic analysis should be done using nuclear genes and more samples from a wider geographical range to unravel the evolutionary history of sunbirds in Sri Lanka.

Financial assistance from the National Research Council, Sri Lanka (Grant No. NRC/17/094), is acknowledged.

Keywords: ATPase 6, *Cinnyris asiaticus*, *Cinnyris lotenius*, *Leptocoma zeylonica*, ND3

Abstract No: 128 ***Life Sciences***

MOLECULAR DISCRIMINATION OF CEYLON CINNAMON (*Cinnamomum verum*) FROM ITS MAJOR ADULTERANT CHINESE CINNAMON (*C. aromaticum*)

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Cinnamomum verum, also known as true cinnamon, is one of the Sri Lanka's premier exports. However, *C. verum* is regularly adulterated with *C. aromaticum*. Therefore, frequent testing for adulteration is of paramount importance to retain the quality and the reputation of Ceylon cinnamon. Although, these two species can be distinguished morphologically and chemically, there are limitations associated with admixtures in the form of powders or value-added products. In this context, molecular techniques can be applied to discriminate even when the admixtures are from genetically close plant species. Therefore, the objective of this research was to develop a novel genetic assay that can be applied in molecular screening methods. In this regard, sequences of *C. verum* and *C. aromaticum* were retrieved from NCBI for *rbc*L, *mat*K, *trn*L, *trn*L-*trn*F and ITS2 barcode regions, and analyzed using MEGA v7.0. The results indicated that the ITS2 region, having the highest variable site percentage (21.99%), was followed by *rbc*L (0.65%) and *trn*L (0.39%). The lowest values were reported by *mat*K (0.15%) and *trn*L-*trn*F (0%). Therefore, ITS2 and *rbc*L regions were selected as the most suitable barcode regions for primer designing. According to the properties of the designed primers, the ITS2 markers were rejected due to the high SNPs dispersion, that affected the anneling temperature of the PCR reaction. The best-performing *rbc*L primer pair was selected through trial and error, and the nucleic acid sequence of the selected primers for *rbc*L region are Forward - 5′-GAGACTAAAGCAAGTGTTGGATTC-3′ and Reverse - 5′- CCACAATA GAAGTAAACATG-3′. This amplifies a region of 348 bp which covers three distinct SNPs that can be used to discriminate *C. verum* from *C. aromaticum*. These preliminary results indicate that the *rbc*L is the most suitable region for designing primers to be incorporated in the genetic assay to detect adulteration in any commercially available *C. verum* product.

Financial assistance from the World Bank (Grant No. AHEAD/RA3/ICE/PDN/SCI/ACTION5) is acknowledged.

Keywords: Adulteration, *Cinnamomum*, *In-silico* analysis, Molecular markers, SNP

Abstract No: 129 ***Life Sciences***

ISOLATION AND AMPLIFICATION OF GENOMIC DNA FROM POWDERED ADMIXTURE OF BLACK PEPPER AND ITS MAJOR ADULTERANTS

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Ceylon black pepper (*Piper nigrum* L.) is traded internationally at a premium price as it is quite rich in piperine. Pepper industry in Sri Lanka faces a major threat due to the adulteration with inferior substitutes, such as papaya seeds and chili. Based on morphological characteristics, it is difficult to distinguish these adulterants since they are converted to visually undetected forms during processing. The use of molecular approaches is the most attractive strategy under these circumstances. However, it is challenging to extract sufficient amount of DNA from this admixture since pepper and papaya seeds are recalcitrant storage tissues containing high level of polyphenols, polysaccharides and proteins. Therefore, isolated DNA is contaminated with a brownish, sticky and viscous matrix. Current protocols for isolation of DNA from black pepper require specific chemicals, such as PEG 6000, liquid nitrogen and commercial kits, and labor-intensive steps to eliminate inhibitors, such as polyphenols. In this research, the original CTAB DNA extraction protocol devised by Doyle and Doyle was modified by increasing the concentration of β-mercaptoethanol up to 0.25%, PVP 2% and a phenol extraction step, to yield high quality DNA from black pepper, papaya and chili. The concentration of DNA of all samples obtained from 0.2 g of starting material exceeded 250 ng μL^{-1}. The isolated DNA was PCR amplified using universal primers, *rbcL* and *psbA-trnH*, and the results supported the efficacy of the protocol to extract good quality DNA for further molecular analysis. The capability of PCR amplification from any material including powdered admixture of black pepper, papaya and chili affirms the validity of the tests being developed in adulterant detection. This may also be applicable to other adulterants in traded black pepper including wild varieties, such as *P. galeatum* and *P. attenuatum*.

Financial assistance from the World Bank (*Grant No. AHEAD/RA3/ICE/PDN/SCI/ACTION5) is acknowledged.*

Keywords: Admixture, Adulteration, Black pepper, CTAB, DNA

Abstract No: 130 ***Life Sciences***

COMPARISON OF ANTIBIOTIC RESISTANCE PREVALENCE BETWEEN CATTLE FARMS IN KANDY AND KURUNEGALA DISTRICTS

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Emergence of antibiotic resistance is one of the intractable challenges to public health. Overuse and misuse of antibiotics in animals can lead to antibiotic resistance development. For example, prolonged exposure to antibiotics can develop resistance in cattle gut bacteria which are released to the environment through excretion. The goal of this study was to compare the antibiotic-resistance of cattle farms in Kandy and Kurunegala Districts. During our previous study, it was found that amoxicillin resistant bacteria (ARB) and chloramphenicol resistant bacteria (CRB) were present in cow dung samples obtained in Kandy District. The same study was continued in Kurunegala District having the highest cattle population in the country. In this research, cow dung samples from 15 farms in Kurunegala District were screened for antibiotics resistance using a 96 well plate-based high throughput assay in the presence of amoxicillin, chloramphenicol, gentamicin, ciprofloxacin and nalidixic acids. *Escherichia coli* (ATCC 25922), *Pseudomonas aeruginosa* (ATCC 25619) and *Staphylococcus aureus* (ATCC 25923) strains were used as susceptibility testers to validate the assay. Out of 30 farms in both districts, 86% showed the presence of ARB. Further, CRB were found in all the selected farms in Kandy District although they were not present in any farm in Kurunegala District. For further characterization, antibiotic-resistant bacteria were isolated from cow dung samples from Kandy District using the pour plate method. Morphological and biochemical tests together with DNA sequencing revealed that ARB and CRB were *Pseudomonas aeruginosa* and *Acinetobacter burmannii*, respectively. Minimum inhibitory concentration (MIC) values of ARB for amoxicillin and CRB for chloramphenicol obtained were 6400 µg mL^{-1} and 640 µg mL^{-1}, respectively, which were 200 and 20-fold higher compared to their standard MIC values. New MIC values of antibiotic resistant bacteria isolated from samples of Kurunegala District are expected to obtain. The preliminary results indicate a variation of the prevalence of antibiotic resistance between the two districts, and hence the study could be expanded to other districts in the country for better understanding. Since cow dung is used as organic manure, our findings are of great importance to understand the dispersal of antibiotic resistance in agricultural fields.

Financial assistance from the University of Peradeniya (*Grant No. URG/2018/38/S*) *is acknowledged.*

Keywords: Amoxicillin, Antibiotic resistance, Chloramphenicol, Cow dung, Minimum inhibitory concentration

Abstract No: 131 ***Life Sciences***

ANTIOXIDANT, ANTIMICROBIAL AND PHYTOCHEMICAL SCREENING OF *Micromelum minutum* LEAF EXTRACTS

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Micromelum minutum (Rutaceae) is a less-known spineless shrub or a small tree, commonly known as *"wal-karapincha"* in Sinhala. *M. minutum* is found in monsoon forests, especially in the North-Central Province of Sri Lanka. This plant is more popular as a spice and a medicinal plant in the country, and as a leafy vegetable in many other countries. Aerial parts and fruits of *M. minutum* contain coumarins and other important phytochemicals, such as phenyl propanoic acid derivatives, polyoxygenated flavonoids, carbazole alkaloids and other phytochemicals. Hence, they possess high antioxidant potency. Therefore, the roots *M. minutum* is used to treat toothache in alternative traditional medicine, and in treatment of malaria and other infectious diseases. Therefore, the antioxidant, antimicrobial and phytochemical screening activities of *M. minutum* were evaluated in the current study to understand its efficacy as a medicinal plant. The macerated methanol extracts demonstrated a significant amount of antioxidant activity (IC_{50} = 263.0 ± 8.8 μg mL^{-1}) in 1,1-diphenyl-2-picrylhydrazyl (DPPH) assays. Furthermore, the methanolic extract contains more or less amounts of tannins, flavonoids, phenols, and alkaloids. Saponins were not found in *M. minutum*. Methanolic leaf extract of *M. minutum* exhibited significant inhibitory activity against *Staphylococcus aureus* and *Escherichia coli*, and the zone of inhibition was 7.43 ± 0.06 mm and 7.13 ± 0.57 mm, respectively. These findings reveal that the macerated methanolic extract is found to have good antioxidant activity as well as antimicrobial activities, and contains many valuable phytochemicals. This study proves the medicinal values of the plant leaf extracts of *M. minutum* that could be used as an excellent source of natural bioactive compounds in pharmacology.

Financial assistance provided by the National Research Council (Grant No. 18-063) is acknowledged.

Keywords: Antimicrobial, Antioxidant, *Micromelum minutum*, Phytochemical

Abstract No: 132 (Oral) ***Life Sciences***

USE OF SPOROPHYTIC CHARACTERS IN THE IDENTIFICATION OF MOSSES (PHYLUM BRYOPHYTA)

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Phylum Bryophyta (Mosses) is the most specious group among bryophytes. According to most recent literature, 575 species of mosses have been recorded from Sri Lanka, and 11% of them are endemic. Mosses, like all other bryophytes, have a life cycle with a dominant, haploid gametophytic generation and a dependent diploid sporophytic generation. Identification of mosses is therefore a challenging task. Hence, the present study was carried out to investigate the use of sporophytic characters in the identification of mosses. Fresh samples of mosses along with sporophytes were collected into paper packets and annotated with collection details. Collected specimens were thoroughly surveyed for their morphological and anatomical characters using dissecting, light and compound microscopes. All the characteristic features of gametophyte and sporophyte were recorded for each specimen studied. Samples were identified up to the generic/species level using available taxonomic keys and monographs. Identified samples were authenticated using protologues. A total of 11 families, 23 genera and 54 species of mosses were identified during the study with two species recorded as new to Sri Lanka: *Tortella flavovirens* (Bruch) Broth and *Hyophila propagulifera* Broth. Unique characters for different taxonomic levels such as pomiform capsule for family bryaceae, nematodontous peristome for genus *Ceratodon*, and needle-like awn in operculum of *Fissidens ceylonensis* were identified. Taxonomic keys were prepared based on the selected unique sporophytic characters. With the two new records identified during this study, the number of recorded moss species of Sri Lanka increases from 575 to 577.

Keywords: Morphology, Mosses, Sporophytes, Taxonomy

Abstract No: 133 ***Life Sciences***

A PRELIMINARY STUDY OF MICROCLIMATIC CONDITIONS ON OCCURRENCE OF BRYOPHYTES

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Sri Lanka is a small island nation in the Indian Ocean. It is part of one of the major biodiversity hotspots in the world. The vast topographic and climatic heterogeneity in the country has contributed to a high diversity of bryophytes in different ecosystems. According to recent literature, Sri Lankan bryophytes comprise of 575 mosses, 330 liverworts and 7 hornworts. Bryophytes are known as primary indicators of changes in climatic conditions in many parts of the world. Bryophytes show species-specific preferences for habitats with varying microclimatic conditions. Therefore, the present study was carried out to investigate the microclimatic conditions preferred by bryophytes in some geographical localities including Kaudulla National Park (Polonnaruwa), Around Bathalegoda lake (Kurunegala), Elkaduwa (Matale), Loolecondera Conservation Forest (Kandy) and Madolsima (Badulla). Microclimatic data including light availability (lux), relative humidity (RH) and air temperature in each habitat considered were recorded during the collection of bryophytes. Soil samples of the substrates were analyzed for soil moisture content and soil pH. Taxa encountered under each microclimatic condition were identified up to generic/specific level using morphological and anatomical characteristics. Identified species included 46 mosses, 14 liverworts and one hornwort. *Tortella tortuosa* (Hedw.) Limpr. was recorded as a species new to Sri Lanka. Majority of taxa encountered during the study preferred < 40,000 lux light intensity, (22 - 27 ^{o}C) temperatures, (70 - 80%) RH, (50 - 60%) soil moisture content and 86% of the taxa studied were found in acidic soil (pH 4.0 - 6.0). The study will be continued in different geographical localities throughout the country during different time periods to explore the effect of microclimatic conditions on bryophyte diversity. The results of the present study will contribute in implementing conservation measures for Sri Lankan bryophytes.

Keywords: Biodiversity, Bryophytes, Conservation, Microclimate

Abstract No: 135 ***Life Sciences***

BIOACTIVE EXTRACTS FROM ENDOPHYTIC FUNGI ASSOCIATED WITH POPULAR ANTIDIABETIC MEDICINAL PLANT *Coccinia grandis*

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Endophytic fungi are an important source of renewable and environmentally friendly novel bioactive compounds. Hence, the present study was undertaken to investigate the chemistry and bioactivities of secondary metabolites of endophytic fungi from *Coccinia grandis* which is well known to possess anti-diabetic activity. The surface treated leaf segments (5×5 mm) were placed on potato dextrose agar (PDA) and two types of endophytic fungi (fungus SB/CG/A and SB/CG/B) were isolated. The pure fungal strains were cultured in Potato Dextrose Broth (PDB) medium. The completion of a 21-day period was followed by extracting the media with ethyl acetate (EtOAc) (1:1) and mycelia were extracted with EtOAc followed by methanol (MeOH). The EtOAc extracts of medium and mycelium of both fungi were separately combined. The crude extracts were screened for DPPH (2,2′-diphenyl-1-picrylhydrazyl) free radical scavenging activity, antifungal activity against *Cladosporium cladosporiodies*, phytotoxic activity against Lettuce seed germination, α-amylase and α-glucosidase enzyme inhibitory activities. Compared to the positive control in each assay, both EtOAc and MeOH extracts of SB/CG/A showed high α-amylase inhibition activity (IC_{50} = 418.38 mg L^{-1} and IC_{50} = 619.75 mg L^{-1}, respectively) while EtOAc extract of SB/CG/B showed high α-glucosidase inhibition (IC_{50} = 207.72 mg L^{-1}). For the antioxidant activity, EtOAc extract of SB/CG/B end up with IC_{50} of 621.56 mg L^{-1}. None of the extracts, except EtOAc extract of SB/CG/A showed antifungal activity. The EtOAc extract of the SB/CG/A inhibit root germination of lettuce seed while MeOH extract inhibited shoot germination. The EtOAc extract of SB/CG/B inhibit both shoot and root germination. Both EtOAc extracts were subjected to column and thin-layer chromatography (Silica gel followed by Sephadex LH-20, RP-18 open columns and PTLC) to give total of 12 compounds. Molecular identification of SB/CG/A and SB/CG/B fungi, structure elucidation of isolated compounds and screening their bioactivities are in progress.

Financial assistance from the National Research Council of Sri Lanka (*Grant No. NRC-17-054*) *is acknowledged.*

Keywords: *Coccinia grandis,* Endophytic fungi

Abstract No: 137 ***Life Sciences***

DETECTION OF *Dirofilaria repens* IN PET DOGS IN NUGEGODA AREA IN COLOMBO DISTRICT, SRI LANKA

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Canine dirofilariasis is a mosquito borne disease caused by Nematodes that belongs to the Genus *Dirofilaria*. Due to its ability to cause ocular dirofilariasis in humans, *Dirofilaria repens* is considered as an important zoonotic parasite. Although ample numbers of studies about human dirofilariasis are recorded in Sri Lanka, only few were focused on canine dirofilariasis. The main objective of this preliminary study was to investigate the prevalence of *D. repens* in domesticated dogs in Nugegoda, a suburb in Colombo District, in order to determine their potential reservoir status. Blood samples (5 mL) were collected from conveniently selected 30 pet dogs from Nugegoda area in Colombo District by registered veterinary surgeons. A single step multiplex PCR was carried out to detect *D. repens* in the blood samples using a set of primers previously designed on a portion of the small subunit ribosomal RNA gene of the mitochondrion (12S rDNA). Positive samples of *D. repens* were provided by the Faculty of Medicine, University of Kelaniya. PCR products were visualized in agrose gel electrophoresis. Modified Knott's Concentration methods was also used as an alternative method. All 30 samples were found negative for PCR methods, which indicates that all owned dogs tested were negative for *D. repens*. Three samples were recorded positive for filarial worms by the modified Knott's concentration method. These may be some other canine filarial worms except *D. repens* as specific PCRs were negative. Further morphological identification is needed to confirm these filarial worms. According to the results, the prevalence of *D. repens* in owned dogs in Nugegoda area are very low. This might be due to the deworming treatments and hygienic conditions provided for owned dogs. However, identification of other filarial worms prevalent in the owned dogs is important as there may be other zoonotic filarial worms also present. Further studies should be proceeded to identify the prevalence of *D. repens* and other possible zoonotic filarial worms in stray dogs and owned dogs.

Keywords: Canine dirofilariasis, Kontt's concentration method, PCR, Sri Lanka

Abstract No: 150 ***Life Sciences***

HEALTHY *Polyscias balfouriana* ROOTED CUTTINGS FOR LOCAL AND EXPORT FLORICULTURE INDUSTRY

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Polyscias balfouriana is an ornamental plant popular in the floriculture industry. Wilting of rooted cuttings is a major problem which reduces the quality. Therefore, this study was conducted to determine the best potting medium and cane characteristics to prevent wilting symptoms of rooted cuttings. The impact of the potting media (*viz*., sand only, coir only and sand:coir 1:1), effect of medium of sterilization (i.e. sterile versus non-sterile), cane characteristics (*viz*., 8 cm and 15 cm lengths and 1 and 2 cm diameters) and appropriate environmental conditions (propagator versus non-propagator) were tested in the study. The parameters measured were the number of leaves, roots, and sprouted nodes, average root length and disease incidence. Koch's postulates were performed to confirm the pathogenicity. Pathogen characterization was undertaken using spore and colony morphology. To minimize the occurrence of disease in the cane cuttings, application of a fungicide (Mancozeb, a contact fungicide) to the top end was tested. Treatments compared were fungicide incorporated with Vaseline, only Vaseline, and the control without any treatment. The parametric data were analysed using General Linear model (MINITAB Statistical software) and non-parametric data were analysed using Kruskal-Wallis test (R version 3.5.3). Plant growth parameters were significantly higher when grown on coir dust medium (p = 0.001 and p = 0.000 with the number of sprouted nodes and number of leaves, respectively). However, sterilization of the coir dust had no significant effect on the growth performance ($p > 0.05$ and $p = 0.04$ with the number of sprouted nodes and roots, respectively). Cuttings performed significantly well when the cutting length and diameter were 15 and 1 cm, respectively. Due to the cost effectiveness and the less disease incidence, the non-propagator conditions were more suitable compared to the use of propagators. Occurrence of the disease leads to stem hollowing. *Lasiodiplodia* sp. was identified as the diseases causing agent. The disease incidence was less with the fungicidal application. Therefore, choosing proper cane characteristics, potting medium and suitable growth conditions may prevent the disease and give healthy grown canes to the local and export industry.

Keywords: Coir, Disease, Fungicide, *Polyscias balfouriana*

Abstract No: 167 ***Life Sciences***

CYTOTOXIC EFFECTS OF *Carica papaya* LEAF EXTRACT AGAINST C6/36 *Aedes albopictus* CELLS

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Carica papaya is a widely used medicinal plant to treat dengue. The CytoTox 96® Cytotoxicity Assay (Promega, USA) is a colorimetric assay that quantitatively measures lactate dehydrogenase (LDH) released upon cell lysis. The objective of the current study was to measure the cytotoxic effect of *C. papaya* leaf extracts against C6/36 *Aedes albopictus* cells. *Carica papaya* leaf extract was prepared in a two-fold dilution series. Two 96 well assay plates were prepared with C6/36 cells nourished by culture medium with essential nutrients. The analytical system consisted of a negative control without C6/36 cells (only culture medium), vehicle control (untreated cells) and positive control (lysis solution) with replicates of eight wells for each. The test wells were treated with *C. papaya* leaf extracts at different concentrations. One plate was incubated at 37 ^{o}C for 5 h (LDH has a half-life of approximately nine h) and another plate was incubated for 24 h (test exposure period is 24 h for virus). Visible wavelength absorbance data were collected using a standard plate reader to enumerate the cytotoxicity of *C. papaya* leaf extracts. The experiment was conducted only once with eight replicates each. Percentage cytotoxicity in dilutions of 1/4, 1/8, 1/16, 1/32, 1/64, 1/128, 1/256, 1/512 and 1/1024 for the plate incubated for 5 h were 92.46, 56.35, 47.71, 46.74, 45.70, 44.43, 42.81, 16.56 and 13.14, respectively, and for the plate incubated for 24 h were 226.71, 135.63, 96.69, 58.39, 39.47, 28.35, 26.82, 15.52 and 15.04, respectively. Colour intensity and absorbance values decreased with the *C. papaya* leaf extract in decreasing concentrations. Higher concentrations of *C. papaya* extract have higher LDH activity and cell lysis. High concentrations of *C. papaya* leaf extracts were cytotoxic to C6/36 cells. Further, cytotoxicity testing of *C. papaya* leaf extracts will help to select the minimum toxic concentrations of the extract for antiviral activity against dengue viral infections.

Financial assistance from the University of Peradeniya (Grant No. URG/2016/47/M) is acknowledged.

Keywords: Absorbance, *C. papaya*, Cell lysis, Color intensity, Cytotoxicity

Abstract No: 174 ***Life Sciences***

RE-EVALUATING THE SPECIES LIMITS OF *Aponogeton kannangarae* AND *Aponogeton jacobsenii* USING ISSR DATA

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Based on the available literature and previous taxonomical studies, there are six *Aponogeton* species in Sri Lanka, *viz. Aponogeton rigidifolius, A. jacobsenii*, *A. crispus*, *A. natans, A. kannangarae* and *A. dassanayakei.* Among those species, the recently described *A. kannangarae* closely resembles *A. jacobsenii* in leaf morphology, especially colour, shape and size. Even though differences in leaf base and folical coat are recognized between the two species, a recent study questions the contribution of these morphological characters in distinguishing the species. Therefore, there are confusions in the identification of *A. jacobsenii* and *A. kannangarae* as two different taxa. Since morphological data did not provide adequate strength to resolve the ambiguities, ISSR (Inter Simple Sequence Repeats) based molecular markers that identify genome-wide sequence characters were utilized to gain additional evidence. Along with *A. jacobsenii* and *A. kannangarae*, two other species that are morphologically similar *A. rigidifolius* and *A. dassanayakei* were studied by ISSR-PCR amplification, and similarities between species were predicted by cluster analysis based on the stable amplified fragments using Minitab (version 16). According to the cluster analysis, *A. rigidifolius* and *A. dassanayakei* showed the highest level of similarity (49.47%). *A. jacobsenii* showed the least similarity (11.27%) to any of the other three species. Therefore, although *A. kannangarae* and *A. jacobsenii* were morphologically similar, those were distinctly different genetically. Therefore, the present molecular analysis strongly supports that *A. kannangarae* and *A. jacobsenii* are two different species, resolving the confusion on their species limits and contributing for their conservation as two distinct taxa.

Keywords: *Aponogeton*, ISSR- PCR amplification, Molecular analysis, Morphology

Abstract No: 182 ***Life Sciences***

PREVELANCE OF *Porphyromonas gingivalis* AND *Streptococcus mutans* IN DENTURE-BIOFILMS FROM A GROUP OF COMPLETE-DENTURE WEARERS ATTENDING DENTAL HOSPITAL (TEACHING), PERADENIYA, SRI LANKA

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Complete dentures (CD) support the oral functions by replacing the missing teeth of edentulous patients. Although dentures promise to solve all the oral problems faced by natural teeth, certain studies as well as cases have reported the opposite stating that CD also facilitates formation of biofilms that may harbor various opportunistic oral pathogens such as *Porphyromonas gingivalis* and *Streptococcus mutans*. These bacteria cause periodontal diseases and dental caries, respectively, and induce systemic infections in compromised patients. Studies on the presence of these microorganisms in the denture-biofilm of complete-denture wearers are rare. Hence, the present study aimed to investigate the prevelence of *P. gingivalis* and *S. mutans* in the denture biofilm of a group of complete-denture wearers attending the Dental Hospital (Teaching), Peradeniya. Biofilm samples were collected from 24 complete denture wearers. Total DNA from the denture biofilm samples was extracted using the NaOH-lysis method. The presence of microorganisms was detected based on *16S rRNA* gene-based DNA profiling. Prevalence of *P. gingivalis* in denture-biofilm was 60 - 70%, whereas prevalence of *S. mutans* was 45%. The pairwise association analysis revealed that there is a significant correlation between males and the prevalence of *S. mutans* (Pearson $\lambda^2 = 4.196$ and $p = 0.041$). A significant relationship among denture hygiene and the patient's age was also reported (Pearson correlation coefficient 0.493, $p = 0.014$) with regard to the prevalence of *P. gingivalis*. Both species were present when the patient was an older male with poor denture hygiene (25% of the subjects); however, females of similar age with good denture hygiene did not harbor either *S. mutans* or *P. gingivalis*. These results suggested that CD facilitate the prevalence of *S. mutans* and *P. gingivalis* even in an edentulous mouth. Hence, maintaining proper denture hygiene is necessary to avoid any opportunistic infections by these potential pathogens.

Keywords: *16S rRNA* gene, Denture-biofilms, Opportunistic infections, Oral pathogens, Pathogenicity of dentures

Abstract No: 183 ***Life Sciences***

BIOACTIVE EXTRACTS FROM AN ENDOPHYTIC FUNGI FROM *Zingiber officinale*

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Plant endophytic fungi have been recognized as an important source of natural products with potential application in industries. The chemistry and bioactivity of endophytic fungi in rhizome of *Zingiber officinale* were investigated to find the possible application in health and agriculture. Triple sterilized rhizome segments of *Z. officinale* were placed on potato dextrose agar (PDA) medium and incubated at room temperature in darkness. Pure culture of endophytic fungi was fermented in 12 L of potato dextrose broth (PDB) medium while shaking at room temperature for 21 days. The medium was filtered and filtrate was extracted with ethyl acetate (EtOAc) and residual mycelium was extracted using EtOAc and methanol (MeOH). Based on thin-layer chromatography (TLC), two EtOAc extracts were combined. EtOAc and MeOH crude extracts of endophytic fungi of *Z. officinale* were screened for antioxidant activity using DPPH radical scavenging method, phytotoxicity by lettuce seed germination assay, brine shrimp toxicity against *Artemia salina*, α-amylase inhibition activity and antifungal activity against *Cladosporium cladosporides*. Phytotoxicity was observed for EtOAc crude extract at 525.97 mg L^{-1} and 483.94 mg L^{-1} root and shoot inhibition, respectively. Moderate level of brine shrimp toxicity was shown in both EtOAc and MeOH extracts at 503.70 mg L^{-1} and 444.67 mg L^{-1}, respectively. Only EtOAc extract showed an inhibition zone against *C. cladosporioides*. Both EtOAc and MeOH extracts showed low antioxidant activity and low activity to α-amylase inhibitory assay. EtOAc extract was subjected to chromatographic separation over silica gel, reverse phase silica, sephadex LH-20 and preparative thin-layer chromatography to furnish eight compounds. Structure elucidation of isolated compounds and determinations of bioactivities of the isolates are in progress. According to the results of this study, antifugal, phytotoxicity and cytotoxicity potential was observed in EtOAc extract of endophytic fungi of *Z. officinale.*

Financial assistance from the National Science Foundation (*Grant No. RG/2017/BS/06*) *is acknowledged.*

Keywords: Bioactive compounds, Condiment plants, Endophytes, Secondary metabolites

Abstract No: 185 ***Life Sciences***

MORPHOLOGICAL CHARACTERIZATION OF CYANOBACTERIA IN EXTREME ECOSYSTEMS OF SRI LANKA

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Sri Lanka, along with Western Ghats of India, is a biodiversity hotspot enriched with floral, faunal and microbial diversity. A diverse collection of ecosystems representing a range of environmental conditions contributes to this diversity. Ubiquitous, photosynthetic cyanobacteria with diverse morphological and biochemical modifications are a significant contributor of higher microbial diversity in these ecosystems. Being photosynthetic and capable of producing diverse, economically valuable bio-compounds make them ecologically and economically important. Most of them are fast growing and require less space and nutrients for growth, thus are economical over plant material in industry. They promote promising safe and low cost natural alternatives for current global demands: food shortage and Ultra Violet protection. However, most of their existence and diversity in these ecosystems is unnoticed thus not considerably discovered. Therefore, this study was carried out to investigate cyanobacteria diversity in extreme ecosystems of Sri Lanka based on morphological characterization. Two water samples were collected from surface and subsurface water in each site representing extreme ecosystems; 13 sites in salt marshes, 18 in mangroves, four in hot-water springs and four in lagoons. Culturing was carried out in BG 11 medium under 1,000 – 2,000 lux fluorescent light intensity with constant illumination at 25 - 30 °C. Purified monocultures were isolated by subsequent plate, liquid culturing and microscopic observations. Microscopic images were photographed with IMAGE FOCUS 4.0 software and morphologically characterized based on comparisons with available literature. One hundred and forty monocultures were isolated and 15 different cyanobacterial genera and orders including *Leptolyngbya*, *Oscillatoria*, *Nodosilinea*, *Anabaena*, *Geitlerinema*, *Gloeocapsa*, *Microcystis*, *Nostoc*, *Synechococcus*, *Lyngbya*, *Spirulina*, *Limnothrix*, *Pseudanabaena*, *Chroococcales* and *Oscillatoriales* were identified. *Leptolyngbya* is a dominant species in 12 salt marshes and 13 mangrove ecosystems while *Chroococcales* and *Pseudanabaena* were frequently recorded in all four studied hot-water springs. Morphological characterization revealed evidence for rich cyanobacteria diversity in extreme ecosystems in Sri Lanka. It further highlights the necessity of conserving this natural resource while utilizing them sustainably. Thus, extensive molecular characterization is necessary to provide a precise, informative and static picture of cyanobacterial diversity in Sri Lanka for conservation, future research and sustainable utilization of this valuable natural resource.

Financial assistance from the National Institute of Fundamental Studies is acknowledged.

Keywords: Cyanobacteria, Diversity, Extreme ecosystems, Morphology

Abstract No: 187 ***Life Sciences***

SPECIES LIMITS OF *Lagenandra* IN SRI LANKA USING MOLECULAR DATA

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Lagenandra Dalz. is a genus of semiaquatic flowering plants belonging to the Family Araceae. This genus is mainly distributed in India and Sri Lanka. According to the last revision in 2000, eight species are recorded in Sri Lanka of which seven are endemic to the country. The genus is of enormous export value to the aquatic plant industry in Sri Lanka, where many members are traded. Overexploitation, destruction of habitats and illegal constructions have imposed many threats to the genus. Consequently, all the species except *L. ovata* and *L. praetermissa* have been listed as endangered during the national red listing in 2012. In Sri Lanka, the taxonomic literature available on the genus is lacking. A preliminary morphometric analysis has revealed eleven phenetic groups within the genus. The objective of the present study was to re-evaluate these phenetic groups using molecular data to determine the species limits of the genus. Molecular analysis was carried out for the genus *Lagenandra*, using the internal transcribed spacer region (ITS) of the nuclear ribosomal DNA. Extraction of DNA was perfromed from freshly collected leaves, followed by PCR amplification. Sequences were edited and phylogenetic trees were constructed using the Parsimony method and model-based methods, such as Maximum likelihood and Bayesian inference analysis. *Lagenandra* species included in the present study were supported as a monophyletic genus in all the trees. Each phylogenetic tree consisted of eleven phyletic groups corresponding to the phenetic groups in the morphological study. Therefore, results support the recognition of eleven phenetic groups in the genus *Lagenandra* in Sri Lanka indicating the presence of more than eight species. This study would bring new insights into taxonomic updating and the conservation strategies of genus *Lagenandra* in Sri Lanka. This is the first study in the world for genus *Lagenandra*, based on DNA sequence data for molecular phylogeny.

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Keywords: ITS, *Lagenandra*, Molecular, Phenetic, Phyletic

Abstract No: 188 ***Life Sciences***

ENZYME INHIBITORY ACTIVITY OF TWO CARBAZOLE ALKALOIDS ISOLATED FROM *Murraya koenigii* (CURRY LEAVES)

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Since ancient times, people have used plant parts and plant extracts to cure diseases and to relieve pain. Since the begining of the 18th century, scientists have been discovering many plant- based drugs that are still used in medical practices. A current drug discovering strategy is to search for enzyme inhibitors. Inhibition of α-amylase or α-glucosidase enzyme with an effective inhibitor is one treatment strategy to control blood glucose level in diabetic patients. Acetylcholinesterase enzyme inhibitors are used in the treatments of neurological disorders. *Murraya koenigii* (Curry leaves) is used in Sri Lankan cuisine as a leafy spice and in the production of cosmetics because of its distinct aroma. Many carbazole and triterpenoid alkaloids with different pharmacological activities have been reported from *M. koenigii*. This study was focused on the investigation of α-amylase, α-glucosidase and acetylcholinesterase enzyme inhibitory activities of compounds present in leaves of *M. koenigii*. Dry powdered leaves were sequentially extracted with hexane, ethyl acetate and methanol and crude extracts obtained were chromatographed to furnish two pure compounds. The compounds were identified as 8-hydroxymahanimbine and (+)-(*R*) mahanine based on NMR analysis. The two carbazole alkaloids were tested for inhibitory activities against α-amylase, α-glucosidase and acetylcholinesterase enzymes. 8-Hydroxymahanimbine showed the highest α-amylase inhibitory activity of IC_{50} 85.2 µg mL^{-1} and α-glucosidase inhibitory activity of IC_{50} 63.5 µg mL^{-1} while (+)-(*R*) mahanine showed α-glucosidase inhibitory activity of IC_{50} 52.9 µg mL^{-1} and acetylcholinesterase inhibitory activity IC_{50} 29.7 µg mL^{-1}. These findings suggest that that 8-hydroxymahanimbine has a good potential as antidiabetic agent while (+)-(*R*) mahanine shows dual activities as an antidiabetic agent and an anticholinesterase agent. This is the first report of 8-hydroxymahanimbine as a natural product.

Keywords: Carbazole alkaloids, Enzyme inhibitors, 8-Hydroxymahanimbine, (+)-(*R*) mahanine

Abstract No: 189 ***Life Sciences***

A PRELIMINARY PHYLOGENY AND MORPHOLOGICAL ANALYSIS OF GENUS *Epidelaxia* (ARANEAE: SALTICIDAE) IN SRI LANKA

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The genus *Epidelaxia* Simon, 1902 contains four species, of which *Epidelaxia albostellata, Epidelaxia albocruciata* and *Epidelaxia obscura* are endemic to Sri Lanka. The fourth species, *Epidelaxia maurerae*, is found in the Philippines. Since its initial description, *Epidelaxia* remained taxonomically unrevised and has never been subjected to phylogenetic evaluation. The objective of the present study was to undertake taxonomical revision and phylogenetically place *Epidelaxia.* Fieldwork was conducted in 31 localities covering the central highlands and lowland rain forests of Sri Lanka based on the localities of the described species. Beating, hand collection and litter sampling were undertaken. Seventy-one specimens were collected and preserved in either 70% ethanol for morphological identification or 100% for molecular analysis. Left male palp and female genitalia were illustrated using stereo microscopes. A series of phylogenetic analysis was performed both on morphological and molecular data. Total genomic DNA was extracted from 25 specimens using DNeasy Tissue Kit. Partial fragment of mitochondrial protein-encoding gene cytochrome c oxidase subunit I (*COI*) and two nuclear ribosomal genes, 18S and 28S rRNA, were amplified. Sixteen DNA sequences were edited and assembled using Geneious 11.0.2 software. Maximum likelihood (ML) trees were inferred with MEGA ver. (X). Parsimony analysis of the morphological data matrix was carried out in TNT 1.1. *E. albostellata*, *E. albocruciata* and *E. obscura* are redescribed and an identification key for all species of *Epidelaxia* from Sri Lanka is provided. *E. albostellata* (60%) is widely distributed in the Central Highlands. *E. albocruciata* (28%) is distributed only in low land rain forests. *E. obscura* (5%) is recorded only in Kandy and Badulla Districts. Two new *Epidelaxia* species were recorded from the Knuckles region and the Kataragama peak. The resulting cladistics analysis, based on 63 morphological characters from 17 taxa (5 *Epidelaxia* species and 12 out - groups) supports 5 species in the genus *Epidelaxia.* All ML trees recovered the *E. albostellata, E. albocruciata* clades and validated the existence of two new species. *E. obscura* needs to be validated in ML tree. Further, ML trees validated the placement of genus *Epidelaxia* and new genera under the tribe Nannenini.

Financial assistance provided by the National Institute of Fundamental Studies, Sri Lanka, is acknowledged.

Keywords: Diversity, *Epidelaxia*, Nannenini, Phylogeny, Sri Lanka

Abstract No: 190 ***Life Sciences***

MOLECULAR PHYLOGENY AND TAXONOMY OF GENERA *Argyrodes* AND *Rhomphaea* (ARANEAE: THERIDIIDAE) IN SRI LANKA

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Comb-footed spiders are highly diverse from the perspective of species richness, morphological diversity, web architecture and behavioural repertoires. The genera *Argyrodes* and *Rhomphaea* are part of the subfamily Argyrodinae. Genus *Argyrodes* is known for their kleptoparasitism and *Rhomphaea* are solitary. A large number of endemic species from both genera remains undiscovered and unrecorded in Sri Lanka. The diversity and phylogeny of Sri Lankan species, in relation to other Asian and American species, were investigated. Field work was conducted in 40 localities representing 12 districts in Sri Lanka. One hundred and seventy (170) spiders from both genera were collected by hand or by beating vegetation. Samples were preserved in 70% ethanol for morphological study or 100% for molecular genetic analysis. Morphological identification was carried out using a stereomicroscope and published descriptions of species from the surrounding region. This was followed by detailed drawings of genitalia. Geometric morphometric analysis was conducted only for *Argyrodes* spp. Digital images of male carapace were taken and processed using tps Util and tpsDig2. Principal Component Analysis (PCA) and Canonical Variance Analysis (CVA) were conducted for digital images of male carapace using MorphoJ v 1.05 to track shape changes of male carapace. A Molecular Phylogeny of 43 Sri Lankan species from both genera with 53 Asian and American species representing six recognised genera of the subfamily Argyrodinae (32 taxa from *Argyrodes*, 17 taxa from *Rhomphaea*, 6 taxa from *Faditus*, 3 taxa from *Neospintharus* and 3 taxa from *Ariamnes*) were sequenced. The matrix of 2152bp length included fragments of three genes: two mitochondrial genes 16S rRNA (primers NIJ-12581 and LRN-12945R~536bp), COI (LCO1-1490 and HCO-2776~1067bp) and one nuclear gene 28S rRNA (28Sc and 28So~544bp). DNA sequences were edited and aligned using Genious 11.1.5 and Mesquite v 3.51. Partition finder was used to determine appropriate model for each partition. Maximum-likelihood (ML) tree was inferred with RaxML and Bayesian analysis on MrBayes. Consensus trees of both Bayesian and ML analysis supported the monophyly of *Rhomphaea*, while *Argyrodes* was paraphyletic. Sri Lankan *Argyrodes* species were recovered in five clades. Morphometric analysis of carapace shape also supported to distinguish the corresponding clusters of *Argyrodes.* Species level identification of both genera was strongly supported by the drawings of their genitalia. Under genus *Argyrodes* five species were diagnosed, and among them, three species (*A. antipodinus, A. flavescens, A. nasutus*) were previously described by Pickard O. Cambridge in 1880 while the other two were new species. Further, the present study records the genus *Rhomphaea* for the first time in Sri Lanka with four new species.

Financial assistance from the National Institute of Fundamental Studies is acknowledged.

Keywords: *Argyrodes*, Molecular, Phylogeny, *Rhomphaea*, Sri Lanka

Abstract No: 191 ***Life Sciences***

CYTOTOXIC POTENTIAL OF *α,β*-UNSATURATED KETONES OF 3*β*-[(*α*-L-ARABINOPYRANOSYL)OXY]OLEAN-12-EN-28-OIC ACID IN HUMAN NON-SMALL CELL LUNG CANCER (NCI-H292) CELLS USING SULFORHODAMINE B ASSAY

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Lung cancer is the leading cause of cancer deaths throughout the world. Non-small cell lung cancers (NSCLC) are the most prevailing lung cancers, accounting for about 80% of all lung cancers. Undesirable side effects and rapid development of resistance for chemotherapeutic drugs have increased the demand for novel alternative therapeutics. A number of new drugs with greater pharmacological activity have been obtained from natural sources by modification of functional groups of leading natural compounds. Therefore, synthesis of natural product derived compound libraries in the search for novel drugs is still a priority goal for cancer therapy. 3*β*-[(*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 μg mL^{-1} while exhibiting a comparable toxicity value (IC_{50}=5.702 μg mL^{-1}) against normal lung (MRC-5) cells. The objective of this study was to synthesize structural analogues at C11 position of the APOA and to study the effect of those on anti-cancer activity. 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 position of the APOA, acetylated APOA (Ac-APOA) and ethyl ester of Ac-APOA were oxidized to afford respective *α,β*-unsaturated ketones, and their structures were confirmed. Comparative cytotoxic effects of the synthesized analogues were assessed using SRB assay against APOA. The results indicated that all the oxidized derivatives exerted potent cytotoxic activity against NCI-H292 cells while being less toxic to normal lung (MRC-5) cells compared to the parental saponin indicating better activity. These empirical data suggest that the modification at C-11 of APOA could be a lead to promising new anticancer agents.

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Keywords: Non-small cell lung cancers, *Schumacheria*, Structural analogues, α,β-unsaturated ketones, Sulforhodamine B assay

Abstract No: 214 ***Life Sciences***

ASSESSMENT OF BLAST DISEASE DAMAGE IN FINGER MILLET FARMER FIELDS: A PRELIMINARY INVESTIGATION

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Blast is a serious disease in finger millet (*Eleusine coracana*) worldwide. The objective of the present study was to estimate blast disease damage in finger millet farmer fields in Sri Lanka. Four randomly selected fields in two agroecological zones DL1b and DL2 were screened. Fields located at DL1b include, one at Anuradhapura which was 2 months after planting (F1), a field at Ampara, which was 4 months after planting (F2) and a field at Puttlum which was 2.5 months after planting (FIV). Fields located at DL2 include one at Puttlum which was 1.5 months after planting (FIII). Variety 'Oshadha' was cultivated in FI and FIV whereas traditional varieties were grown in FII and FIII. Three independent researchers visually estimated disease incidence (DI) percentage and disease severity (DS) percentage in three 1 m^2 plots per field. A detailed analysis was carried out using samples of 30 plants from FIII and FIV using a 1 to 9 DS scale based on lesion counts. The DS was 5%, 5%, 30% and 23% and DI was 84%, 0%, 100% and 100%, respectively, in the Fields I, II, III and IV. Seed broadcasting was practiced in three out of the four fields studied (FI, FIII and FIV) where the average plant density was 99/$m^{2.}$, twice higher than in field where transplanting was practiced. The variety Oshadha in FI and FIV rated different DI and DS despite both fields being in DL1b; thus details of agronomic practices that directly affect disease damage need to be well-thought-out in large-scale disease assesments. Based on lesion counts FIII rated 4, and FIV rated 8, showing that visual estimations and counted data were in contrast highliging the need for more accurate protocols for field disease evaluation. Compared to the rest, FIII rated low lesion counts and lesions were ≤ 1 mm in diameter. Restricted lesion diameter indicates R gene mediated host resistance and the farmer variety in FIII provide genetic resources for potential putative R genes. The outcome of this study provides essential preliminary infomation for implementing an island-wide disease assessment.

Financial assistance from the National Research Council (*Grant No. 18-091*) *is acknowledged.*

Keywords: Agro-ecology, Agronomy, Disease incidence, Disease severity, R genes

Abstract No: 216 ***Life Sciences***

ANTIFUNAGAL NAPHTHOQUINONES FROM FUNGUS *Monacrosporium ambrosium* FROM *Camellia sinensis*

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Tea (*Camellia sinensis*) is a perennial crop that is grown on large continuous areas and creates a stable environment for plant feeding insect pests. The tea shot-hole borer (TSHB) beetle (*Xyleborus fornicatus*) is one such insect pest. TSHB has a symbiotic relationship with the filamentous fungus *Monacrosporium ambrosium* (ambrosia fungus, Syn. *Fusarium ambrosium)*. In this study, the focus has been on to identify the naphthoquinone metabolites produced by *M. ambrosium* in a laboratory culture of this fungus, and to evaluate the antifungal activity of the compounds. Usually microorganisms are able to excrete substances that affect the growth and development of other species. Cultures of *Fusarium* sp. are prolific producers of naphthoquinones. During our previous investigations, we have reported antifungal javanicin, dihydroanhydrojavanicin, anhydrojavanicin, 5,8-dihydroxy-2-methyl-3-(2-oxopropyl) naphthalene-1,4-dione, anhydrofusarubin and solaniol. In this study, TSHB beetles were collected from infested tea stems of TRI 2025 from the Tea Research Institute (TRI), Hantana. The fungus was identified as *F. ambrosium* by sequence analysis as well as morphological characteristics. Pure cultures of *M. ambrosium* were inoculated into conical flasks, each containing PDB medium (400 ml) and the flasks were incubated with occasional shaking at room temperature for 28 days. The culture broth was partitioned with EtOAc and the mycelium was extracted into EtOAc. The EtOAc extract was separated using several chromatographic techniques (column chromatography, PTLC, HPLC) to obtain fusarubin, fusarubin methyl ether, fusarnaphthoquinone B, and 2-acetonyl-3-methyl-5-hydroxy-7-methoxynaphthazarin in addition to previously reported techniques. These compounds were identified by the ^{1}H, ^{13}C NMR and MS data, and compared with literature reports. All four compounds exhibited the antifungal activity against *Cladosporium cladosaporioides* at 64 µg mL^{-1}.

Keywords: Antifungal, *Camellia sinensis*, *Moncrosporium ambrosium*, Naphthoquinone

Abstract No: 221 ***Life Sciences***

METHOD MODIFICATION AND DEVELOPMENT FOR ANALYSIS OF SYNTHETIC FOOD COLOURANTS

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Use of synthetic food colourants has played an ever-increasing role in colouring food and beverages. There are only nine permitted synthetic food colourants in Sri Lanka. However, usage of non-permitted colourants is frequently observed. The current method for qualitative analysis of synthetic food colourants used in Sri Lanka is paper chromatography and thin layer chromatography. However, there are many short-comings of such chromatographic methods in qualifying synthetic food colourants. The study is based on paper chromatographic, thin thin-layer chromatographic, column chromatographic, UV-visible spectrophotometric and high performance liquid chromatographic techniques (HPLC) which are more practiced. The study was carried out using candies, carbonic beverages and jelly products. For paper chromatographic and thin-layer chromatographic analysis, shortcomings were highlighted carrying out the experiments. As retention factor results might not be enough to confirm an unknown colourant, UV-visible spectrophotometric technique followed by column chromatographic separation for samples was carried out as a modified method. Column chromatographic separation is inadequate, and results cannot be used for qualitative analysis because it gave different spectral shapes and λ_{max} values from those of standards. Carbonic beverages and jelly products analyzed with an advanced separation by HPLC coupled with photodiode array detection. Sunset yellow, Tartrazine, Allura Red AC, Indigo carmine, Erythrosine B, Carmosine, Ponceau 4R, Fast green FCF as permitted and two non-permitted synthetic food colourants, namely Rhodomine B and Metanil Yellow, were analyzed. Both qualitative and quantitative analysis can be performed together using HPLC method which resulted in chromatograms with very sensitive sharp peaks without significant residual peaks. The recovery studies indicated recovery of almost 100% for carbonic beverages, and for jellies around 80%. According to the results obtained, HPLC technique was more reliable. However, as this study was carried out only on two food matrices, the technique should be further improved for other food matrices.

Keywords: Analysis of food colourants, HPLC, Sunset yellow, Tartrazine

Abstract No: 222 ***Life Sciences***

GROUNDWATER QUALITY AND ANTIBIOTIC RESISTANCE OF BACTERIA IN WILGAMUWA, AN AREA OF CHRONIC KIDNEY DISEASE OF UNKNOWN ETIOLOGY (CKDu) IN SRI LANKA

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Wilgamuwa region is identified as a hotspot of Chronic Kidney Disease with unknown etiology (CKDu). In this region, groundwater is the main source of drinking water. Since there are no records as yet of coliform bacteria in drinking water and their influence on the etiology of CKDu in these areas, an investigation was carried out to assess the presence of coliform bacteria in drinking water samples and ascertain their antibiotic resistance. The results were compared with drinking water samples from Minipe, an area considered as a non-prevalent region. Twenty-six and 25 groundwater samples, from Wilgamuwa and Minipe respectively, were collected during January-October 2019. Membrane filtration technique was performed to obtain total and fecal coliforms, followed by biochemical tests on randomly selected typical coliform colonies for further identification. Antibiotic Sensitivity Testing (ABST) was carried out using 12 antibiotics, to assess the antibiotic resistance of bacterial strains isolated from both regions. In groundwater from Wilgamuwa and Minipe regions, the average total coliform (TC) counts were 19.26 and 16.72 CFU/100 mL, respectively, while the average fecal coliform (FC) counts were 5.2 and 5.0 CFU/100 mL, respectively. These values exceeded the permitted values stipulated by WHO guidelines (0 CFU/100 mL for both TC and FC) and SLS standards (< 4 and 0 CFU/100 mL, for TC and FC, respectively) for coliforms in drinking water. Out of a total of 120 isolates, *Escherichia coli*, *Klebsiella* sp. and *Yersinia* sp. were identified in both areas, while *Enterobacter* sp. was identified only in Wilgamuwa. A higher prevelance of antibiotic resistance was observed in the isolates from Wilgamuwa region compared to those from Minipe, which was significant at $p < 0.05$. In conclusion, the high coliform counts and the high antibiotic resistance observed in bacterial isolates in the CKDu areas may give a lead to the treatment regime of secondary infections of CKDu patients. Further investigations have to be carried out including all CKDu hotspots, and comparisons with non-endemic regions in Sri Lanka are necessary to confirm these findings, using the current study as a baseline.

Financial assistance from the National Institute of Health (USA) and Federal Ministry of Science and Technology (Germany) is acknowledged.

Keywords: Antibiotic resistance, CKDu, Coliforms, Drinking water quality, Wilgamuwa

Abstract No: 229 ***Life Sciences***

MODIFICATIONS OF C-3 AND ANTIBACTERIAL ACTIVITY OF 6*β*-HYDROXYBETUNOLIC ACID

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Antibiotic resistance crisis has become one of the major public health problems all over the world. Hence, there is an urgent need to find new antibiotics to combat these resistant organisms. Plants and their secondary metabolites have promising bioactivity, which could be effectively used in drug discovery. 6*β*-Hydroxybetunolic acid is one such secondary metabolite (lupeol type triterpenoid) isolated from the bark of *Schumacheria castaneifolia*, a plant endemic to Sri Lanka, and is reported to possess antibacterial activity against *Staphylococcus aureus.* The objective of this study was to evaluate the antibacterial activity of structural derivatives of 6*β*-hydroxybetunolic acid against selected bacterial strains. Four structural derivatives of 6*β*-hydroxybetunolic acid were synthesized by modifying the carbonyl group at C-3 to obtain cyclic ketal, secondary alcohol, acetylated alcohol and oxime and their chemical structures were confirmed through the spectroscopic data. Antibacterial activity of these was tested against six strains of Gram-positive organisms (*S. aureus* ATCC 29213, *Enterococcus faecalis* ATCC 29212 and four stains of clinically isolated methicillin resistant *S. aureus*) and eight strains of Gram-negative organisms (*Escherichia coli* ATCC 25922, *Pseudomonas aeruginosa* ATCC 27853, carbapenem-sensitive and carbapenem-resistant *Kebsiella pneumonia* ATCC BAA 1705 and 1706) and four stains of clinically isolated *Acinetobacter* sp., utilizing broth microdilution assay in 96 well plates according to Clinical and Laboratory Standards Institute recommendations. Results revealed that 6*β*-hydroxybetunolic acid and its derivatives showed antibacterial activity against Gram-positive organisms (MIC 8 - 512 mg L^{-1}) while no activity was observed against the Gram-negative organisms (MIC > 1,024 mg L^{-1}). Hence, it is concluded that the presence of carbonyl group at C-3 is important for the antibacterial activity 6*β*-hydroxybetunolic acid against Gram-positive organisms.

Financial assistance from the Medical Research Institute is acknowledged.

Keywords: Antibacterial activity, 6*β*-hydroxybetunolic acid

Abstract No: 230 ***Life Sciences***

CURRENT STATUS OF IVORY TRADE IN SRI LANKA: KNOWLEDGE AND PRACTICES OF LOCAL VENDORS

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The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) banned the international trade of elephant ivory in 1976. However, until recently, tourist shops sold items made of ivory, and Sri Lankan ports served as a transit point in ivory trafficking. In this research, a semi-structured, questionnaire-based survey was carried out in 2017 to assess the status of the ivory trade in Sri Lanka. The shops were selected in major tourist cities (Kandy, Matara, Galle and Colombo) using a snowball sampling method. Interviews were conducted in vernacular after their informed consents. Ninety outlets were visited, of which 40% were more than 30 years old. The respondents (sale associates, owner or the manager - 55%) were mostly above 30 years old (69%) and males (65%). Sixty percent had secondary education and 48% had more than ten years of experience in the profession. All claimed that currently they are not selling any ivory products, but 23 shops (26%) carried items made out of ivory or fake products (souvenirs and jewelry). Some (38%) claimed that they had been involved in ivory trade more than ten years back and their suppliers were mostly from Galle (52%). About one fourth (26%) of the respondents were unaware that selling ivory was illegal, and 35% claimed that there is still demand from customers for ivory products. The respondent's awareness and practices on ivory trade did not depend on the sex, age, education or sales experience. However, higher number of older shops used to sell ivory products in the past compared to new outlets (Fisher's exact test, $p < 0.05$). The results of the survey show that ivory trade can no longer be considered a pervasive threat to elephant conservation efforts. However, continued vigilance is required to assess whether clandestine trade still remains substantial.

Keywords: Ivory trade, Sri Lanka, Tourist cities

Abstract No: 239 ***Life Sciences***

CELL LINE BASED RESEARCH ON HEPATO PROTECTIVE PLANTS MENTIONED IN AYURVEDA: A REVIEW

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Management of liver diseases and finding solutions for over hundred well known liver diseases with diversified etiopathology are a challenge. The most hepatic diseases include infectious agents, fatty liver disease, liver injury, and genetic liver diseases, autoimmune hepatitis, liver cirrhosis, and liver cancer. Jaundice and hepatitis are two major hepatic disorders leading to a high death rate. Exposure of the liver to free radicals derived from some xenobiotic leads to oxidative stress causing liver injury. Most of hepatotoxic chemicals damage liver cells by lipid peroxidation and other oxidative damage. The oxidation process generates oxygen species causing damage to living organisms. The oxygen centered free radicals and other reactive oxygen species (ROS), result in cell death or tissue damage. The natural plant based antioxidants are important and a number of medicinal preparations in Ayurveda are recommended for treatment of liver disorder. Despite advances in modern medicine, effective and reliable drugs that can stimulate liver functions are lacking. The therapeutic values on hepatic protection were tested against a few chemical-induced subclinical levels of liver damages. Cell line research on *Terminalia bellerica, Inula racemosa, Aloe indicum, Solunum nigrum, Boerhaavia diffusa, Picrorhiza kurroa, Tinospora cordifolia, Zingiber officinale, Berberis aristata, Terminalia chebula, Azadirachta indica, Trichosanthes dioica, and Rumex vesicarius, Eclipta prostrate, Moringa oleifera, Phyllanthus amarus and Terminalia arjuna* are proven to have certain hepatoprotective action. These plants are also used in medication for "*Paandu", "Kaamala", "Udara," "Visha", "Arshas"* and *"Vishamajwara*" in Ayurveda. For the reviewing purpose, 190 plants were selected from the standard ayurvedic texts "*Vruddatra", "Laguthra"* and *"Deshiya Chikithsa Sangraha"*. For the literature study "*Ayurvedic samprapthi*" of the selected diseases with liver pathogenesis of modern co-relation of the diseases were compared. Seventeen cell line research articles that gave general hepatoprotective action of the discovered plants were reviewed to identify their correlation of Ayurvedic diseases with modern pathologies. To develop satisfactory herbal combinations to treat severe liver diseases, plants have to be evaluated at molecular level studies, systematically for properties such as antiviral activity, anti-hepatotoxicity, stimulation of liver regeneration. The plants with remarkable activities for hepatic protection have to be identified. Development of hepatic protective medicines with standards of safety and efficacy can improve the treatments of liver disorders.

Keywords: Hepato protection, Cell lines, Liver function

Abstract No: 241 ***Life Sciences***

ASSESSMENT OF INDIGENOUS TREATMENT REGIMEN IN THE MANAGEMENT OF BLADDER CARCINOMA: A CASE SERIES

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Bladder carcinoma is the ninth most common cancer and the 13th most common cause of death from cancer throughout the world. Around 430,000 new cancer cases were recorded all over the world in 2012. The main signs and symptoms of bladder carcinoma are blood in urine, painful urination, frequent urination, urgent urination, urinary incontinence, and pain in the lower back. In the last few years, much of the scientific attention has drawn to the discovery of novel and effective chemo-preventive agents from natural sources. The objective of this study was to evaluate the efficacy of the indigenous treatment regimen in the management of bladder carcinoma. The present study was carried out at the Cancer Clinic at the Bandaranaike Memorial Ayurvedic Research Institute. Two bladder cancer patients who underwent Trans Urethral of Bladder Tumour several times and one bladder cancer patient without previous treatment history volunteered for this study. Three patients were treated with two indigenous herbal drug compounds namely C1 powder, 10 g/day, and IM powder, 10 g/day, for six months. Cystoscopy was the main investigational diagnostic tool in this study. Cystoscopy was carried out before and after treatment. After six months of treatment, all the three patients presented with cystoscopy reports which showed no evidence of recurrence of malignancy. In addition, their main associated symptoms such as blood in urine, painful urination, frequent urination, and pain in the lower back disappeared. In conclusion, the bladder cancer patients were asymptomatic and showed no evidence of recurrence of malignancyin cystoscopy after six months of treatment with the indigenous treatment regimen. Further investigations are required to evaluate the mechanism of effectiveness of this indigenous treatment regimen in controlling bladder carcinoma.

Keywords: Bladder carcinoma, Indigenous treatment

Abstract No: 250 ***Life Sciences***

ASSOCIATION OF ENTOMOLOGICAL INDICES OF DENGUE VECTORS WITH WEATHER VARIABLES IN KURUNEGALA DISTRICT

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Dengue has been identified as one of the major public health problems in Sri Lanka. This study aimed to determine the association between weather variables and the entomological indices of *Ae. aegypti* and *Ae. albopictus* in selected localities in Kurunegala District. Larval surveillances were carried out in 4,833 houses in two urban areas (Bandarnayakapura, Galgamuwa), a semi-urban area (Meegahakotuwa) and a rural area (Buluwala) from January, 2019 to December, 2019. A total of 2,935 larvae (*Ae. albopictus* = 2702; *Ae. aegypti* = 235) was collected and monthly larval indices, *viz.* Premise Index (PI), Container Index (CI) and Breatue Index (BI) were calculated according to WHO guidelines. *Aedes aegypti* was collected only from urban sites showing a preference of this species to urban areas. *Aedes albopictus* was the dominant species in the area spreading from urban to rural communities. For *Ae. aegypti*, PI (r = 0.785) and BI (r = 0.745) had positive significant correlations (p < 0.05) with RH in Meegahakotuwa site. For *Ae. albopictus* also these two indices, PI (r = 0.644) and BI (r = 0.666), had significant correlations with RH for the same site. In addition, both these indices of *Ae. albopictus* showed positive significant correlations with rainfall (PI: r = 0.981, BI: r = 0.970) and RH (PI: r = 0.893, BI r = 0.892) for Bandaranayakapura study site. No other significant correlations were observed between weather parameters and the entomological indices. The change in BI with rainfall data for one-five-week lag periods was analyzed. Observations revealed a significant positive correlation for *Ae. aegypti*, between rainfall and BI after one-week and two-week lag period. For *Ae. albopictus*, the rainfall data significantly correlated with BI at the time of rain, BI after one-week, two-week range and three-week lag periods. These data indicate that *Ae. albopictus* is capable of surviving in a wide range of water availability. Since there was a significant correlation between rainfall and BI at Bandaranayakapura, the data were used to develop a prediction model. Model is supported with Rsq with 89%. This study provides baseline information on the association between meteorological factors and the larval indices.

Keywords: Dengue, Indices, Kurunegala District, Prediction model

Abstract No: 257 ***Life Sciences***

COMPARISON OF THREE BIO-PROCESSING METHODS IN ETHANOL PRODUCTION: A POTENTIAL GREEN SOLUTION FOR FUTURE ENERGY CRISIS

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Bioethanol is an alternative energy fuel for the current fossil fuel depletion and it can be used either as a fuel enhancer or as an independent fuel. Bio-ethanol production includes two major conversions: cellulose into fermentable sugar and sugar into ethanol. There are three major bio-processing methods that convert cellulose biomass into the end product, 'ethanol'. The present study focused on evaluation of the efficiency of the three different biological pathways involved in bio-ethanol production using carboxymethylcellulose (CMC) as a raw material; Separate enzymatic hydrolysis and fermentation (SHF), Simultaneous saccharification and fermentation (SSF) and Enzyme-microbe synergy method (EMS). The crude cellulase enzyme filtrate used for SHF and SSF methods was obtained from *Bacillus* sp. which was isolated from termite gut. In the SHF method, hydrolysis was performed at 50 ^{o}C for 72 hours using cell-free crude cellulase enzyme filtrate and the fermentation was conducted by decreasing the temperature to 37 ^{o}C with supplementing 15 mL of glucose-free Yeast Extract-Peptone-Glucose (YPG) broth. Subsequently, *Achromobacter* sp., which was isolated from palm wine, was inoculated and incubated for 72 h at 100 rpm. In the SSF and EMS methods, hydrolysis and fermentation steps were conducted under the same conditions, *viz.* temperature 37 ^{o}C and incubation period 72 h, while in the SSF method, hydrolysis was conducted using cell-free crude cellulase enzyme filtrate; in the enzyme-microbe synergy method hydrolysis and fermentation steps were carried out with bacterial cells. The stirring rate was kept at 100 rpm in a shaking incubator for all the processes and ethanol percentage was quantified through solid phase micro-extraction (SPME) by selected ion mode (SIM) method coupled with gas chromatography-mass spectrometry (GC-MS). Bioethanol production from the SSF method was recorded as the highest (1.67%) followed by the SHF method (1.25%) and the EMS method (1.17%). Out of these different bioprocesses, the SSF method was the most efficient for bioethanol production for further studies involving combination of potential bacterial candidates, *viz. Bacillus* sp. with *Achromobacter* sp.

Keywords: Bioethanol, Enzyme-microbe synergy method (EMS), Separate enzymatic hydrolysis and fermentation (SHF), Simultaneous saccharification and fermentation (SSF)

Abstract No: 265 ***Life Sciences***

HEALTH EXPENDITURES IN SRI LANKA

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Health expenditures play a key role in the economy of a country. It is important to understand how health expenditure distributes among different health sector components in order to make effective decisions. Therefore, the objective of this study was to identify the variations in health expenditure data in Sri Lanka. In this research, the health expenditure data of Sri Lanka and bar charts, stacked bar charts, and line graphs were used to visualize these data. The current health expenditure and capital formation were considered as a percentage of gross domestic product. The current health expenditure percentage fluctuates while the capital formation percentage shows a significant increase. It was noted that the current health expenditure percentage of Sri Lanka is low when compared to countries in the African, American, European and the Western Pacific regions. However, the highest current health expenditure and total health expenditure per capita growth rates are recorded in the years 2004 and 2015, respectively. It is conspicuous that the maximum current health expenditure percentage was incurred by the hospitals while the highest current health expenditure of the central Ministry of Health and Provincial Department of Health percentage are distributed among teaching and special hospitals. Of the current health expenditure by functions, a significant percentage is spent on inpatient care. It is clearly visible that the maximum current health expenditure percentage is spent on non-communicable diseases while the minimum percentage is spent on nutritional deficiencies. It is concluded that more attention is needed for health expenditure when making necessary health policies in Sri Lanka.

Keywords: Capital formation, Current health expenditure, Health expenditure

Abstract No: 269 ***Life Sciences***

PHYTOCHEMICAL SCREENING, QUANTITATIVE ANALYSIS AND CYTOTOXIC POTENTIAL OF *Hemidesmus indicus* LEAF EXTRACTS IN VITRO

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Medicinal plants are considered as a dietary supplement for living organisms and play a beneficial role in treatment of many health problems in humans in certain South Asian countries including Sri Lanka. *Hemidesmus indicus* (L.) R. Br. is one of the widely used medicinal plants in Ayurveda in Sri Lanka and its local variety is known as 'Heen Iramusu'. The present study focused on screening and quantification of phytoconstituents in *H. indicus* crude extracts and cytotoxicity in vitro. Leaves of *H. indicus* collected from the dry zone in Sri Lanka were frozen, crushed, freeze-dried and powdered. Leaf extracts were prepared by shaking overnight a suspension of leaf powder (1 g) in 25 mL of ethanol, hexane and distilled water, separately, in triplicates. A qualitative analysis based on phytochemical screening was carried out. Total Phenolic Content (TPC) was determined according to the Folin-Ciocalteu procedure using gallic acid as the standard and Total Flavonoid Content (TFC) was determined using aluminum chloride colorimetric assay with quercetin as the standard. The water extract of *H. indicus* was examined for cytotoxicity in 3T3-L1 cells using MTT assay in order to identify possible consumable concentration levels of the extract. The phytochemical screening confirmed the presence of flavonoids, tannins, alkaloids and coumarins in the three extracts. TFC and TPC were highest in water and lowest in hexane extracts. TPC in water extract was 3-fold higher than hexane extract and TFC in water extract was 6-fold higher than hexane extract. Water extract showed no toxicity at concentrations below 300 µg/ml against 3T3-L1 cells. The flavonoids, coumarins and alkaloids present in *H. indicus* could be responsible for the medicinal properties of the plant.

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Keywords: *Hemidesmus indicus*, Cytotoxicity, Phytochemical analysis, TFC, TPC

Abstract No: 281 ***Life Sciences***

ISOLATION OF LIPOLYTIC BACTERIA FROM OIL CONTAMINATED SOIL AND PRODUCTION OF LIPASES

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Hydrolytic enzymes, such as lipases, have emerged as key enzymes in a broad array of biotechnological industries due to their multifaceted characteristics. The aim of this study was to isolate lipase producing bacteria from oil contaminated soil and subsequent optimization of their culture conditions to maximize lipase production. Novel lipolytic bacteria were isolated from oil contaminated soil by serial dilution technique on a minimal salt media containing olive oil as the main carbon source. Out of nine bacterial isolates purified, five isolates (LDB1, LDB2, LDB3, LDB4 and LDB5) screened positive for lipase activity by means of phenol red and tween 20 media. To select a promising lipolytic candidate para-nitrophenol palmitate assay was used. LDB-1 isolate, which showed the highest absorbance at 410 nm was chosen for further optimization. To determine the optimum culture conditions, pH (3-12), temperature (30-70 °C), carbon source and nitrogen source were studied. Isolate LDB-1 showed the highest lipase activity at the temperature of 30 °C (0.112 U mL^{-1}) and at a pH of 6 (0.076 U mL^{-1}). Among the various carbon sources tested, olive oil exhibited the maximum enzyme activity of 0.115 U mL^{-1}. With yeast extract as the nitrogen source, the highest enzyme activity of 0.102 U mL^{-1} was recorded in comparison with other nitrogen sources tested. Hence the optimum culture conditions for enhanced lipolytic activity was identified as pH 7, at a temperature of 30 °C, with olive oil as the carbon source and yeast extract as the nitrogen source. The results are a clear indication of culture conditions being able to bring about remarkable alterations in the level of enzyme production and activity.

Keywords: Lipase, Oil contamination, Optimization, pNPP assay, Screening

Abstract No: 282 ***Life Sciences***

ISOLATION OF CELLULOSE DEGRADING BACTERIA FROM SOIL AND OPTIMIZATION OF THEIR CELLULASE PRODUCTION

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Utilization of microbial cellulases is a promising approach towards feasible and cost-effective processing of accumulating cellulosic waste. As there is a less emphasis on cellulases of bacterial origin, the current study was designed as an attempt to isolate and screen soil bacteria possessing cellulolytic potential and to optimize their cellulase production. Bacteria in soil samples collected from locations in and around the premises of the University of Peradeniya were isolated using a selective medium and screened for cellulolytic potential by congo red and iodine methods. Cellulase produced by isolates that screened positive for cellulolytic activity were quantified by 3,5-Dinitrosalicylic acid (DNS) method. To determine optimal culture conditions to enhance cellulase production, culture parameters, such as incubation period (day 1 to 6), temperature (30 – 70 °C), pH (4 to 12) and varying carbon and nitrogen sources, were tested. Two potent cellulolytic isolates, CDB 2 and CDB 9 were identified out of a total of 11 presumptive cellulose degrading isolates. CDB 2 showed maximum enzyme activity at an incubation period of 24 hours recording an activity of 1.64 U mL^{-1} and CDB 9 at 48 hours with 2.25 U mL^{-1}. The temperature assessment demonstrated the highest cellulase activity at 40 °C in both isolates CDB 2 (2.66 U mL^{-1}) and CDB 9 (2.89 U mL^{-1}), respectively. Among pH ranges tested, highest activity was at pH 8 for CDB 2 (1.57 U mL^{-1}) and pH 7 for CDB 9 (2.03 U mL^{-1}). As carbon sources, glucose for CDB 2 (19.95 U mL^{-1}) and lactose for CDB 9 (17.73 U mL^{-1}) were determined as the best for enhancing cellulase activity while as nitrgeon sources tryptone for CDB 2 (1.81 U mL^{-1}) and $(NH_4)_2SO_4$ for CDB 9 (1.51) displayed the highest activities. Ideal culture conditions for CDB 2 were hence identified as, pH 8, at a temperature of 40 °C, incubated for 24 hours with glucose and tryptone as the carbon and nitrogen sources, respectively, while CDB 9 exhibited optimal cellulase activity when cultured for 48 hours in a media of pH 7, at a temperature of 40 °C, with lactose as the carbon source and $(NH_4)_2SO_4$ as the nitrogen source. It is evident that culture conditions and composition profoundly affect and alter cellulase production and activity. Identification of optimal culture media specifications can therefore tremendously contribute towards integral findings in terms of industrial applications.

Keywords: Bacterial cellulases, Cellulose, Optimization, Screening, Soil bacteria

Abstract No: 287 ***Life Sciences***

VERTICAL DISTRIBUTION OF ORNITHOPHILIC MOSQUITOES IN FORESTED HABITATS OF CENTRAL SRI LANKA

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Spatial and temporal distribution of host is a crucial factor in feeding preferences of blood feeding insects. The spatial distribution of ornithophilic mosquitoes that feed on avifauna at different strata of the forest ecosystems is important in determining their role as vectors of blood parasites. In this study, vertical distribution of ornithophilic mosquitoes was explored in two secondary natural forests [SNF = Hantana (HAN) and Halgolla (HAL) Forest Reserves] and two forested areas in human settlements [HS = Peradeniya (UOP) and Gampola (GAM)] of central Sri Lanka. Bird-baited traps using Japanese quails (*Coturnix japonica*) as bird baits were used to collect ornithophilic mosquitoes. A total of 20 sampling sessions was done between January and May 2019. Bird-baited traps were set up from 18:00 - 22:00 h at three different height levels, 1 m, 3 m and 6 m, at each sampling site. The selected height levels represent the forest floor, understory vegetation, and canopy level, and these are common nesting and roosting sites of the local avifauna. Three bird-baited traps and a control trap without bird bait were set up at each height level. Mosquitoes collected were euthanized at −4 °C and identified using standard taxonomic keys. Diversity indices were used to characterize the species diversity and the abundance of collected mosquitoes. Variations of diversity and the abundance of mosquito fauna at each habitat type were compared using One-Way ANOVA. There was a significant difference in abundance of ornithophilic mosquitoes among three height levels [SNF (F = 4.28, df = 29, p = 0.024) and HS (F = 19.57, df = 29, p < 0.001)]. The highest numbers of ornithophilic mosquitoes were reported from the 6 m height [HAN (219; 53.3%), and HAL (93; 49.5%), GAM (136; 45.5%), UOP (163; 51.7%)]. The diversity of the mosquito fauna in three different height levels was not significantly different (p > 0.05). A total of 1,212 individual mosquitoes belonging to 15 species and seven genera (*Aedes*, *Armegeres*, *Coquilletidia*, *Culex*, *Mansonia*, *Mimomyia*, *Orthopodomyia*) were identified. Of them, *Culex bailyi*, *Orthopodomyia flavithorax*, *Or. anopheloides*, and *Mansonia annulifera* were restricted to the SNF, while *Cx. sitiens*, *Cx. fuscanus*, *Aedes albopictus*, and *Mimomyia chamberlaini* were limited to the HS. HS forests were dominated by *Cx. nigropunctatus* (44.9%) followed by *Cx. quinquefasciatus* (28.7%), and both species were distributed evenly along the vertical axis of the vegetation. *Culex pseudovishnui* (38.9%) and *Orthopodomyia flavithorax* (17.7%) were the most common mosquitoes at SNF, and their distribution were also somewhat similar along the vertical axis. *Culex vishnui* was reported only at 6 m height level of both HS and SNF while *Cx. sitiens*, *Cx. fuscanus*, and *Mimomiya chamberlaini* were reported only at 6 m height level of HS. Results of this study provide important information about the spatial distribution of ornithophilic mosquitoes in Sri Lanka.

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Keywords: *Culex*, Disease transmission, Mosquito stratification, Ornithophilic mosquitoes, Vertical distribution

Abstract No: 291 ***Life Sciences***

IN VITRO ANTIOXIDANT POTENTIAL AND TOTAL POLYPHENOLIC, FLAVONOID AND ANTHOCYANIN CONTENT OF EDIBLE FLOWERS IN SRI LANKA

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Edible flowers which have been used in traditional cuisine as a component for visual appeal and aroma have received attention recently as rich sources of bioactives. Bioactives have been explored widely due to their antioxidant properties which control chronic diseases. Natural sources of antioxidants are of great importance currently and edible flowers are extensively investigated for their antioxidant potential. However, only a narrow spectrum of available flowers has been investigated in Sri Lanka. The flowers investigated in the present work have been consumed in China, Thailand and India in various forms. The aim of this study was to determine the content of bioactive compounds and evaluate the antioxidant potential of edible flowers available in Sri Lanka. Flower samples were randomly collected from different locations of Sri Lanka. Assays for total phenolic, total flavonoid and total anthocyanin content were used to evaluate the content of bioactives of the edible flower extracts. Antioxidant properties of edible flowers were determined using ferric reducing power assay, 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay and total antioxidant capacity assay. The studied flowers exhibited a wide range of variation in the phenolic, flavonoid and anthocyanin contents. Hydromethanolic extracts of flowers of *Cocos nucifera* showed the highest total phenolic content. Total flavonoid content of the extracts was within the range of 0.59 (± 0.06) and 19.81 (± 0.83) mg Rutin equivalents/g dry weight. Extracts of *Hibiscus rosa-sinensis* and *Clitoria ternatea* exhibited higher contents of monomeric anthocyanins compared to the other flowers investigated. Extracts of *Calendula officinalis* expressed the highest radical scavenging ability, reducing power and total antioxidant capacity. The outcomes of the study demonstrate that the edible flowers are good sources of bioactives with antioxidant potential which can be incorporated into food as a natural ingredient that could deliver health benefits to consumers.

Financial assisstance from the National Research Council (Grant No. 19-033) is acknowledged.

Keywords: Antioxidant capacity, Bioactives, Edible flowers

Abstract No: 295 ***Life Sciences***

ANALYSIS OF THE SEVERITY OF THE ACCIDENTS IN THE SOUTHERN EXPRESSWAY

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The World Health Organization (WHO) report on "Global Health Safety 2018" revealed that road traffic injuries claim more than 1.35 million lives each year, and have a huge impact on health and development of the human society. Introduction of the expressway concept to the road network of the country is undoubtably a development which has made transportation and commuting easy and time saving. However, the number of accidents and the severity of the accidents occurring in the Southern Expressway have reflected an increase over the years. This study attempted to identify the factors affecting the severity of the accidents in the Expressway. The study utilized secondary data collected by the Southern Expressway Operation Maintenance and Management Division (EOMMD) during the period from 2011 to 2018 which consisted of 5239 observations. Variables in the data set consisted of accident related information, such as accident type, reason for the accident, accident time, location, driver related data, weather condition and road condition. Preliminary analysis is conducted followed by multinomial logit regression analysis, hotspot analysis and photographic and video graphic survey methods under qualitative techniques. Study also collected information from the officers of the Expressway Management via discussions in order to triangulate and validate the results. Accident prone locations for severe and minor level accidents were identified along with the significant reasons for accidents. Among the numerous reasons affecting the severity of the accidents, the behavioural factors, such as drunk driving, fatigue and driving speed, were significant. Road side landscape and structural elements were also found to be important factors to be considered.

Keywords: Expressway accidents, Hotspot Analysis, Multinomial logit regression, Severity

Abstract No: 298 ***Life Sciences***

POSSIBLE DRUG-DRUG INTERACTIONS IN PRESCRIPTIONS OF DISCHARGED PATIENTS AT A SELECTED TEACHING HOSPITAL IN COLOMBO DISTRICT

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Drug-Drug Interactions (DDIs) can be defined as alteration of the response of one drug by another drug, when two or more drugs are administered simultaneously. Alterations can be synergism, antagonism or idiosyncratic. Early detection of DDIs can prevent the occurrence of undesired effects. In Sri Lanka, limited research has been conducted in relation to DDIs. This study was directed to bridge aforesaid gap and to assess possible DDIs in prescriptions of discharged patients at a selected Teaching Hospital in the Colombo District. A descriptive cross sectional study was carried out in ten randomly selected medical wards at the selected teaching hospital. A total of 132 discharged prescriptions were included through convenience sampling. Data collection sheet was used to extract required data from discharged prescriptions. Preliminary detection of DDIs was done using the software, Drugs.com. Then confirmation and further analysis were performed using National Formularies (British National Formulary, Australian Medicine Handbook). Data were analyzed descriptively and inferentially using SPSS (version 21) software. A majority (81.1%) of the prescriptions were of married female patients over 51 years of age (72.6%) with up to secondary education (75%). Cardiovascular disease was reported in 43.6% of the patients with discharged prescriptions in the past medical history. Out of 132 discharged prescriptions with 705 medicines, 54 (40.9%) discharged prescriptions were detected with possible DDIs. The average presence of DDI per prescription was 0.6 and average number of medicines per prescription was 05. Maximum number of DDIs recorded per prescription was 07 out of 09 drugs on the prescription. There was no relationship between the number of drugs and the presence of DDIs (p = 0.0423). Out of total interaction, 26.9% interactions were major (only in 09 prescriptions) and 70.4% were moderate (in 46 prescriptions) as per the severity level in the above Formularies. The most frequent (n = 24) DDI was between Clopidogrel and Aspirin combination which is with moderate severity level. Considerably, major DDIs were reported with Furosemide and Amiodarone (n = 06s) combinations and Losartan and Amlodipine (n = 6) combinations. There was a significant relationship between the age and the presence of DDIs in discharged prescriptions (p = 0.0341). Prevalence of possible DDIs in discharged prescription of elderly people need to be considered even with significant absence of major DDI as per the study. More emphasis on DDI detection process in discharged prescriptions could improve medication safety and prevent medication associated hospital readmissions.

Keywords: Drug-Drug interactions, Discharged prescriptions

Abstract No: 315 ***Life Sciences***

ANTIOXIDANT ACTIVITY AND PHENOLIC COMPOUNDS AVAILABLE IN METHANOLIC SEED EXTRACTS OF THREE *Annona* SPECIES

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Annona species are recognized for their therapeutic potential ages ago. The seeds of *Annona squamosa*, *Annona muricata* and *Annona reticulata* are a primary waste fraction when the flesh part is consumed. The objective of this study was to evaluate the availability of phenolic compounds in methanolic extracts prepared from freeze dried seed powder of the above three species. Crude extracts were analyzed for total phenolic content (TPC), DPPH radical scavenging assay and total flavonoid content (TFC) using UV/Vis spectrophotometric methods. DPPH radical scavenging activities of seed extracts of *A. reticulata*, *A. muricata* and *A. squamosa* were 2.55%, 21.57% and 47.15%, respectively. The TFC was lower in *A. reticulata* [0.92 mg rutin equivalent (RE) / g dry weight (dw)] and *A. muricata* (1.95 mg RE / g dw) than *A. squamous* (7.37 mg RE / g dw). The TPC recorded for *A. muricata*, *A. squamosa* and *A. reticulata* were 7.59, 281.28 and 463.51 µg gallic acid equivalent per g dw of seed, respectively. The data obtained in the present study did not show a good correlation between the radical scavenging activity and the phenolic content. However, it can be concluded that *A. squamosa*, *A. reticulata* and *A. muricata* seed extracts be good sources of phenolic compounds, and may be used effectively for functional food product and nutraceutical development through further characterization of bioactive compounds.

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Keywords: *Annona*, Flavonoids, Functional food, Methanolic, Seed

Abstract No: 7 ***Physical Sciences***

ONE-POT SYNTHESIS OF NITROGEN-DOPED REDUCED GRAPHENE OXIDE AS THE EFFICIENT ELECTROCHEMICALLY MODIFIED ELECTRODE MATERIAL FOR Hg(II) DETECTION

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Nitrogen-doped reduced graphene oxide (N-rGO) was synthesized by one-pot facile hydrothermal method for electrochemical detection of trace Hg(II). In this research, urea, a nitrogen-rich material, was used to dope N in graphene oxide. Comparing to graphene, the N-rGO modified glassy carbon electrode exhibits excellent electrochemical response towards Hg(II) with sensitivity of 19.38 $\mu A\ \mu M^{-1}$ and limit of detection (LOD) of 9.29 nM (3σ method). The coordination of N-rGO and HgII) was confirmed by X-ray photoelectron spectroscopy and density function theory (DFT) calculation results. Additionally, the anti-interference test of related cations was also studied. Hence, the approach in this work provides a novel method for intrinsically regulating carbon materials, which could be used as advanced electrodes in the field of electrochemical detection.

Financial assistance from the National Research Council, Sri Lanka (Grant No. 16-015) and National Natural Science Foundation of China (Grant No. 21777164) is acknowledged.

Keywords: DFT calculation, Electrochemical detection, Hg(II), Hydrothermal, Nitrogen-doped reduced graphene oxide

Abstract No: 22 ***Physical Sciences***

AN ELECTROSPRAY-BASED FABRICATION OF SILICA AEROGEL EMBEDDED POLYURETHANE ULTRAHYDROPHOBIC SURFACE

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Superhydophobic surfaces with water contact angles (WCA) greater than 150° have gained much attention of researchers due to their interesting properties, such as self-cleaning, anti-corrosive, oil-water separation, and especially, extreme water repellency. Superhydrophobicity can be achieved by fabricating nano/micro structures on a surface with the appropriate roughness and low surface free energy in order to trap air between the material surface and water droplets. In this work, such surface has been fabricated for the first time with a single-step electrospraying process using polyurethane (PU) added with silica aerogel (Si). The water contact angle along with surface morphology was studied by varying electrospraying parameters, such as relative contents of PU and aerogel, needle size, and electrospraying time. The morphology of the modified surface was analyzed using scanning electron microscopy. Elemental mapping of the surfaces was performed using energy-dispersive X-ray spectroscopy. It was observed that the addition of the aerogel to the PU electrospraying mixture resulted in morphological changes on the surface introducing a surface roughness, which in turn increased the WCA of the surface from 143° to 154°, which is indicative of ultrahydrophobicity. Enhanced thermal insulation was also observed with the PU+Si surface when it was assessed against the same fabric electrosprayed with only PU. This could be attributed to the thermal insulation property of Si aerogels. In this facile method, polyurethane in combination with silica aerogel introduces appropriate surface roughness and low surface free energy to gain increased hydrophobicity.

Keywords: Electrospray, Polyurethane, Silica aerogel, Ultrahydrophobic

Abstract No: 46 ***Physical Sciences***

EFFECT OF HYDROPHOBICITY ON ENTRAPMENT EFFICIENCY OF DENDRIMERS

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Dendrimers are highly branched macromolecules having potential applications in medicine as drug delivery vehicles. In order to design new dendrimer molecules with high drug loading capacities, it is important to understand their structure-property relationships. Hydrophobic-hydrophilic interactions between the drug and the dendrimer plays a major role in drug loading. However, understanding the hydrophobic effect is difficult due to the limitations of conventional experiments. In this study, the effect of hydrophobicity on the entrapment efficiency of dendrimers using molecular dynamics simulations is reported. Simulations were performed with parameters derived from the force field developed by Shinoda, DeVane and Klein, for dendrimers of generation 2, 3 and 4 with a range of hydrophobicity. Hydrophobicity was varied with a parameter ζ (zeta), which was defined with $0 < \zeta < 1$; for the hydrophobic end of the range, ζ was defined as 0, and for the hydrophilic reference, $\zeta = 1$ was assigned. Phenol was used as the loading molecule and drug analogue. First, phenol was overloaded to the dendrimer by simulating the dendrimer in a phenol box. In order to see the entrapment capabilities, phenol overloaded dendrimer was simulated in a water box, allowing the overloaded phenol to release with time. By extrapolating the releasing behaviour, the equilibrium entrapment capacities were determined. It was found that entrapment capacity decreases with increasing hydrophilicity of the dendrimer for generation 2 and 3 dendrimers. However, for the generation 4 dendrimer, the highest entrapment capacity is observed for $\zeta = 0.3$. Analysis of the radius of gyration and root mean square separation of branch points clearly shows the coil-to-globule transition from $\zeta = 0.6$ to $\zeta = 0.8$ for all dendrimers. According to this study, entrapment capacity depends on many factors, such as hydrophobic interactions between drug and dendrimer, size of the dendrimer and solvent environment. This study provides valuable data to design new dendrimers with high loading capacities which were unable to access previously using conventional wet-lab experiments.

Keywords: Coil-to-globule transition, Dendrimers, Entrapment efficiency, Hydrophobicity

Abstract No: 62 ***Physical Sciences***

ENHANCEMENT OF EFFICIENCY OF ZINC OXIDE BASED PHOTO-ELECTROCHEMICAL CELL BY COUPLING OF MULTIPLE DYES

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Dye-sensitized solar cells (DSSCs) are the photovoltaic cells which use a dye as the light harvesting layer. In such solar cells, a single dye is used to harvest solar energy. Increase in the efficiency of DSSCs is one of the scientific hurdles faced, since the absorption spectrum of a single dye lies on a limited wavelength region. An appropriate coupling of multi-dye coated electrodes enhances the performance of solar cells by means of expanding photo-absorbance properties of the electrode. In the present work, multi-dye coated electrodes were used to enhance the efficiency of the cell. Sensitization process of two dyes, namely Black dye (N749) and D358, and their mixtures on ZnO films were studied by means of utilization as light harvesting electrodes in ZnO|photosensitizer|electrolyte (I^-/I_3^-) type of photo-electrochemical cells. Multi-dye coated electrodes were prepared by dipping ZnO nano-powder coated on FTO glass plates in both black dye and D358 dye solutions. Current-voltage characteristics and incident photon to current efficiency (IPCE) measurements were obtained for DSSCs with the sensitizer D358, Black dye and Black dye|D358. Coupling of Black dye with D358 dye provides higher power conversion efficiency as compared to that of individual dyes. The maximum power conversion efficiency of 3.0% was obtained for ZnO-based photo-electrochemical cells when coupling Black dye and D358 dye.

Keywords: Black dye, D358, Efficiency, Photovoltaic cells, ZnO

Abstract No: 64 ***Physical Sciences***

SIZE DEPENDENCE OF HOST-GUEST INTERACTIONS OF *β*-CYCLODEXTRIN *IN SILICO*

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Cyclodextrins (CDs) are cyclic oligosaccharides with glucopyranose units bonded together with 1-4 linkages to form a truncated cone. The cavity within this cone can make inclusion complexes with various molecules; either engulfing part or the whole molecule. The outer surface of CDs is more hydrophilic than the interior. *β*-CDs, which consist of seven glucopyranose units, are used extensively in oral pharmaceutical formulations as a functional excipient. Measurements of the cavity size have been reported using molecular visualization software, however, the actual size range of guests that *β*-CD can accommodate has not been systematically studied. The glucopyranose rings can distort depending on the functional groups of the guest molecule and the nature of the surrounding environment (solvent, temperature, etc.). Therefore, a novel approach was taken to measure the size range of the guest molecules that *β*-CDs can accommodate irrespective of their geometry and chemistry. Molecular dynamic simulations were carried out using spherical implicit continuum particles with different sizes to observe complex-forming behaviour and to determine the maximum size of the guest molecule. The results revealed that the actual size range of the guest molecules that the *β*-CDs can complex is greater than expected, with the reported cavity size of 6.0 − 6.5 Å. Particles with the radius of 0.9 − 1.9 Å range make the complexes with *β*-CD. However, the full inclusion complexes only form for sizes 0.9 − 1.2 Å. From size 1.6 Å above they can make only partial complexes up to 1.9 Å. It should be noted that radial distribution plots of water around the probe particles show that the effective radius of particles is approximately 2.4 Å greater than the radius. Interestingly, some larger particles above the cavity size remain in close contact with the broader ring of the *β*-CD throughout a majority of the simulation time even though they did not make inclusion complexes. These results may help in the development of formulations and understanding the interaction of guest molecules with cyclodextrins.

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Keywords: Continuum particle, Inclusion complexes, Molecular dynamics

Abstract No: 66 ***Physical Sciences***

SYNTHESIS AND INVESTIGATION OF THERMOELECTRIC PROPERTIES OF POLYANILINE AND NICKEL

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The Peltier module is a *p-n* junction, which consists of two dissimilar thermoelectric materials (TEs) generating a temperature difference as a result of an applied voltage across the junction. Due to the hazardous nature of best-known TEs, such as Bi_2Te_3 and Sb_2Te_3, an attempt has been made to search for new TEs. Investigation of conducting polymers as TEs has become of interest due to their environmentally friendly nature, and a wide range of easily tunable electrical and thermal properties. In this study, an effort was made to utilize polyaniline (PANI)/nickel (Ni) as a *p-n* junction for a Peltier module with optimized thermoelectric parameters. Pressed pellets of PANI powder, which was synthesized using a chemical method doped with HCl aqueous solutions of 1 M and 2 M, were used as the *p*-type material, and both pressed pellets of Ni powder and a sheet of Ni metal were tested as the *n*-type material. The synthesized PANI was characterized by Fourier-transform infrared spectroscopy (FTIR), and FTIR bands were observed corresponding to polyaniline emeraldine salt at 1,559.2 cm^{-1} and 1,306.5 cm^{-1}. The band observed at 1,135.9 cm^{-1} was characteristic to conductive PANI. Electrical conductivity, thermal conductivity and Seebeck coefficient were measured, and figure of merit, Lorentz number and power factor were calculated for both individual materials, PANI and Ni as well as for the constructed junction. The metal and powder pellets showed negative Seebeck coefficients of -13.5 $\mu V\ K^{-1}$ and -13.7 $\mu V\ K^{-1}$, respectively, and PANI pellets doped with HCl of 1 M and 2 M aqueous solutions showed positive Seebeck coefficients of 253.3 $\mu V\ K^{-1}$ and 157.8 $\mu V\ K^{-1}$, respectively, being consistent with the standard values. PANI doped with HCl from 1 M aqueous solution showed a better Seebeck coefficient than that with HCl from 2 M aqueous solution leading to a higher power factor of 0.074 $W\ m^{-1}\ K^{-2}$ compared to 0.054 $W\ m^{-1}\ K^{-2}$, and figure of merit of 1.95×10^{-5} compared to 6.14×10^{-6}. Individual thermoelectric parameters of chemically synthesized PANI and Ni were better than that of the junction, suggesting the method of the junction construction be improved.

Keywords: Figure of merit, Power factor, Polyaniline, Seebeck coefficient, Thermoelectricity

Abstract No: 70 ***Physical Sciences***

PANI/PCL BLENDED CONDUCTIVE AND BIODEGRADABLE NANO-FIBRE TWISTED YARNS FOR BIOMEDICAL APPLICATIONS

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Development of polymer nano-fibres has a great scientific and technological attraction due to a vast array of applications in biomedicine and biotechnology. These nano-fibres have been found novel in applications such as biomimetic nanostructures that can act as extracellular matrix because of their porosity and higher surface area. This research was aimed at design and fabrication of conductive, biodegradable, and porous nanofibrous yarn comprised of polyaniline (PANI) and poly(3-caprolactone) (PCL) for three dimensional microporous scaffolds for tissue engineering applications. The nano-fibres were fabricated using a customised eletrospinning setup with a rotary collector. Electrospun mats were twisted into nanofibrous yarn. Electrical and mechanical properties of conductive yarns were evaluated for an array of PANI:PCL ratios. Yarn samples were characterised using scanning electron microscopy, differential scanning calorimetry analysis, and thermal gravimetric analysis. The applicability of nanofibrous yarns for biomedical applications were evaluated by testing biodegradability and in-vitro degradability. The results of this study demonstrated that PANI/PCL nano-fibres produced from PANI:PCL (4:16) solution exhibited the lowest resistance of 10 ± 4 MΩ cm^{-1}. The twisted plied yarns were incorporated into fabric by stitching or weaving to demonstrate the ability of constructing 3D microporous nano-fibre assemblies without disturbing the conductivity. It can be envisaged that this approach presents an early step on the way to the realisation of nano-fibre assemblies for tissue engineering.

Financial assistance from the University of Moratuwa (*Grant No. SRC/LT/2018/ 33) is acknowledged.*

Keywords: Biodegradable conductive, Eletrospinning, Polyaniline (PANI), poly(3-caprolactone) (PCL)

Abstract No: 73 ***Physical Sciences***

GENERATION OF A COARSE-GRAINED MOLECULAR MECHANICS MODEL FOR POLOXAMER MOLECULES

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Poloxamers are amphiphilic triblock copolymers with a central hydrophobic polypropylene oxide (polyPO) block connected on either end to two hydrophilic polyethylene oxide (PolyEO) blocks. These polymers are widely used in medical applications, foaming, detergency, dispersion and stabilization. Computer simulations can provide support in characterizing, and guiding modifications to their structure. Here, a novel coarse-grained (CG) molecular mechanics model for Poloxamer molecules is presented. All-atom (AA) resolution models already exist for these molecules; however, the time and length scales afforded by AA simulations cannot capture the complex behaviour of these molecules. The proposed model aims to create general parameters for the PO bead, making the model extensible to any chain length of Poloxamer. In the study, all-atom molecular dynamics (MD) simulations were carried out using the NAMD code with CHARMM 35 force field data to obtain reference structural data for small individual units of the PPO blocks. Then the CG model was developed and parameterized to reproduce target data using LAMMPS (Large-scale Atomic/Molecular Massively Parallel Simulator) MD code using the force field of Shinoda, DeVane and Klein. The bond stretching and bond angles of the CG model were iteratively adjusted in explicit solvent simulations to reproduce the behaviour of the Poloxamer. The non-bonded parameters were adjusted to reproduce the experimental density and surface tension of the polymer melt. After the development of the model the transferability and versatility were demonstrated, by calculating the radius of gyration (rg) of two commercially available designed Poloxamer molecules, P65 and F68 (Pluronic®). The simulated results give close precision to the available experimental rg data of P65 and F68 proving that the CG model developed can perform *in silico* investigation of these molecules in further development and application.

Keywords: Molecular dynamics, Pluronics, Polymer simulations, SDK force field

Abstract No: 88 ***Physical Sciences***

INHIBITION OF HISTONE DEACETYLASE LIKE PROTEIN: INSIGHTS FROM COMPUTATIONAL STUDIES

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Histone deacetylase (HDAC) enzymes modify the histone protein by removing the acetyl group from the lysine residues, known as histone deacetylation. HDACs have been reported to be involved in the alteration of gene expressions of cancer suppressor proteins, resulting in the development of the cancer cells in the human body. Many recent studies have proven that inhibition of HDAC significantly contributes to the control of cancer growth. Therefore, HDAC inhibitors have been considered promising anticancer agents. Several HDAC inhibitor compounds are currently in different stages of clinical trials. This study is focused on studying the impact of HDAC inhibitors on the stability of the histone deacetylase like protein (HDLP) through computational techniques. The selected inhibitors for this study are SAHA (suberoylanilide hydroxamic acid/vorinostat), LBH589 (panobinostat), and PXD101 (belinostat). SAHA is considered as a reference drug because it is a well-known drug in clinical practices. Molecular dynamics (MD) studies were used to investigate the atomic level description of drug binding sites and how the HDAC inhibitors change the environment of the active site of the HDLP. The inhibition potent was analyzed in terms of hydrogen bond analysis, secondary structure analysis, and interaction energy analysis. This work was carried-out with molecular docking and MD simulations for 100 ns with the gromos53a6 force field, and the resultant trajectories of the HDLP-inhibitor complexes were analyzed. The results contributed to examine and compare the stability of the mutated HDLP in HDLP-inhibitor complexes in the aqueous environment. The results revealed that the HDLP-LBH589 complex has greater interaction energy (-303.98 ± 5.9 kJ mol^{-1}), a higher number of amino acids in alpha-helix (129) secondary structures and an increased number of hydrogen bonds (5) compared to other two systems. Therefore, the LBH589 complex has greater stability. According to this study, the stability order varies as HDLP with LBH589 > SAHA > PXD101. This theoretical observation is correlated with experimental IC50 values of LBH589 (5 nM), SAHA (10 nM), and PXD101 (27 nM). Therefore, the findings revealed that LBH589 is more potent than SAHA to stabilize HDLP. Therefore, the use of LBH589 in the clinical application will give more effective results to cure epigenetically caused cancer.

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Keywords: Histone deacetylase (HDAC), Histone deacetylase like protein (HDLP), Molecular docking, Molecular dynamics simulation

Abstract No: 92 ***Physical Sciences***

CONCENTRATION DEPENDENCE OF SINGLE BUBBLE SONOLUMINESCENCE THRESHOLD IN SULFURIC ACID

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Single Bubble Sonoluminescence (SBSL) is observed when an isolated gas bubble is acoustically trapped in a liquid and the bubble undergoes oscillations in synchrony with the applied acoustic field and produces sub nanosecond flashes as the bubble collapses. In this study, the behaviour of SBSL was experimentally investigated in sulphuric acid (H_2SO_4) of different concentrations, since the concentration dependence of formation of SBSL for a wide concentration range has not been studied so far in detail. The experimental setup consists of a spherical flask, an impedance matching circuit, and a data acquisition system. Before the host liquids are used for the experiment, they have to be degassed and dissolved with Ar since only a specific concentration of Ar need to be present in the liquid for obtaining SBSL. Then the host liquid resonator was acoustically driven in the resonance frequency which is in the range of 24.1 - 28.0 kHz for different solutions. Next, the intensity of the sound wave was changed until SBSL was observed. Photomultiplier tube (PMT) and spectroscopic data were recorded for the temperature range of 15 – 40 °C. The SBSL bubble in 98, 85 and 65 wt% concentrations was stable for a wider temperature range. The stable SBSL emission for 58, 50 and 40 wt% concentrations was obtained only up to 30 °C. The SBSL bubble in 65 wt% H_2SO_4 was stable for the entire temperature range. It was found that the maximum SL radiation is observed from the solution of 98 wt% of H_2SO_4 for the entire temperature and concentration ranges. It is possible to predict that the temperature independence of SBSL can be expected in the region between 58 - 65 wt%. It was also found that UV contribution of SBSL spectrum is high for the concentrations less than 58 wt% of H_2SO_4 while visible and IR contributions are high for the concentrations higher than 65 wt% of H_2SO_4.

This research was supported by National Institute of Fundamental Studies, Kandy, Sri Lanka.

Keywords: Acoustic, Electrical, Resonance, Sonoluminecence, Spectrum

Abstract No: 111 ***Physical Sciences***

LOW-COST PEROVSKITE SOLAR CELLS BASED ON ACTIVATED COCONUT SHELL CHARCOAL AS THE HOLE-TRANSPORT LAYER

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Perovskite solar cells (PSCs) have attracted intense attention due to their record high conversion efficiencies. A PSC is a type of solar cell that replaces the dyes used in dye-sensitized solar cells by a perovskite-structured compound; most commonly, a tin halide-based material or a hybrid organic-inorganic lead halide as the light-harvesting active layer. These solar cells give over 22% efficiency when spiro-OMeTAD is used as the hole-conducting material. However, the cost of spiro-OMeTAD is unbearably high, and researching for low-cost alternatives is obligatory for the practical applications of PSCs. As such, in this study, a low-cost PSC was fabricated using activated coconut shell charcoal (ACSC) powder which was prepared by activating CSC at high temperatures, in the range from 500 °C to 1000 °C, followed by immediate quenching in water and drying the powder thus obtained at 100 °C. The ACSC was powder-pressed on to the perovskite layer present on the working electrode, without using any solvent or binder, and the counter electrode was pressed on it to complete the solar cell. The working electrode of the PSC was fabricated using solution-processed methylammoniumlead halide deposited on an FTO plate, and a platinum-coated FTO glass plate was used as the counter electrode. Solar cells were prepared using ACSC prepared at different temperatures, and their efficiencies were measured. The solar cell made using ACSC powder activated at 950 °C has the highest conversion efficiency of 4.94% under AM 1.5 simulated sunlight under ambient conditions.

Financial assistance from the National Science Foundation. (*Grant No. RG/2018/BS/03) is acknowledged.*

Keywords: Activated coconut shell charcoal, Low-cost hole-transport material, Perovskite solar cell, Powder pressing

Abstract No: 113 ***Physical Sciences***

USE OF SELECTED AGRICULTURAL WASTE MATERIALS FOR SOUND ABSORPTION APPLICATIONS

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Agricultural and industrial dry waste materials accumulated in large quantities have become environmental pollutants. The present research project was focused on utilizing waste materials as sound absorbing materials for building walls, giving waste a value addition. Paddy straw, rice husk, coconut coir, jaggery pith and saw dust were selected as raw materials. Weighed 95% of dry waste material was thoroughly mixed with 5% Chemifix as a binding agent. The mixture was filled to a metal mould and 500 N was applied for 1 hour to make 1 cm thick sheets of size 28×20 cm^2 and dried in air for 5-7 days. A sound test box was constructed and one surface was covered with the sample sheets. Sound waves of frequency range from 250 Hz to 2000 Hz were generated, amplified and fed to a speaker. The sound reflection and transmission were measured using a sound level meter from 30 dB to 130 dB range, and used for calculation of sound absorption coefficients. The variation of sound absorption properties with thickness were also measured. Further, the density and modulus of rupture were measured to identify the strength of the materials. Jaggery pith waste sheets with modulus of rupture of 5.1×10^6 N m^{-2} and density of 467 kg m^{-3} showed the highest sound absorption coefficient, α = 0.12 at 1000 Hz for 1 cm thickness. The sheets made from rice husk showed the lowest α = 0.07 among the selected waste materials. Thus, all the material sheets are suitable as insulation boards without using a backing sheet as they are strong enough. Jaggery pith sheets of 2.0 cm thickness show α = 0.22, which is comparable to the commercially available 1.4 cm thick cork floor-tiles with α = 0.25 at 1000 Hz. Hence, these waste materials can be used as an alternative substitute for acoustical insulation.

Keywords: Acoustical insulation, Agricultural dry waste, Modulus of rupture, Sound absorption, Sound test box

Abstract No: 117 ***Physical Sciences***

LOW-COST WATER PURIFICATION SYSTEM USING CONDENSATION

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Access to pure drinking water is a major problem for underprivileged people in the dry zone of Sri Lanka, and as a result, most of them suffer from kidney diseases. Therefore, this research project was focused on designing and testing a low-cost and easily maintainable water purification system for obtaining pure drinking water. The principle is based on evaporation of water using solar energy to obtain saturated vapour at high temperature and to condense at lower temperature. Using an El Toro insulating sheet and a thin galvanized sheet, a thin wide channel was designed, which was connected to the water inlets. The other end of the galvanized iron envelope folds onto the El Toro sheet to wet the surface. Solar energy entering through the glass window heats the wet surface and produces hot saturated water vapour. The inner surface of the glass window was used for condensation. The purification ability was tested using dilute NaCl solution. To increase the yield, the El Toro wetting surface was modified by incorporating pot clay, coconut charcoal and manganese dioxide incorporated clay or coconut charcoal to increase its wettability and heat absorption. The maximum temperature difference of 14 °C between the wetting chamber and the condensation chamber was observed with MnO_2 incorporated coconut charcoal when the double glazing was used. The yield obtained was 249 mL m^{-2} h^{-1}, and it was given by the surfaces made of coconut charcoal and modified coconut charcoal. The yield increased to 416 mL m^{-2} h^{-1} when the double-glazed glass unit was used to separate the condensation surface and the wetting surface. The quality of the water samples collected from different locations was tested using the facility at National Water Supply and Drainage Board, and the results agreed well with the drinking water standards of Sri Lanka and World Health Organization.

Keywords: Manganese dioxide, Modified charcoal, Pot clay, Solar distillation, Water purification

Abstract No: 125 ***Physical Sciences***

Fe/Cu-CO-DOPED TIO_2 FOR EFFICIENT PHOTOCATALYTIC DYE DEGRADATION UNDER VISIBLE LIGHT

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TiO_2 photocatalysts have been widely used for the removal of pollutants from the environment. However, TiO_2 is active only in the UV range due to its wide band gap limiting its ability to harvest the full solar spectrum. Therefore, it is beneficial to extend its absorption to the visible region. TiO_2 has been doped with metals and non-metals to improve the visible light sensitivity. In this study, TiO_2 has been co-doped with Fe and Cu to enhance the use of the full solar spectrum via both reduction in the band gap and surface plasmon resonance effect. Nanoparticles of Fe doped TiO_2, Cu doped TiO_2 and 0.05 mol% Fe/Cu co-doped TiO_2 were synthesized via sol gel synthesis. These catalysts were tested for their photocatalytic activity for the degradation of methylene blue under visible light. Nanoparticles were characterized by powder X-ray diffraction (PXRD), transmission electron microscopy (TEM), Raman spectroscopy, scanning electron microscopy (SEM) and diffuse reflectance UV-Visible spectroscopy. PXRD patterns and Raman spectra show that the as-prepared TiO_2 photocatalysts have anatase and rutile crystalline phases. TEM and SEM images show agglomerated nanoparticles. Selected area diffraction patterns also show the presence of both anatase and rutile crystal phases. All the doped TiO_2 photocatalysts were red shifted and extended absorption in the visible region. Based on the diffuse reflectance spectra, the band gaps are calculated to be 2.85 eV (TiO_2), 2.80 eV (Fe-TiO_2), 2.74 eV (Cu-TiO_2) and 2.74 eV (Fe/Cu-TiO_2). These results indicate that doped nanoparticles are catalytically more active than undoped TiO_2. Further, Cu-TiO_2 show the highest rate of photocatalytic activity (0.1 min^{-1}) due to its comparatively narrow band gap and enhanced surface plasmon effect. Rate of reaction is very similar in Fe-TiO_2 and Fe/Cu-TiO_2 (0.009 min^{-1}). However, Fe/Cu co-doped TiO_2 shows less photocatalytic activity due to the electron hole pair recombination effect. Therefore, it could be concluded that Cu doped TiO_2 triggers the reaction via band gap reduction and surface plasmon effect, and that co-doping has reduced the band gap with enhancing the electron hole pair recombination.

Financial assistance from Sri Lanka Institute of Information Technology is acknowledged.

Keywords: Environment, Fe/Cu co-doped TiO_2, Photocatalysis, Pollutants, TiO_2

Abstract No: 143 ***Physical Sciences***

ELECTRICAL AND OPTICAL PROPERTIES OF F-DOPED SnO_2 NANOSTRUCTURED THIN FILMS SYNTHESIZED BY SEQUENTIAL NEBULIZER SPRAY PYROLYSIS

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Transparent conductive films are widely used to prepare photovoltaic solar cells, photoelectrochemical solar cells, flat panel displays, touch screens, light-emitting diodes, smart windows, gas sensors and frost-resistant surfaces. Both high electronic conductivity and high optical transmission are essential properties of transparent conductive oxides (TCO) for applications. In this work, transparent and electrically conductive F-doped tin oxide (FTO) thin films were deposited on glass substrates (soda-lime glasses). Sequential nebulized spray pyrolysis (NSP) was used to synthesize nanostructured FTO layers with the aid of a homemade low-cost spray gun. The surface morphology of FTO layers prepared was analyzed using scanning electron microscopy (SEM) and X-ray diffraction (XRD). The study confirmed the formation of pure SnO_2 phase with F being incorporated into the crystal structure. XRD pattern showed peaks at 2θ values of 26.64° (110), 33.90° (101), 37.95° (200), 51.87° (211), 56.17° (200), 60.05° (310) and 61.89° (301), corresponding to respective crystal planes of SnO_2. SEM images reveal that synthesized films have homogeneous surface coverage, and the size of crystallites is in the range of 5 - 15 nm. The results are in accordance with crystallite sizes calculated from Rietveld refinement. The optical transparency of the films was evaluated by absorption spectroscopy, which revealed more than 65% transparency in the visible regime for the films having 25 Ω cm^{-2} sheet resistance. The bandgap energies were estimated from standard Tauc plots, which resulted in 3.7 eV for the substrate with 25 Ω cm^{-2} sheet resistance. The FTO conductive films prepared in this research were used to prepare a quasi-solid-state dye-sensitized solar cell (DSC). The DSCs exhibited 4.8% power conversion efficiency, 86% fill factor and higher short-term stability.

Financial assistance from the University of Peradeniya Sri Lanka (*Grant No. URG/2019/27IS*) *is acknowledged.*

Keywords: FTO, Optical transparency, Spray pyrolysis, Surface morphology, Transparent conductive films

Abstract No: 147 ***Physical Sciences***

PLANT PIGMENTS FOR SUNSCREEN: A SPECTROSCOPIC STUDY

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Exposure to ultraviolet (UV) radiation may result in developing sunburns on the skin surface, and this may cause skin cancer. Sunscreens with ultraviolet B (UVB) absorbers are available to protect the skin from UV radiation. The effectiveness of sunscreen against UVB radiation is quantified by Sun Protection Factor (SPF), a parameter defined in the UVB region. Even though there are a variety of synthetic sunscreens available, the use of natural antioxidants in skincare products has attracted increased interest in recent years. Antioxidants, such as anthocyanin, flavonoids and phenolic acids, have the potential to quench the effect of reactive free radicals formed upon exposure to UV radiation. In this study, pigments from several flowers and fruits with a high content of anthocyanin were tested for UV absorbance and the SPF values were calculated. The highest SPF value of 18.54 was observed for pigment from Shoe flower (*Hibiscus rosa-sinensis*) - *cyanidin*, at a concentration of 0.03 g L^{-1}. For further enhancement of SPF value, *lawsone*, a pigment from Henna tree was added and sunscreen was formulated using glycerin as the base cream with an improved SPF of 19.11. This sunscreen shows a comparable UV absorption similar to the commercially available sunscreens. Moreover, the calculation of SPF value of the sunscreen prepared was compared with that of commercially available sunscreens having SPF values of 15, 20+ and 30+. The vibrational spectroscopy was utilized for the structural characterization of *cyanidin* and *lawsone*. Furthermore, the pigments present in the sunscreen were stable for a range of temperatures and had a long shelf life. Overall, the results show that the combination of the above pigments acts as a natural UV protector.

Keywords: Antioxidant, Herbal sunscreen, Shoe flower, SPF, UV

Abstract No: 148 ***Physical Sciences***

STUDIES ON UV ABSORPTION AND VISIBLE EMISSION OF *La* DOPED *ZnS*

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Semiconductor nanoparticles have steadily drawn attention during the last few years due to their new-fangled optical, physical and electrical properties than their bulk particles**.** Zinc sulphide (ZnS) is a very important wide band gap semiconductor belonging to II-VI semiconductor type. It has a wide band gap of 3.7 eV at room temperature, and is primarily a compound for UV light emission. The luminescence properties of ZnS strongly depend on the intrinsic and extrinsic defects. To study the optical properties of ZnS, lanthanum (0.1, 0.5 and 1.0 mol%) doped ZnS nano-powder was successfully synthesised by co-precipitation method. Lanthanum (La) is used in the preparation of advance materials with superlative optical and structural properties. Doping with such materials would enhance unique properties of the host material. Samples prepared were characterized using Fourier transform infrared (FTIR) spectroscopy, X-ray diffraction (XRD), UV absorption spectroscopy and photoluminescence. In FTIR spectra, characteristic peaks observed at 465 and 600 cm^{-1} are due to stretching bond of Zn-S, while XRD analysis confirms the cubic zinc blend structure of ZnS. According to the Debye Scherer's formula, the crystallite size was found to be 2.89 nm. The optical absorption edge was calculated using Tauc equation. The optical energy band gap is observed to increase with La doping which may be due to quantum confinement effect. The emission broad peak centred at 483 nm was due to Zn vacancies. Hence, the blue-green emission may be due to some self-activated defect centres related to Zn vacancies. The intensities of the peaks of ZnS:La were less than those of the undoped ZnS. The reduction in the emission intensity is due to the increase in the non-radiative recombination process. Thus, samples prepared show good optical properties, and they are useful for opto-electronic applications.

Keywords: La, Visible emission, ZnS, Zn-vacancy

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Abstract No: 149 ***Physical Sciences***

CALIBRATION OF PERIOD-LUMINOSITY RELATION OF HIGH AMPLITUDE δ SCUTI TYPE VARIABLES USING BAADE-WESSELINK METHOD

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High amplitude δ Scuti (HADS) variables are a promising set of candidates to be utilized as a cosmic distance indicator which is one of the fundamental tools in many fields of modern astrophysics. The Baade Wesselink method provides precise techniques to establish the distances to standard candles like High amplitude δ Scuti variables by the determination of their stellar radii. Photometric data was obtained for SZ Lyn and BS Aqr using the GOTO 45 cm Cassegrain telescope from the Arthur C. Clarke Institute of Modern Technologies. The data was reduced and analyzed using IRAF image reduction application. The radial velocities for both SZ Lyn and BS Aqr were obtained from the Vizier portal provided by (Strasbourg Astronomical Data Center CDS). The application of the Baade Wesselink method to both HADS variables resulted in placing SZ Lyn at a distance of 430.725 ± 14.876 pc and BS Aqr at a distance of 361.077 ± 6.301 pc with mean absolute magnitudes of 1.91 ± 0.45 and 1.57 ± 0.38 for SZ Lyn and BS Aqr, respectively. The Period-Luminosity (PL) relation was found out to be $\langle M_V \rangle = -(1.561 \pm 0.341) \log_{10} P + 0.475$, which was then used to determine the distances to nearby galaxies. Pulsation periods and V band magnitudes of High Amplitude δ Scuti variables of the Large Magellanic Cloud and Carina spheroidal galaxy were obtained from Optical Gravitational Lensing Experiment (OGLE) and General Catalog of Variable Stars (GCVS) catalogues through the vizier portal. Upon the implementation of the PL relation, it was determined that the distance to the Large Magellanic Cloud is 51.56 ± 2.00 kpc and Carina is at a distance of 111.93 ± 4.33 kpc. Through the comparison of these distances with other works in the same area it was concluded that the Baade Wesselink method for high amplitude δ Scuti variables is a viable option for cosmic distance measurements.

Keywords: Carina galaxy, Cosmic distance indicator, IRAF, Large Magellanic Cloud, δ Scuti variables

Abstract No: 152 ***Physical Sciences***

CYCLIC VOLTAMMETRY STUDY ON ZINC RECHARGEABLE CELLS

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All renewable energy sources require energy storage devices, such as rechargeable cells and super capacitors, due to their fluctuations and continuous unavailability. Zinc (Zn) rechargeable cells have received much attention when compared to lithium (Li) based cells since mainly Zn is safer than Li. This paper is on characterization of a Zn cell with a natural rubber (NR) based electrolyte and a natural graphite (NG) based electrode using cyclic voltammetry. For the preparation of the electrolyte, NR was mixed in tetrahydrofuran (THF). The mixture was stirred using a magnetic stirrer for 24 h. Zinc trifluoromethanesulfonate (ZnTF) solution was prepared separately in THF. NR-ZnTF solutions were then mixed together and stirred further to form a homogenous electrolyte solution. The final solution was then poured into a petri dish and left to slowly evaporate the solvent. This resulted in a thin solid electrolyte film. The cathode consisted of 80% NG and 20% poly (vinylidenefluoride)-co-hexafluoropropylene (PVdF co HFP), whereas Zn was used as the anode. First, the suitable potential window for continuous cycling was determined by varying the potential window width. When widening the window, capacity (C_s) increased, but at the same time, current increased very much for wider windows. The width selected was from 0.4 V to 1.4 V. Continuous cycling was done at the scan rate of 10 mV s^{-1} for 1000 cycles. The C_s values varied from 2.20×10^{-5} mA h to 2.86×10^{-6} mA h during 1000 cycles. Possible reasons for the observed drop of C_s could be the loss of contacts between the electrode/electrolyte interfaces and degradation of the electrolyte. The results obtained provide evidence for the possibility of using NR and NG for zinc cells improving features of safety and low-cost. Further studies are progressing to improve the performance of the cells.

Financial assistance from the National Research Council, Sri Lanka (Grant No. NRC 17-006) *is acknowledged.*

Keywords: Capacity, Natural rubber, Zn rechargeable cells

Abstract No: 153 ***Physical Sciences***

SRI LANKAN NATURAL GRAPHITE/GEL POLYMER ELECTROLYTE BASED ELECTROCHEMICAL DOUBLE LAYER CAPACITOR

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Graphite has been identified as a good electrode material to be used in the supercapacitors. Graphite can be readily intercalated to host various atoms and molecules. Furthermore, it can reversibly accumulate/release ions at very high and low potentials. Thus, graphite is proven to be a better candidate for electrodes. Graphite can be found in synthetic and natural forms. Natural graphite is abundantly available in mines located in Sri Lanka, China, Brazil, Canada and Russia. In Sri Lanka, graphite can be obtained cheaply in the purest form. This study aims to give a value addition to Sri Lankan natural graphite by using it as an electrode material in electrochemical double layer capacitors (EDLCs). Laboratory-scale EDLCs were fabricated using the prepared graphite electrodes and polyvinylidene fluoride based gel polymer electrolyte (GPE). They were characterized using cyclic voltammetry (CV) and galvanostatic charge-discharge (GCD) tests. CV studies were carried out by varying the potential window, and the +0.001 V to +0.8 V potential window was chosen as the optimum, considering the maximum current and the required shape of the cyclic voltammogram. The GCD test was carried out in the voltage range of +0.1 V to +0.8 V with a constant current of 0.034 mA. Specific discharge capacitance (C_{sdc}) of 0.69 F g^{-1} was reduced to 0.63 F g^{-1} (91.3 % retention) after 10,000 charge-discharge cycles indicating outstanding rate capability. These results also indicate good contacts between the electrode/electrolyte interfaces. All these tests demonstrated the capacitive behavior of the graphite based EDLC and revealed its excellent cycling stability and rate capability. Further modifications are needed to improve the performance of Sri Lankan natural graphite to promote it as an industrial, low-cost and eco-friendly electrode material.

Financial assistance from the National Research Council (*Grant No. 18-007*) *is acknowledged. Bogala Graphite Lanka Ltd. is acknowledged for supplying graphite.*

Keywords: Graphite, Electrochemical double layer capacitor, Cyclic voltammetry, Specific capacitance, Galvanostatic charge discharge test

Abstract No: 154 ***Physical Sciences***

CHARGE-DISCHARGE BEHAVIOUR OF AN IONIC LIQUID GEL POLYMER ELECTROLYTE BASED ZINC/ NATURAL GRAPHITE CELL

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Due to the rapid increase of demand for uninterrupted power, harnessing energy from renewable sources has received a great attention in the twenty first century. To tackle the major issue with renewable energy, which is in continuous unavailability with desired intensity, use of energy storage devices is of utmost importance. Extensive research activities are being carried out to explore energy storage devices with attractive features, such as higher energy density and higher power density. However, their high cost and safety have to be addressed in order to make them attractive for present day concerns on economical and environmental aspects. The main objective of the present study was therefore to fabricate a Zn rechargeable cell having features of low-cost and safety, and to analyse its charge-discharge behavior. As such, zinc and natural graphite electrodes were combined with 1-ethyl-3-methylimidazolium chloride/poly(vinylidene fluoride-co-hexafluoropropylene) gel polymer electrolyte to assemble the cells, and characterization was done using galvanostatic charge-discharge test. Under a constant current of 40 mA, variation of discharge capacity was observed for 1000 cycles using a galvanostat/potentiostat. The initial discharge capacity of the cell was 4.9×10^{-3} mAh which was quickly dropped down to 1.7×10^{-3} mAh. Subsequently, the rate of decrease in discharge capacity was rather slow. However, the cell was able to keep the discharge capacity above 1.0×10^{-3} mAh for 1000 cycles further proving the durability of the device. This cell is identified to be low-cost and safe. With suitable modifications, the performance can be improved further.

Financial assistance from the National Science Foundation, Sri Lanka (Grant No. RG/2017/ BS/02) is acknowledged.

Keywords: Galvanostatic charge-discharge test, Natural graphite, Zn electrodes

Abstract No: 169 ***Physical Sciences***

THICKNESS CONTROLLED FABRICATION OF Sb_2S_3 PLANAR STRUCTURE ENHANCED LIGHT HARVESTING AND CHARGE COLLECTION EFFICIENCY

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Utilization of semiconductors as a light absorbing material has recently been receiving much attention. Among the range of investigated semiconductors, antimony sulfide (Sb_2S_3) is appealing as a promising light absorber due to its suitable bandgap (1.5 - 1.7 eV), one dimensional crystal structure and non-toxic constituents. Among a number of methods available, spin coating is known as the simplest technique to fabricate Sb_2S_3 thin films. In this investigation, the thickness of the Sb_2S_3 light harvesting layer was optimized by varying the spin coating conditions. Different Sb_2S_3 photoanodes were fabricated on the TiO_2 compact layer/FTO substrates by spinning the Sb_2S_3 precursor solution of antimony chloride and thiourea (2:3) in 2-methoxyethanol at 3000, 4000, 5000 and 6000 rpm for 30 s. The devices, fabricated with the configuration of FTO/compact TiO_2/Sb_2S_3/P3HT/Ag, showed an increase of solar cell performance with an increase of the spinning rate of the Sb_2S_3 precursor solution up to 5000 rpm. The thickness of Sb_2S_3 film, which was fabricated at 5000 rpm was ~ 265 nm, showed the highest power conversion efficiency of 4.01% with 619.2 mV as open circuit voltage, 14.05 mA cm^{-2} as short circuit current and 46.1% as a fill factor. The IPCE measurements were in good agreement with the *I-V* performance of the devices. Generally, the morphology of the films has no significant changes with the spinning speed. However, the thicknesses of Sb_2S_3 films were decreased by increasing spinning speed, which was examined by UV-Vis absorption spectra of Sb_2S_3 films. Therefore, the thickness of Sb_2S_3 film should be one of the critical factors that highly affects the performance of Sb_2S_3 solar cell devices. Herein, the performance of the Sb_2S_3 based solar cell was improved upon changing the thickness of Sb_2S_3 film based on spinning speed.

Financial assistance from the National Research Council (*Grant No. 18-005*) *is acknowledged.*

Keywords: Light absorber, Planar structure, Spinning speed and Thickness

Abstract No: 171 ***Physical Sciences***

PHYCOREMEDIATION OF METHYLENE BLUE

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Industrial dyes are a major contributor towards pollution of natural water bodies. Accumulation of these molecules in higher concentrations in the environment is harmful for all living organisms. Removal of such synthetic dyes from industrial effluents when present at low concentrations is difficult and expensive. Currently, adsorption-based methods using activated charcoal and polymeric material are widely used. Biomass originated from higher plants or microorganisms provides alternative low-cost adsorbents. While dry biomass can only adsorb pollutants, live biomass is capable of adsorption as well as degradation of molecules to less toxic substances. Phycoremediation utilizes algae for the removal or biotransformation of pollutants including nutrients and xenobiotics from wastewater. Among many different types of microorganisms, microalgae are more practically useful for bioremediation due to ease of handling and adaptability to environmental conditions. This study was focused on using two live microalgae species; *Chlorococcum aquaticum* and *Chlorella* sp. isolated from polluted water bodies in Sri Lanka to remove methylene blue in water. The factors affecting the bio-removal process, adsorption models and kinetics were studied in detail. *C. aquaticum* showed 75.54% decolorization within seven days with a dosage of 6.4×10^1 mg mg^{-1} of cell culture in 150 min whereas *Chlorella* sp. showed 71.10% decolourization within seven days with a dosage of 1.2×10^2 mg mg^{-1} of cell culture in 150 min. *C. aquaticum* - methylene blue adsorption processes showed a fit to the Langmuir adsorption isotherm whereas *Chlorella* sp. - methylene blue adsorption system fitted to the Temkin adsorption isotherm model. Both the adsorption systems were well fitted to the pseudo second order kinetics. This study revealed the adsorption of methylene blue by growing *Chlorococcum aquaticum* and *Chlorella* sp. introducing a potential eco-friendly, and low-cost alternative for the removal of methyl blue from industrial effluents.

Keywords: Adsorption kinetics, Bioremediation, *Chlorella* sp., *Chlorococcum aquaticum*, Methylene blue

Abstract No: 172 ***Physical Sciences***

INVESTIGATION OF CHARGE TRANSPORT IN POLYETHYLENE OXIDE-BASED IONIC CONDUCTORS

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Solid polymer electrolytes are a key component in many electrochemical devices such as dye-sensitized solar cells (DSCs), batteries and supercapacitors. In this study, three electrolytes based on polyethylene oxide (PEO) host polymer, ethylene carbonate (EC) plasticizer and Al_2O_3 filler were investigated. The polymer electrolyte comprised of $(PEO)_9(EC)_9(LiCF_3SO_3)_2(Al_2O_3)_{0.75}$ was synthesized, and characterized by analyzing DC conductivity, frequency dependence of AC conductivity and complex dielectric function. For in-depth analysis of electrolytes, dielectric analysis was used to determine charge carrier density (n), mobility (μ) and diffusion coefficient (D) of the electrolytes. The method of calculating charge transport parameters is further reinforced by making it possible to calculate these parameters simply by using electrochemical impedance analysis. A plasticized and composite electrolyte (PEO + EC + Al_2O_3 + $LiCF_3SO_3$), a composite electrolyte (PEO + Al_2O_3 + $LiCF_3SO_3$) and a plasticized electrolyte (PEO + EC + $LiCF_3SO_3$) were prepared to study the effects of organic solvents and fillers on n, D and μ. The temperature dependence of n, D and μ has also been studied. The total number of Li^+ ions available in polymer electrolytes from the salt was evaluated to check the reliability of the method. According to the calculations, EC can increase ionic conductivity by increasing the number of free mobile ions. Even though polymer electrolyte with Al_2O_3 has low ionic conductivity than that of the plasticized polymer electrolyte, the physical properties improve along with the addition of Al_2O_3. The present study confirms that the plasticizer EC and the filler Al_2O_3 contributed to improve the conductivity by enhancing n and μ. At 28 °C, $(PEO)_9(EC)_9(LiCF_3SO_3)_2(Al_2O_3)_{0.75}$ shows n, D and conductivity of 1.27×10^{27} m^{-3}, 3.8×10^{-11} m^2 s^{-1} and 2.96 mS cm^{-1}, respectively. The values determined for D, μ and n parameters of the three electrolytes are in agreement with those available for similar electrolytes.

Financial assistance from the University of Peradeniya (*Grant No. URG/2019/27IS*) *is acknowledged.*

Keywords: Electrochemical impedance analysis, Gel polymer electrolyte, Solid polymer electrolyte

Abstract No: 175 ***Physical Sciences***

EFFECT OF PATIENT POSITIONING IN THREE-DIMENSIONAL CONFORMAL RADIOTHERAPY FOR CARCINOMA IN THORAX REGION

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In radiotherapy, it is mandatory to maintain the patient at the original setup position to deliver accurate dose to the tumour and reduce dose to normal tissues. However, there may be slight deviations in patient position due to random and systematic errors. The impact of patient positioning deviations in Three-Dimensional Conformal Radiotherapy (3DCRT) for carcinoma in the thorax region and possible solutions to decrease these deviations are discussed in this research. A thorax phantom was used to simulate the thorax region and Computed Tomography (CT) scan of it was taken. Then Clinical Target Volume (CTV) and Organs at Risk (OAR) were contoured using computerized Treatment Planning System (TPS). Planning Target Volume (PTV) was contoured by symmetrically expanding the CTV by 1 cm. Three radiation beams were introduced such that PTV is covered by 95% to 107% isodose lines and OAR are below their tolerance dose limits. Monitor units (MU) for each beam and calculated dose to PTV, lungs and spinal cord reference points for the original setup position were recorded according to the TPS. Then the thorax phantom was set up on the linear accelerator treatment couch with an ionization chamber and electrometer to measure the absolute dose to each reference point. After that, the couch was moved to different positions by 1 cm to simulate the setup error and absolute dose to each reference point at each movement was measured. Percentage deviations between the calculated dose and measured dose were calculated. Agreement criteria for percentage deviation were taken as $\pm 2\%$, $\pm 4\%$ and $\pm 3\%$ for tissue, air and bone respectively. The results showed that the PTV reference point dose, lung reference point doses and spinal cord reference point dose deviate from the agreement criteria for some movements of the phantom. However, Dose Volume Histograms (DVH) for each movement of the phantom revealed that 99% volume of the CTV was always covered by at least 95% isodose line and OAR doses were always within their tolerance limits. Considering these findings, it is concluded that setup variations, which are similar to or less than the size of 1 cm PTV margin from the original setup position in any direction is acceptable to proceed with the radiation treatment.

Keywords: Patient positioning errors, PTV margin, Three-dimensional conformal radiotherapy

Abstract No: 176 ***Physical Sciences***

Zn AND Ni BASED METAL-ORGANIC FRAMEWORKS FOR PHOTOVOLTAIC APPLICATION

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Metal-organic frameworks (MOFs) are a class of materials which are identified as three-dimensionally linked coordination networks, and they are formed by metal ions or clusters linking with rigid organic linkers. Hence, MOFs possess remarkable properties and synthetic flexibilities which allow tuning their properties. Thus, MOFs have attracted great attention among researchers for their applications in the energy sector, such as light/energy harvesting and energy-storing. MOF-74 (Zn) [zinc(II) 2,5-dihydroxyterephthalic acid (DHTP)] and MOF-74 (Ni) [Ni(II) DHTP] are two coloured MOFs which belong to the MOF-74 family. Both have the same organic ligand and two different metal centers. In this study, a core-shell structure of MOF-74 (Zn, Ni) was synthesized by incorporating TiO_2 nanoparticles, to enhance the light-harvesting and conductivity of TiO_2 nanoparticles. These two composites, MOF-74(Zn)/TiO_2 and MOF-74(Ni)/TiO_2, were included in photovoltaics as the photoanode material. Photovoltaics that consist of MOF-74(Zn)/TiO_2 and MOF-74(Ni)/TiO_2 as photoanode materials demonstrated open circuit voltage (*V*oc) of 0.45 V and 0.36 V, short-circuit current density (*J*sc) of 0.18 mA cm^{-2} and 0.19 mA cm^{-2}, fill factor (*FF*) of 0.46 and 0.41, and percentage efficiency of 4.0×10^{-2} and 3.0×10^{-2}, respectively. According to *I-V* characteristics, shunt resistance (5.9 kΩ) of cells were found to be similar to that of a typical solar cell implying low manufacturing defects. However, series resistance is 10 times higher than that of a typical solar cell (0.4 kΩ) which may have resulted in low overall cell performances.

Financial assistance from the National Science Foundation (*Grant No. G/BS/2016/05*) *is acknowledged.*

Keywords: Metal-organic frameworks, Photoanode, Semiconductor, TiO_2

Abstract No: 177 ***Physical Sciences***

ESTIMATION OF SURFACE AND BUILD-UP REGION DOSE FOR COBALT-60 TELE-THERAPY UNITS

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In radiotherapy, the amount of dose absorbed at the surface and the build-up region is important to assess the skin damage, decide on the use of bolus and design the treatment technique. In this study, percentage surface dose and percentage depth dose were measured using a calibrated PTW 31014 cylindrical type ionization chamber. Irradiation was done using a Theratron 780E ^{60}Co tele-therapy machine, and all the measurements were taken in a water phantom. Surface dose was measured by placing the chamber on the water surface and increasing the field size from 5×5 cm^2 up to 30×30 cm^2. When irradiated, some extra number of electrons is produced due to the scattering from the portion of chamber that is above the water surface. As expected, the measured percentage surface dose was higher than the published values. Increment in percentage surface dose with the field size was fitted using a linear model for both measured and published data. Comparing these two linear fits, correction for the percentage surface dose measurements was identified as $0.53\,x - 45.47$ for any field size x. Field size was fixed to 10×10 cm^2, and depth doses were measured by immersing the chamber in water phantom until 12 mm depth. Measured depth doses were lower than the published depth doses in the depth region 1 - 4 mm. This is due to the higher attenuation of radiation in the region by the relatively thick wall of the cylindrical chamber. Below 4 mm depth, the PTW 31014 chamber reads the accurate dose. In 1 - 4 mm region, variation in percentage depth dose with the depth was fitted using a polynomial of degree two for both measured and published data. Comparing the two second order fits, correction for the measured percentage depth dose was identified as $-8.94\,z^2 + 44.28\,z - 33.96$ for some depth z.

Keywords: Absorbed dose, Build-up region, Depth dose, Surface dose

Abstract No: 178 ***Physical Sciences***

GRAPHITIZED CARBON SPHERES (CSs) WITH HIERARCHICAL SURFACE MORPHOLOGY BY CHEMICAL VAPOUR DEPOSITION (CVD)

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In recent years, different forms of carbon structures with extraordinary properties and multidisciplinary applications have been discovered. Among them, carbon spheres (CSs) are unique materials because they can be fabricated with significant characteristics, such as adjustable porosity, uniform geometry, surface functionality, flexible particle size distribution, and outstanding chemical and thermal stability. In this work, graphitized CSs with varying diameters and hierarchical surface morphology were synthesized on iron-coated silicon (100) substrate, at 750 °C, using catalytic chemical vapor deposition (CCVD). CSs with different sizes were produced by varying the flow rates of the carbon source and the method of catalyst coating. Scanning electron microscopic examination shows that CSs produced in this manner have a regular and uniform shape with smooth surface properties. The catalyst coating methods employed in this work produce high yield CSs with the diameter ranging from 0.5 - 3.5 μm. By using ImageJ, the effect of the catalyst prepared by spin-coating and dip-coating methods on the variation of the diameter (surface morphology) of the carbon spheres was investigated. The results show that the formation of micro-sized carbon spheres (1.0 - 3.5 μm) is favoured on catalyst coated on silicon (100) by spin-coating method at a lower flow rate of carbon source, acetylene. The average diameter of the CSs was 3.1 μm under optimum conditions of acetylene to nitrogen ratio of 500:200 sccm. Results of Raman spectroscopy and X-ray diffraction confirmed the presence of graphitized hexagonal carbon networks of the products, and their applications depend significantly on the shape and size of the particles. The results observed are explained with the view of using such CSs in the unit process of water treatment plants, sodium-ion batteries and nano-composites.

Financial assistance from the National Research Council (Grant No. 16-015) is acknowledged.

Keywords: Carbon spheres (CSs), Chemical vapor deposition (CVD), Dip coating, Hierarchical surface morphology, Spin coating

Abstract No: 202 ***Physical Sciences***

CONSTRUCTION OF A LOW-COST AUTOMATED SPECTRUM ANALYSER

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Spectral analysis of electromagnetic radiation is important in many branches of science with a wide range of applications. An optical spectrum analyser is able to detect the visible region of the electromagnetic spectrum. The objective of this research was to build a spectrum analyser with high spectral resolution and accuracy at a relatively low cost so as to integrate the instrument to the local scientific community. The main operating principle of the spectrum analyser is diffraction. Light enters the spectrum analyser through a single slit of 1.81 mm, and then collimated by a convex lens which is kept at its focal length from the single slit. A diffraction grating receives the collimated beam where Fraunhoffer diffraction occurs. The diffracted beam is then exposed to an image sensor. The image sensor is a charged coupled device. The data was processed with the open source software Theremino (v2.8). The software processes the image data into a bitmap image with a data point for each pixel. The individual colour data values of pixels are counted with an algorithm to provide the intensity data. The calibration was done with a standard low-pressure Hg source. The spectrometer possesses a spectral range of 380 - 710 nm. The software is capable of resolving a wavelength with an accuracy of 0.5 nm. The spectral resolution of the spectrometer which was calculated in accordance with the industry standard. For the given spectral range, the spectral resolution was 4.4 nm. The spectrometer can be utilized to observe emission spectra to analyse the ionic compositions in solutions. The spectrum analyser can also be modified as a tool in astronomical spectral analysis as a low-cost alternative. The spectrometer could be further improved with better image sensors to extend the spectral range.

Keywords: Analyser, Optical, Spectrum, Visible

Abstract No: 203 ***Physical Sciences***

CHEMICAL BATH DEPOSITION: AN EFFECTIVE METHOD FOR DEPOSITION OF THIN FILMS OF METAL ORGANIC FRAMEWORKS

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Metal-organic frameworks (MOFs) are porous materials that are a subclass of coordination polymers consisting of metal clusters and organic linkers. Properties, such as surface area, porosity, absorptivity and electrical conductivity, can be easily fine-tuned by varying the metal nodes or organic linkers. Due to their diverse functionality, MOFs have been extensively investigated in research fields, such as gas storage and separation, catalysis, drug delivery and sensing. Recently, MOFs have been investigated in the field of photovoltaics, with promising results. The deposition of thin films of MOFs is a crucial requirement to be applied in these devices. Up to date, thin films of MOFs have been obtained using deposition techniques, such as liquid phase epitaxy, layer by layer deposition, electrochemical and doctor blading. Non-uniformity and instability on the substrate are limitations that are associated with these methods. However, chemical bath deposition (CBD) is typically utilized as a thin film deposition technique in the field of photovoltaics that yields stable, adherent, uniform, and hard films with good reproducibility by a relatively simple process. Yet, it has not been utilized in the fabrication of MOFs. In this study, CBD is used to fabricate a uniform, thin porous film on fluorine-doped tin oxide (FTO) substrate. MOF199 was selected as the choice of MOF due to its easy synthesis procedure and stability. The deposition of MOF199 on FTO was confirmed by powder x-ray diffraction and Fourier transformation infrared spectroscopy, where further characterization such as conductivity measurements and SEM are to be done. To enhance film adherence on the surface of FTO, NaOH and 4-aminobenzoic acid was used as a surface activator. Then, different conditions were optimized to obtain a stable thin film of MOF, where an optimum deposition temperature of 30 °C, dormant period 24 hours, and a deposition angle of 30° were identified. A stable and uniform thin film of MOF199 with fine tunable layer thickness could be successfully fabricated using the CBD technique. Thus, this study paves the way to obtain high-quality thin films of MOFs by a simple process.

Keywords: Chemical bath deposition, Coordination polymers, Organic frameworks, Organic linkers, Photovoltaics

Abstract No: 207 ***Physical Sciences***

FABRICATION OF POLYVINYLIDENE FLUORIDE PIEZOELECTRIC FILM FOR NANOGENERATORS

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Nanogenerators based on piezoelectricity is a promising technology for energy harvesting, sensors, biomedicine and in many other fields. Properties of piezoelectric material are influential factors to improve the output capability of piezoelectric nanogenerators. Polymer piezoelectric materials, especially polyvinylidenefluoride (PVDF), has attracted attention because of its high flexibility, chemical stability, non-toxicity, biocompatibility and high thermal stability apart from its piezoelectric properties. PVDF is a semicrystalline polymer with four different crystalline phases α, β, γ and δ. In this work, the electrospinning technique was used to fabricate PVDF fiber film to enhance the β phase content, which is responsible for piezoelectricity. The electrospinning process with optimal parameters was carried out to obtain uniform and well-aligned fibers as observed by scanning electron microscopy (SEM). The morphology of the PVDF fiber film, observed by SEM, showed uniform, smooth and consistent fiber formation without beads, and moreover, the fiber diameters were in the range of 700 – 1,000 nm. The crystalline phase of PVDF was characterized by analyzing X-ray diffraction patterns and Fourier transform infrared spectra. The β phase content of the electrospun film was 80.1%, while it was 64.4% for the solvent casted PVDF film. This result showed that electrospinning increases the percentage of the β phase present within the film. A nanogenerator was constructed from assemblies of fabricated PVDF fiber film and copper electrodes. The piezoelectric response of the nanogenerator impacted by the applied force was evaluated by measuring the peak-voltage outputs. Variations in the tapping frequency have not significantly affected the amplitude of the output voltage of the nanogenerator. However, the applied force and detected output voltage are linearly correlated within the observed region. The maximum voltage generated was 1.0 V with finger tapping, and it was 1.3 V with a custom-designed tapping machine. Improvements of this PVDF piezoelectric nanogenerator can be used in many potential applications in several fields, especially as energy harvesters and sensors.

Keywords: Electrospinning, Nanogenerator, Piezoelectricity, Polyvinylidene fluoride

Abstract No: 211 ***Physical Sciences***

UREA: ADIPIC (2:1) CO-CRYSTAL AS A SLOW RELEASE NITROGEN SOURCE

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Slow and sustained release fertilizer system was introduced using urea containing co-crystals. Urea is the most widely used plant nutrient as the nitrogen source. However, nutrient use efficiency (NUE) of urea is very low due to high solubility, hygroscopicity, and volatilization in the form of ammonia and nitrogen oxides. In addition, urea can be incorporated into soil organic matter promoting many environmental issues. During this study, attempts were made to evaluate the potential of a novel urea-based cocrystal polymorph [urea: adipic acid (2:1)] as a slow and sustain release fertilizer. Urea: adipic acid (2:1) cocrystal was synthesized by the liquid assisted grinding technique in the presence of a few drops of methanol as the solvent. The successful cocrystal formation was confirmed by powder X-ray diffraction, differential scanning calorimetry, thermogravimetric analysis and Fourier transform infrared spectroscopy. The release behavior of prepared fertilizer was investigated in the soil medium (pH = 5.1), and it was observed that nitrogen release from the cocrystal composition was in a slow and sustained manner up to 18 days whereas pure urea had released 80% of nitrogen within 6 days. The carbonyl group of urea acts as a very strong acceptor center while two amine groups offer rich donor capabilities resulting in hydrogen bonds with adipic acid. Such non-covalent interactions between urea and adipic acid would reduce the rate of dissolution and hydrolysis of urea to gaseous products. The proposed cocrystal based composition can be a potential candidate for the development of an efficient fertilizer formulation.

Keywords: Liquid assisted grinding, Release behavior, Slow release fertilizer, Urea co-crystal

Abstract No: 219 ***Physical Sciences***

CARBOXYMETHYL CELLULOSE COATED UREA INTERCALATED MONTMORILLONITE NANOCOMPOSITES FOR CONTROLLED RELEASE OF UREA

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Nitrogen is one of the most important plant nutrients in fertilizers, and urea has been widely used to fulfil the global need. However, due to leaching and volatilization, 50 - 70% of urea is lost resulting in very low Nitrogen Utilization Efficiency (NUE) to plants. Slow and controlled release fertilizers are believed to have more potential in increasing NUE. Urea intercalated clay-polymer nanocomposites are one of the promising candidates as a controlled release nitrogen fertilizer. In this study, a nanocomposite was prepared by intercalating urea into montmorillonite (MMT) clay to control urea release rate. The nanocomposite was then coated with a polymer to further decrease the release rate of urea. Carboxymethylcellulose, a biodegradable and environmentally friendly polymer, was used as the coating. During this work, urea was intercalated into MMT matrix in 1:1 ratio in deionized water by stirring at 400 rpm for 1.0 h. Then, 5% polymer by mass, dissolved in hot (60 °C) deionized water, was added and stirring was continued at 400 rpm for further 30 min. Samples prepared were dried in oven at 60 °C for 48 h and characterized by powder X-ray diffraction. Expansion of the interlayer space of MMT indicated the successful intercalation of urea molecules into the interlayer space of nanoclay. A study was carried out to investigate the extent of release for soil collected from Kandy of Sri Lanka using 1:1 nanocomposite and commercial urea separately. The release study results showed that 60% commercial urea is released to the soil within 2 days whilst about 10% urea was released by nanocomposite for the same time interval. Furthermore, nanocomposite prepared took 26 days to release about 85% urea, and around 15% urea might have escaped as gasses or trapped inside the clay matrix. These findings reveal that the nanocomposite fertilizer prepared is a potential candidate to address the low NUE in agriculture.

Keywords: Biodegradable, Controlled release, Intercalation, Nanocomposite

Abstract No: 223 ***Physical Sciences***

EFFICIENCY ENHANCEMENT IN SnO_2 BASED DYE-SENSITIZED SOLAR CELLS BY INCORPORATING PLASMONIC GOLD NANOPARTICLES

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Dye-sensitized solar cells (DSSCs) are photoelectrochemical cells and promising candidates to replace expensive silicon solar cells because of reasonably high efficiency and lower production cost. Due to the wider band gap, notable photostability and high charge mobility, SnO_2 is an attractive semiconductor material for DSSCs. Series of DSSCs were fabricated using SnO_2 photoanodes sensitized with Indoline D149 and incorporating different amounts (1 – 4 μL) of gold nanoparticle solution (AuNPs) containing 70 - 80 nm sized particles by the drop casting method. These were characterized by photocurrent density-voltage (*J – V)* and open circuit voltage decay measurements, incident photon-to-electron conversion efficiency (IPCE) spectroscopy, and electron impedance spectroscopy (EIS). Under the illumination of 100 mW cm^{-2} (AM 1.5), the efficiency of the DSSC with SnO_2 photoanode without AuNP was 2.28%, while the optimized efficiency of the DSSC with AuNP incorporated plasmonic SnO_2 (Au@SnO_2) was 2.89%. The efficiency increase (~ 26.7%) of the plasmonic DSSCs appears to be due to the increased short-circuit photocurrent density from 6.48 mA cm^{-2} to 9.19 mA cm^{-2} (~ 41.8%) by enhanced light harvesting caused by the surface plasmon resonance effect. Significant enhancement in IPCE was observed upon the use of Au@SnO_2 in DSSCs. Further, EIS analysis showed that the incorporation of plasmonic Au metal nanoparticles leads to about 35% lower interfacial charge transfer resistance at the SnO_2/electrolyte interface which essentially increases the rate of charge transfer at this interface and increase the power conversation efficiency of the solar cells.

Keywords: Au nanoparticles, Indoline D149, Plasmonic, Power conversion efficiency, SnO_2

Abstract No: 226 ***Physical Sciences***

ELECTROCHEMICAL EXFOLIATION OF GRAPHITE INTO GRAPHENE WITH BLACK TEA

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Graphene is a monolayer of carbon atoms, bound in a hexagonal honeycomb lattice, and layers of graphene from graphite. It has attracted attention due to its wide range of possible applications and academic interests on its unique properties. However, graphene is not a rare substance, and there are over four million graphene layers in a 1 mm thick graphite sheet. Several methods, such as mechanical exfoliation, chemical vapor deposition, carbon dioxide reduction and chemical exfoliation, have been used to produce graphene. In this work, vein graphite found in Sri Lanka was successfully exfoliated to graphene using an electrochemical exfoliation and prolonged sonication. Raw vein graphite pieces were used directly as both electrodes along with aqueous K_2SO_4 electrolyte for the electrochemical exfoliation process. The suspension for the sonication was prepared by mixing the yield of electrochemical exfoliation and a black tea solution. The replacement of toxic and costly solvents, such as dimethylformamide (DMF) and dichlorobenzene, by black tea is an advantage. Scanning electron micrographs were utilized to study the morphology of intermediates and yields of the process. X-ray diffraction patterns of graphene prepared were used to calculate the number of layers. This study confirmed that the resulted graphene had less than seven layers highlighting the successful exfoliation. Further, conductive graphene sheets (32 Ω sq^{-1}) were fabricated by painting a suspension of graphene (10 mg mL^{-1}) in DMF. A flexible supercapacitor (SC) was assembled by sandwiching a separator between two graphene-coated sheets (2×2 cm) using KOH as the electrolyte and stainless steel as current collectors. The gravimetric capacitance of the flexible SC prepared using exfoliated graphene is determined to be ~2.2 F g^{-1}.

Keywords: Black tea, Electrochemical exfoliation, Graphene, Gravimetric capacitance, Supercapacitor

Abstract No: 235 ***Physical Sciences***

HYDROTHERMAL SYNTHESIS AND CHARACTERIZATION OF MORDENITE

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Mordenite is one of the most highly siliceous zeolites, which has an ideal composition of $Na_8Al_8Si_{40}O_{96}.24H_2O$. Mordenite has been used mainly as a catalyst for many industrially important reactions such as alkylation, hydrocracking, hydroisomerization, dewaxing, reforming, and cracking. Mordenite has also been used in the absorptive separation of gas or liquid mixtures, where it is used as a molecular sieve. Even though mordenite occurs as a natural mineral, synthetic mordenite are better suited to meet many of the industrial requirements. Main reasons behind this are its purity and controlled pore structure. In this work, mordenite was synthesized by a hydrothermal synthesis method. Hydrothermal synthesis is commonly used in the synthesis of aluminosilicate zeolites due to its advantages over other methods such as effective solvation ability of water, increased solubility of reactants and increased nucleation. Effect of different parameters in the synthesis of mordenite was investigated by adjusting the gel composition and optimizing parameters such as crystallization temperature (170, 180, 190 and 200 °C), crystallization time (24, 36, 48 and 72 h) and aging time (2, 4 and 8 h). Mordenite was successfully synthesized in the absence of seeds and in the absence of organic templates at 170 °C, 48 h of crystallization time and 4 h of aging of the synthesis mixture. Gel composition of the mixture was $6Na_2O:Al_2O_3:30SiO_2:780H_2O$. Mordenite was also successfully modified with Fe and Zn to get Fe-MOR and Zn-MOR respectively. Modification with iron was done by a solid ion-exchange method using $FeSO_4$ and zinc modification was done by a wet ion-exchange method using a $Zn(NO_3)_2$ solution. The products were characterized using powder X-ray diffraction, Fourier transform infrared spectroscopy, X-ray fluorescence spectroscopy and particle size analyzing techniques. This work demonstrates an eco-friendly method for the synthesis of mordenite under laboratory conditions.

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Keywords: Aluminosilicate, Catalyst, Hydrothermal synthesis, Mordenite, Zeolite

Abstract No: 246 ***Physical Sciences***

COMPATIBILITY OF DIFFERENT ELECTROLYTES WITH CARBON-BASED ELECTRODES IN ELECTROCHEMICAL DOUBLE-LAYER CAPACITORS

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Supercapacitors are emerging as alternative energy storage devices against electrochemical cells due to their greater power density, short charging time and longer cycling ability. Electrochemical double-layer (EDL) capacitors consist of two electrodes separated by an electrolyte preferably with a liquid electrolyte. The capacitance arises from electrostatic charge separation as EDL at the interface between the electrode and liquid electrolyte. In this investigation, the compatibility of liquid electrolytes was studied with three types of carbon electrodes in EDL capacitors. Sri Lankan natural graphite, commercially available activated carbon and graphene were used as carbon materials. Electrodes were prepared by applying a slurry containing a mixture of 80 wt% of one of the above carbon materials, 15 wt% polyvinylidenedenefluoride and 5 wt% carbon black powder in tetrahydrofuran (THF) on thin foil of aluminum. Lithium chloride dissolved in distilled water was used as an aqueous electrolyte and lithium perchlorate dissolved in THF was used as the non-aqueous electrolyte. A gel polymer electrolyte was prepared by dissolving appropriate amounts of polyethylene oxide and lithium perchlorate in THF. Fabricated EDL capacitors were characterized by complex impedance spectroscopy and cyclic voltammetry. The galvanostatic charge-discharge measurements were carried out using LoggerPro 3.6.1 instrument. A single conductivity mechanism could be verified from the smooth semicircular section of impedance plots, and the linear portion confirmed the non-reacting nature of materials at the interface. Cyclic voltammograms verified the chemical stability of the cell within the charge-discharge limits of ± 1.0 V for aqueous solution and ± 2.0 V for non-aqueous electrolytes. The graphene electrode with aqueous LiCl showed ionic conductivity of 0.22 S cm^{-1} and capacitance value of 0.446 F for potential between ± 1.00 V, and 0.25 F for potential between ± 2.00 V for non-aqueous electrolyte. From the experimental results, it can be concluded that graphene, having highest surface area, is suitable for stable high capacitance with better compatibility of the systems studied.

Keywords: Carbon-based electrode, Electric double-layer, Gel polymer electrolyte, Interfacial compatibility, Supercapacitors

Abstract No: 288 ***Physical Sciences***

EVALUATION OF NUTRITIONAL AND PHYSICOCHEMICAL CHARACTERISTICS OF *Lasia spinosa* ROOT

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Lasia spinosa (*Kohila*) roots are consumed as a vegetable in local Sri Lankan population. It is also traditionally used in ayurvedic medicine due to its high amount of dietary fiber and antioxidant content. Antioxidant, anti-diabetic, anti-hyperlipidemic, anti-bacterial, anti-inflammatory and anti-tumor effects are the certain health benefits that have been identified from L. *spinosa* root. However, the utilization of L. *spinosa* roots in food industry is not much popular in Sri Lanka. The objective of this study was to evaluate certain nutritional and physicochemical properties of locally available L. *spinosa* roots, and impress the potential of applying the L. *spinosa* root flour into functional food formulation. Nutritional properties, such as total starch content, total dietary fiber content, amylose content and amylopectin content, were determined while water holding capacity, oil holding capacity, swelling power and water solubility were determined as physicochemical parameters. Quantified amounts of total starch and total dietary fiber in L. *spinosa* roots (g/100 g dry basis) are 5.68 ± 0.85 and 38.96 ± 1.02, respectively. Amylose content of the L. *spinosa* root was 79% and amylopectin content was 21% on average. They show 8.38 ± 0.19 g g^{-1} of water holding capacity and 1.90 ± 0.07 g mL^{-1} of oil holding capacity. Swelling power and the water solubility were observed as 19.82% and 5.95%, respectively. L. *spinosa* roots contain 38% of dietary fiber that could lead to several health benefits along with physicochemical properties that are favorable for food processing.

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Keywords: Dietary fiber, Functional food, *Lasia spinosa*, Starch

Abstract No: 314 ***Physical Sciences***

DESIGN AND OPTIMIZATION OF AN ACTIVE FLOW CONTROL METHOD TO OPTIMIZE THE AERODYNAMIC PERFORMANCE OF AN AIRFOIL IN A COMPRESSIBLE FLOW

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Active flow control is being widely popular to enhance the aerodynamic performance of flight vehicles. It can effectively interfere with the boundary layer flows that can be manipulated to achieve the desired performance. In this study, the aerodynamic performance of an airfoil was optimized for the flight Reynolds number of 1.27×10^7 at compressible regime. Synthetic Jet, a type of low energy consuming active flow control method, was used to enhance the lift-to-drag ratio of the airfoil. The optimization of the active flow control was done for three design variables; velocity of the inlet jet, actuating frequency and the location of synthetic jet on the surface of the airfoil. The dataset was created by doing transient state simulations for NACA 0015 airfoil with different combination of design variables. Box–Behnken design was considered for experimental design. For the optimization process, Response Surface Methodology was implemented to analyse the response of design variables on lift-to-drag ratio, which was further optimized using Genetic Algorithm. Locating the synthetic jet at the optimized location showed 8.44% increase in the aerodynamic performance of the airfoil. Furthermore, comparison between applicability of synthetic jets in incompressible and compressible flow was done. The application of synthetic jets for any suitable range of design variables showed a definite increase in aerodynamic performance for incompressible flow, while only certain input combinations simulated favorable performance in compressible flow. The flow visualization also confirmed the reduction of wake size when synthetic jet was actuated at the range of 0.4 to 0.5 chord locations. Aerodynamic buffeting, which causes adverse effect in the control, stability and the structure of the aircraft parts during high speed flights could be reduced by the application of synthetic jets at the optimized location.

Keywords: Active flow control, CFD, Compressible flow, Optimization, Synthetic jets

Abstract No: 40 ***Science Education***

EFFECT OF GUIDED INQUIRY-BASED LABORATORY EXPERIMENTS ON ATITUDES OF STUDENTS TOWARDS SCIENCE LEARNING

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Positive attitudes towards science is important for the enhancement of science learning. Most of the school students consider science as a difficult subject, having a fear towards science learning and also they do not demonstrate accepted levels of achievement in applying knowledge. The main objective of the study was to find the effect of guided inquiry-based laboratory experiments on the attitudes of students towards science learning. Quasi experimental research design was implemented under quantitative approach. Pre-test and post-test control groups with experimental group design were used. The sample consisted of Grade nine students of a purposively selected Type 1C school in Matale Education Zone. Quantitative data were collected through an attitude test, and the qualitative data were collected through structured interviews and observations. A questionnaire with Likert scale questions, interview schedule and an observational schedule were used in data collection. Hypothesis testing was performed to analyze quantitative data. An independent sample *t*-test (Pooled *t*-test) was conducted to test the difference between the attitudes of male and female students towards science learning, and the paired *t*-test was conducted to find the effect of guided inquiry-based laboratory experiments on the attitudes of students towards science learning using SPSS-22 statistical software. Qualitative data were analyzed descriptively under three themes. Findings revealed that Grade nine students had positive attitudes towards science learning (77.64 $\pm$ 6.56%). Both observation and interview results also revealed that students have positive attitudes towards science. Findings further showed that there was no significant difference between male and female students (p = 0.869). Analysis of qualitative data also showed that both male and female students have positive attitudes towards science learning. The guided inquiry-based laboratory experiments also showed a significant impact on improving attitudes of students towards science learning (p = 0.000). This was supported by the results of observation and interviews. Therefore, Grade 9 students of selected schools have positive attitudes towards science learning, and there is no significant difference between the attitudes of male and female students towards science learning. Also, there is a positive effect of guided inquiry based laboratoty experiments on students' attitudes towards science learning. Since this information is from one single school, the study can be further expanded to arrive at a stronger conclusion.

Key words: Attitudes, Inquiry-based learning, Science learning

Abstract No: 69 ***Science Education***

EFFECT OF SELF-DETERMINATION THEORY IN PHYSICS TEACHING PROCESS IN JUNIOR SECONDARY CLASSES IN JAFFNA DISTRICT

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In Sri Lanka, majority of junior secondary science teachers are trained and produced by National Colleges of Education. To date, no sufficient effort is made to measure the intrinsic motivation of the prospective teachers in the Sri Lankan education system. The main objective of this study was to investigate the level of fulfilment of the basic psychological needs of prospective teachers and compare that with experienced teachers in physics teaching process in junior secondary level. Theoretical foundation of this study was drawn from the Self-Determination Theory according to which the basic psychological health requires satisfaction of all three psychological needs, such as Autonomy, Competence and Relatedness. The level of fulfilment of basic psychological needs of prospective teachers during their internship was investigated by quantitative study using a survey questionnaire. The Korean Basic Psychological needs Questionnaire (K-BPNS) with four types Likert scale (with 15 items) was administered using Google online form from all the internship science teachers (55) in Jaffna National College of Education and randomly sampled experienced science teachers (97) from five zones in Jaffna district. It was found that the mean level of fulfilment of basic psychological needs of prospective teachers and experienced teachers was 48.8 and 47.7 out of 60, respectively. Thus, it is just higher in prospective teachers than in experienced teachers. Hence, more enhancement and maintenance of the above three psychological needs of prospective teachers would be desirable during the internship in order to facilitate the learners towards meaningful learning.

Keywords: Autonomy, Competency, Intrinsic motivation, Relatedness, Self-Determination Theory

Abstract No: 158 ***Science Education***

CHALLENGES OF SCIENCE EDUCATION OF INDIGENOUS STUDENTS: A CASE STUDY FROM UVA PROVINCE, SRI LANKA

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Progress of science, especially in the developing countries, has been retarded by barriers to science education. Further, educators all over the world grapple with how to engage indigenous students in science. Therefore, science education researchers try to identify the challenges of science education of both indigenous and non-indigenous students. In Sri Lanka, there is a gap on challenges of learning science between indigenous and non-indigenous students at secondary school level. This study presents challenges of science teaching and learning identified qualitatively in three secondary schools with indigenous students in Uva Province, conducted between 2018 and 2020. Qualitative data were collected by semi-structured interviews with 14 indigenous parents, 15 non-indigenous parents, 10 indigenous students,12 non-indigenous students, 7 teachers (6 science and 1 mathematics) and 5 indigenous leaders/senior community members and 27 classroom observations (average 23 minutes). Qualitative data were analyzed thematically, and data triangulation was used to ensure the validity of findings. It was identified that poor physical resources and poor human resources at schools challenged science learning of indigenous students and non-indigenous students. There was a paucity of basic physical resources, such as water, electricity, necessary scientific equipment and chemicals, for science learning. In terms of human resources, there was no science teacher at one school for nearly one and a half years, and there were not enough science teachers to cover the classes from Grade 6 to 11 in another school. It was shown that majority of the indigenous parents were relatively less capable of teaching science to their children at home compared to non-indigenous parents. Further, the teachers expressed that, financial constraints negatively affected the indigenous parents more compared to the non-indigenous parents in providing necessary physical resources and additional science learning opportunities to their children. Relatively poor education level of indigenous parents could be the reason for their less capability to teach science at home. These findings confirmed some of the international literature on challenges of learning science such as inadequacy of physical and human resources to teach science, and relatively poor financial and educational levels of indigenous parents. Further, the above study showed that majority of the indigenous and non-indigenous students shared similar challenges for science learning.

Keywords: Challenges, Education, Indigenous, Qualitative, Science

Abstract No: 173 ***Science Education***

PERCEPTION OF SCIENCE TEACHERS TOWARDS CHEMISTRY LABORATORY WORK

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The present study aims to reveal "The science teachers' positive attitudes on the chemistry laboratory work". This aim has two subsidiary questions: "What are the teachers' perceptions on Teacher Instruction Manual and Syllabus regarding chemistry laboratory work?" and "What are the teachers' perceptions on available facilities and methods used in conducting chemistry laboratory practical work?". The mixed methods approach was used to find out the answers to these questions. The sample consisted of 75 science teachers selected from secondary level, under the purposive sampling techniques to find out their positive attitudes on chemistry practical work. The questionnaire and semi-structured interview schedule were used as research instruments. Closed questions in the survey questionnaire for teachers were used to collect quantitative data. Semi-structured interview schedule and open-ended questions in the questionnaire were used to collect qualitative data. The percentage values for closed questions were obtained, and thematic analysis was conducted to find out answers for the above research questions. About 88% of the teachers in the sample responded "Yes" for the question, "Do you feel that Teacher Instruction Manual needs revisions?**".** Further, the percentage values confirmed that covering the chemistry laboratory work in the syllabus was not possible in the allocated time, and the Syllabus failed to make interest in chemistry practical work among the students. The students' dependence on teachers' guidance is high for practical work. Semi-structured interview also confirmed the above findings. Therefore, Teacher Instruction Manual and Syllabus should be simplified, and the methods used in conducting laboratory work should be in a productive manner to enhance students' practical skills.

Keywords: Chemistry laboratory, Positive attitudes, Science teachers

Abstract No: 184 ***Science Education***

EFFECT OF USING ESSENTIAL LEARNING CONCEPTS ON STUDENTS' G.C.E. (O/L) MATHEMATICS PERFORMANCE

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Mathematics is a highly important subject in the Sri Lankan junior secondary curriculum. From 2010 to 2014, the students' pass rate of mathematics at G.C.E. (O/L) examination was 55% on average. Necessary recommendations to increase these pass rates have been proposed by a Special Consultative Committee. Based on some of the recommendations, 53 Essential Learning Concepts (ELCs) were identified to assess the learning outcomes of the curriculum. The first question paper of G.C.E. (O/L) was formulated in accordance with these ELCs. This was first implemented in the year 2016. Consequently, the pass rate of mathematics increased to 67.2%, an increase of 12% over the year 2015. Since this is a considerable growth in the pass percentage, it is important to examine whether the changes to the structure of the examination based on the introduction of ELCs affected the results. Thus, the main purpose of this study was to find the effects of using ELCs on students' G.C.E. (O/L) mathematics performance. The mixed-methods approach was used in this study as evaluating both qualitative and quantitative aspects with triangulation would strengthen the findings. The multi-stage sampling method was used to select the sample, which consisted of 10 teachers and 200 students of 1AB schools, 100 students of 1C schools, and 100 students of Type 2 schools from Mulatiyana Educational Zone in the Southern Province. Two test papers were constructed to compare the performance level of the students, one limited to ELCs and the other one not limited to ELCs. Semi-structured interview schedules were developed for teachers to evaluate their perception of new paper structure with ELCs. The paired sample *t*-test revealed that the students' performance in ELC based examination was significantly higher compared to the examination not based on ELCs ($p < 0.01$). Moreover, qualitative analysis of teachers' responses revealed that ELC based examinations could improve results. It is also revealed that remedial programmes that target a specific number of learning outcomes make it easier for students to pass the examination. Hence, the paper format with ELCs shows a direct impact on the growth rate of the G.C.E. (O/L) pass rate. However, students could score up to 50% marks in the first paper based on the identified ELCs. As such, without some content knowledge in the syllabus, students can easily obtain a high grade in mathematics at G.C.E. (O/L). Thus, it is suggested to use the identified ELCs for the first question paper, and to improve the second question paper to get a meaningful evaluation of the students' achievements.

Keywords: Essential Learning Concepts (ELCs), G.C.E. (O/L), Mathematics, Performance

Abstract No: 234 ***Science Education***

TEACHER INVOLVEMENT IN DEVELOPING STUDENTS' SCIENCE PROCESS SKILLS OF ADVANCED LEVEL BIOLOGY TEACHING IN KURUNEGALA DISTRICT, SRI LANKA

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Science Process Skills (SPS) are special skills that simplify learning science, encourage students in their own learning and practice them in scientific method. The teacher should play a crucial role in developing students' SPS. It is well-known that the teacher should have the required knowledge, perceptions and the ability to teach SPS. Thus, this study was focused on investigating the teacher involvement in developing students' SPS in advanced level biology teaching in Kurunegala District. The objectives of the present study were to find out the level of awareness and level of perception of teachers towards SPS, the issues and problems faced by the teachers when developing SPS, and how the teachers develop students' SPS in the real classroom settings. Convenient data sampling technique was used to select 30 biology teachers from 16 selected 1AB schools in Kurunegala District. The mixed-methods approach was used. Quantitative data were collected using a questionnaire and analyzed for descriptive statistics using MS Excel. Qualitative data collected through interviews and classroom observations were analyzed using the Thematic Analysis Technique. Results confirmed that 73% of the teachers were unaware about the SPS. It was found that most of the teachers had positive perceptions towards improving the students' SPS. However, the teachers preferred to improve basic SPS rather than improving integrated SPS. There was a relationship between the gender and the perception of the teachers towards SPS ($p > 0.05$), and there was no relationship between seniority and the perception towards SPS ($p < 0.05$). Moreover, the teachers did not use suitable teaching methods to develop students' SPS in the real classroom settings. There were many problems that badly affected for development of the students' SPS, such as examination oriented heavy load of biology syllabus, requirement of sound knowledge, and lack of resources in the schools. Hence, biology teachers were unable to provide a conducive environment to develop the students' SPS at the desired level in Kurunegala District.

Keywords: Basic science process skills, Biology teaching, Integrated science process skills, Science process skills

Abstract No: 261 ***Science Education***

EFFECT OF ENTREPRENEURIAL ORIENTATION ON EDUCATIONAL ADMINISTRATION TO ENHANCE SCIENCE EDUCATION: A CASE STUDY IN JAFFNA, SRI LANKA

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To improve science education, both the number of students studying science for G.C.E. (A/L) and their performance at the examination should be improved. In Sri Lanka, studies on educational administrators' contribution to enhance science education is rarely researched. Thus, this study aimed at exploring those aspects in Jaffna District. The Morris and Joyce scale on entrepreneurial orientation dimensions, such as innovativeness, risk taking and proactiveness, are adapted to survey educational managers' perceptions. Based on this foundation, the study empirically investigates the effects of entrepreneurial orientation on the enhancement of science education in terms of performance and number of students studying science for G.C.E. (A/L) in Jaffna, Sri Lanka. This study used both interviews and perception surveys of educational managers. Thirty-nine educational managers were selected from 56 1AB schools in Jaffna District through convenience sampling. Descriptive statistics and multiple regressions were used in data analysis, and the reliability of the questionnaire was checked through Chronbach's alpha value (0.94). The findings revealed that 28% of the educational managers perceived that they are entrepreneurially oriented to enhance the science stream. The multiple regression analysis showed that students' performance depends on the managers' entrepreneurial orientation ($R^2 = 0.678$, $p < 0.01$). The study also found that there is no causal relationship between the number of students and entrepreneurial orientation ($R^2 = 0.042$, $p > 0.05$). Thus, entrepreneurial orientation is a highly important tool which could be used to re-evaluate the school science education in order to improve the level of standards in practices of science teaching and learning process.

Keywords: Educational managers, Entrepreneurial orientation, Performance, Science education

Abstract No: 285 ***Science Education***

USE OF ETHNOMATHEMATICS IN SECONDARY SCHOOL CURRICULUM: A CASE STUDY IN KANDY EDUCATION ZONE

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Mathematics relates to every aspect of our life. It is a skill which is essential to understanding the situation and decision making in day-to-day life. In the Sri Lankan educational system, Eurocentric mode of delivering mathematics as a subject has been introduced during the colonial period. Mathematics was one of the compulsory subjects at the G.C.E. (O/L) examination and the most basic qualification considered for every aspect. The bond between culture and Mathematics causes school Mathematics always a crucial task for many Sri Lankans. During this study, testing of less mathematics concepts in critical and analytical thinking was identified as one of the inadequacies in the existing curriculum. As a consequence, without better understanding of concepts while developing the skills, students obtain better results annually. Ethnomathematics is one of the resenting processes applied world-over in the formative period to obtain a satisfactory progress in applications of Mathematics during lifelong learning. Thus, the main focus of this study is to introduce ethnomathematics in the classroom setting of Grades 6 and 7. Three schools in the Kandy Educational Zone with 510 students were selected through convenience sampling. Five lessons for Grade 6 and four lessons for Grade 7 were prepared for the lessons given in the curriculum. A pre-test was administered to separate the student sample into two groups as experimental and control. Experimental group was instructed using ethnomathematics while using traditional method of teaching for the control group. Before the intervention students' motivation was also tested. A post-test was administered for both the groups to test their performance in relevant topics. Open-ended questionnaires were also administered to collect information of the current problems. Structured interviews were administered to teachers, school Principals and zonal Directors. Term test marks along with relevant topic test marks were analysed. Independent sample *t*-test on the students performance revealed that there was a significant ($t = 556$, $p < 0.05$) improvement in the experimental group compared to the control group. The intrinsic motivation of the students has also been improved after the intervention. Thematic analysis of the structured interviews revealed that many teachers do not feel that the secondary school is not a crucial level for learning mathematics. Teachers were also of the view that adapting to new teaching methods is challenging. Thus, the findings of this study are encouraging enough to conduct further research in the direction of teaching ethnomathematics at the secondary school level to enhance students' meaningful leaning while increasing their intrinsic motivation to meet the challenges faced in contemporary life and careers.

Keywords: Ethnomathematics, G.C.E. (O/L), Motivation, Performance

Abstract No: 292 ***Science Education***

EFFECTIVENESS OF APPLYING SELF-DETERMINATION THEORY IN TEACHING MATHEMATICS: A CASE STUDY IN HATTON EDUCATION ZONE

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Self-Determination Theory (SDT) is a motivation theory which emphasizes student centered learning under three main subcomponents, *viz*. autonomy, competence and relatedness. The teacher becomes a facilitator based on the above theory. This approach is different from traditional teacher-centered method and it is meant to be more effective in improving student performance in mathematics. This study compares the effectiveness of applying SDT against traditional method. The sample selected, based on the convenience sampling method, consisted of eighty (80) Grade 10 students and five (5) mathematics teachers from three schools in Hatton Education Zone. Data collection was conducted through questionnaires, semi-structured interview schedules, and question papers. Quantitative data were analyzed using SPSS 17.0 and qualitative data were analyzed using thematic analysis. The lesson unit selected for the study is perimeter including length and perimeter of a sector of circle. Two homogeneous samples were identified as control and experimental groups through a pre-test which was used to explore students' prior knowledge. Prior to the intervention, a questionnaire was administrated to both groups to investigate motivation and aspirations of students. The experimental group was instructed according to the aspects of SDT and the traditional method was used for the control group. Students' performance, motivation and aspiration were examined in both groups after the intervention. An independent sample *t*-test showed that there is a significant difference in students' performance between the control and the experimental groups ($t = 12.224$, $p = 0.012 < 0.05$) according to the post-test marks demonstrating higher performance in the experimental group (*mean* = 64.75) compared to the control group (*mean* = 29.95). Moreover, there are significant differences on students' motivation ($t = 8.152$, $p = 0.001 < 0.05$) and aspirations ($t = 20.048$, $p = 0.0001 < 0.05$) between the control and the experimental groups, showing higher motivation (*mean* = 2.96) and aspirations (*mean* = 3.25) in the experimental group. Thus, performance, motivation and aspiration of students have increased with the lessons prepared based on the aspects of SDT as compared to the traditional method of teaching. Qualitative findings reveal that time management and non-willingness by the teachers on SDT are problems to introduce new teaching methods. However, most of the students experienced positive attitudes on the use of the new approach of teaching. Thus, it is suggested that the present classroom teaching method be changed to student centered approach with the use of aspects in SDT.

Keywords: Mathematics, Self-Determination Theory, Student-centred teaching

Abstract No: 293 ***Science Education***

STUDENTS' PERFORMANCE AND PERCEPTIONS OF STUDENTS AND TEACHERS IN GRADE FIVE AND GRADE SIX MATHEMATICS: A CASE STUDY IN TRINCOMALEE EDUCATION ZONE

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Mathematics consists of many abstract concepts. Hence, it is crucial to the development of high order thinking skills in all of us. The logical and structured nature in mathematics help one to understand social and real-life phenomena, and answer related questions in a precise manner. Thus, the aim of the present study was to explore students' performance and perceptions of students' and teachers' in mathematics of Grades five and six to make suggestions to enhance students' mathematics achievement. The study sample consisted of 1,520 students and 42 teachers from the Trincomalee Education Zone. Data were collected using documents, questionnaires, and interview schedules, and they analyzed on descriptives, correlations and content. Grade five provincial model papers have a statistically significant impact on the results of Grade five scholarship examination ($r = 0.858$, $p < 0.05$). Thus, the study has revealed valuable information on the strength of the Grade five model examination that is conducted by the Provincial Department of Education. It has also revealed that the performance of students at Grade five scholarship examination has a significant impact on the performance of students at Grade six mathematics ($r = 0.807$, $p < 0.05$). Moreover, the results revealed that the teachers possess adequate teaching experience and knowledge in teaching mathematics, though they frequently use traditional methodologies. Grade six students show an interest to learn the subject mathematics than the Grade five students. Thus, the students' interest in mathematics has to be maintained and enhanced through appropriate ways in order to facilitate meaningful learning for a better future.

Keywords: Grade five model examination, Grade five scholarship examination, Grade six mathematics performance, Students' and teachers' perception

Abstract No: 299 ***Science Education***

PERCEPTIONS ON NON-MATHEMATICS TEACHERS' PEDAGOGICAL SKILLS IN TEACHING MATHEMATICS

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In the education system of Sri Lanka, teachers who are appointed as mathematics teachers, in general, are in excess (342). However, a significant number of non-mathematics teachers, teaches mathematics at secondary level, a majority of them for Grades six to nine in schools. As such, there could be a negative effect on teaching- learning process of mathematics, resulting in a loss of enthusiasm and discouragement among the learners. Prior research has shown that non-mathematics teachers faced more challenges with their pedagogical skills. Thus, the aim of this study is to investigate perceptions of mathematics education officers and non-mathematics teachers on pedagogical skills. Convenience sampling techniques was used for sampling, and there were 32 non-mathematics teachers, 8 provincial coordinators and 16 assistant directors of education in the study sample. Ethical approval was obtained, and data were collected through interviews using Zoom tool and a questionnaire. Data were analyzed using thematic analysis. Majority (88%) of the non-mathematics teachers were willing to accomplish their challenging job by enhancing their pedagogical skills. Moreover, some (38%) of the non-mathematics teachers were more confident about their pedagogical skills as they enhance the skills with their experience. Perceptions of provincial coordinates and assistant directors of education reveal that in most of the non-mathematics teachers and mathematics teachers' pedagogical skills are not upgraded to the expected levels. Thus, enhancement and upgrading of pedagogical skills of non-mathematics teachers are highly important in uplifting mathematics education at secondary level in Sri Lanka. Hence, the improvement of pedagogical skills of non-mathematics teachers through appropriate interventions has to be seriously considered to achieve the goals of mathematics education in Sri Lanka.

Keywords: Non-mathematics teachers, Pedagogical skills, Secondary level

Abstract No: 319 ***Science Education***

EFFECTIVENESS OF LABORATORY WORKSHOPS TO IMPROVE STUDENTS' SCIENCE PRACTICAL SKILLS: A CASE STUDY IN KATUGASTOTA EDUCATION ZONE

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In Sri Lanka revision of the G.C.E. (O/L) science syllabus has been carried-out in every eight years, to improve, develop and update. In the most recent revision conducted in 2015, a competency based curriculum has been introduced. Laboratory work always has a key role in science teaching. Thus, each and every science lesson should be based on laboratory work to develop authentication. However, most of the teachers tend to teach science using traditional teaching methods without concentrating on the practical aspects of the subject. Even, if they utilize some laboratory classes to teach science, they do not necessarily consider the basic practical skills that students should possess. This study was aimed at investigating the effect of laboratory workshops on enhancing students' laboratory skills. Mixed-methods approach consisting both qualitative and quantitative aspects were used in the study. The sample consists of Grade 11 students by selecting 15 students from each school representing all three types of schools, namely; 1-AB schools, 1-C schools and Type 2 schools in Katugastota Education Zone. The data obtained from the instruments (observation schedules and written test) in the pre-test and post-test were analyzed by paired sample t-test using SPSS. The results revealed that, there is a significant difference in the mean values of pre-test (Practical test 29.82; Written test 17.27) and post-test (Practical test 56.4; Written test 43.13). Further, students obtained hands-on experience in conducting experiments and improved their higher order skills such as problem-solving and critical thinking. Therefore, the classroom learning practices are to be reevaluated in enhancing students' meaningful learning in G.C.E. (O/L) Science.

Keywords: Competency, Laboratory workshops, Practical skills

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