Applied Sciences Undergraduate Research Sessions

ASURS 2019

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Faculty of Applied Sciences

Rajarata University of Sri Lanka

Contents

MESSAGE FROM THE VICE CHANCELLOR

Universities play an important role in creating and spreading knowledge. To create knowledge research is a must. I believe that research and teaching are closely interconnected and reinforce each other. Therefore, the Rajarata University students should be educated in a research-informed environment.

I am glad to hear that student who are about to complete their degrees in the areas of Biology, Chemistry, Computing, Physics, Mathematics and Health Promotion have engaged in research projects for testing and exploring novel thoughts they had during the course of studies are now ready to make presentations to elaborate their findings. I appreciate the commitments of organizing committee of the symposium and the dean and the staff of the faculty who guided students towards academic research.

I take this opportunity to congratulate forty-eight students who make deliberations in the Research Sessions 2019 and I wish this endeavor every success.

Dr. B. A. Karunaratne

Vice Chancellor

Rajarata University of Sri Lanka

Mihintale

MESSAGE FROM THE DEAN

It gives me great pleasure to write this message on the occasion of the Third Undergraduate Research Session of the Faculty of Applied Sciences.

The proceeding of this year's research session consists of 48 abstracts presented by final year special degree students with the supervision of academic staff in eight disciplines. The Undergraduate Research Session provides a forum for our students and staff to present their work and interact constructively with each other. While facilitating teamwork the forum ensures that research activities of the faculty maintains a stranded of quality. The opportunity provided by such an event, for the students to exhibit their talent and achievements and to improve the quality of their paper presentation to be recognized.

I would like to thank Dr. Lalith Senarathne, the Chair and Dr. (Ms) H. O. Wijewardane Editor in Chief of the research session and their team for the tremendous effort for the success of this event. Moreover, my sincere appreciation goes to academic and nonacademic staff of the faculty for providing their commitment towards making this event a success. I would like to place a special thank to the Vice Chancellor, Dr. B. A. Karunaratne and other university authorities which contributed to make this event a success. The financial support provided by the University is highly appreciated. There are many others who have worked in a most committed manner which contributed largely towards the success of this event. On behalf of the Faculty of Applied Sciences, I express my gratitude to each and every one of them.

As the dean of the faculty of Applied Sciences it is my privilege to congratulate the undergraduates who are taking part in this invaluable session. Finally let me welcome all paper presenters, reviewers, panel chairs and all the participants.

I hope you have a successful and an academically productive day.

Dr. Sriyani Wickramasinghe

Dean of the Faculty of Applied Sciences

Rajarata University of Sri Lanka

Mihintale

MESSAGE FROM THE PROGRAM CHAIR

It is with great pleasure that I welcome you all to Applied Sciences Undergraduate Research Session (ASURS) 2019. It is a great honor for me to serve as the chair of this session, where final year undergraduate students from six disciplines share research projects with higher standards.

Research is an integral part of undergraduate education. Incorporating a research component into academic programs enables students to develop independent critical thinking skills along with oral and written communication skills. The research process impacts valuable learning objectives that have lasting influence on as undergraduate students prepare for career advancements in professional services and postgraduate studies. Publication and presentation of research findings also create opportunities to exposure to the scientific community and increase visibility in respective fields.

ASURS 2019 provides opportunity for our final year undergraduate students to present their research findings to scientific community in an academic conference environment. Today, a total of 48 undergraduate students from biology, physics, chemistry, mathematics, computing and health promotion present their research works. This exposure will be highly valuable for professional and research careers of the students. I congratulate all the students and their supervisors for working tirelessly to produce research of high standard. This represents the commitment of the academic community of the Faculty of Applied Sciences towards fostering a culture of scientific research and dissemination. This event may have not been possible, if not for the cooperation rendered by Dr. Ananda Karunaratne, the Vice Chancellor of the Rajarata University of Sri Lanka. Dr. Sriyani Wickramasinghe the Dean of the Faculty of Applied Sciences was the driving force behind the organizing committee of ASURS 2019. I also appreciate the support extended by the Heads of the Departments and the Deputy Registrar of the Faculty of Applied Sciences to make this event a success. The support from all the academic and non-academic staff members of the Faculty of Applied Sciences was significant and I appreciate it.

I would like to thank the reviewers and evaluation panels for sacrificing their precious time for our students. My sincere thanks go to the students and their supervisors for contributing their work to ASURS 2019. I would like to extend my special thanks to the members of the editorial board and organizing committee. Without their enthusiasm and dedication, organizing this event would not be possible. Congratulations to the authors and speakers of ASURS for a job well done. I hope you have a successful and fruitful day.

Dr. Lalith Senarathna
Program chair
ASURS 2019
Faculty of Applied Sciences
Rajarata University of Sri Lanka

REVIEWER PANEL

Dr. C. de Silva, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka

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Dr. S. A. Hewage, Consultant Community Physician, Ministry of Health

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Biology

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Health Promotion

Mathematics

ABSTRACTS

BIOLOGY

Analysis of Mortality Patterns and Causes of Mortality of Asian Elephants (*Elephas maximus*) from 2009 to 2018 in the Northern and North-Western, Sri Lanka

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The Asian elephant (*Elephas maximus*) is threatened globally by habitat loss, poaching and ever-increasing human-elephant conflict (HEC). While HEC related mortality is as a key impediment to the conservation of wild elephants in Sri Lanka, very little information is available on the precise factors responsible for the mortality of elephants in Sri Lanka. In this study, we analysed the necropsy reports of wild elephants from Anuradhapura, Kurunegala, Puttalam and Mannar districts from 2009 to 2018 obtained from the Wildlife Health Management Division, Pandulagama, of the Department of Wildlife Conservation (DWC) of Sri Lanka. A total of 498 elephant deaths were recorded during this period, of which, the highest proportion was from Anuradhapura (61.87%) followed by Puttalam (18.26%), Kurunegala (14.40%) and Mannar districts (5.48%). Of the recorded deaths, 281 (65.8%) were males and 146 (34.2%) were females. There was temporal variation in deaths, with the highest number of deaths being reported in 2011 (73) and the lowest in 2014 (35). Anthropogenic factors were the cause of majority of the deaths (85.1%), with gunshot injuries (27.5%), improvised explosives (16.4%), electrocution (14.2%) and gunshot induced septicaemia (13%) and poisoning (7.4%) being the five leading causes of death. The highest percentage of deaths were recorded in adult males (31.10%) followed by sub-adult males (21.34%). There was a significant association between the top five anthropogenic causes of death and the four districts ($\chi^2 = 21.026$, *d.f.* = 12, $p \leq 0.007$) suggesting spatial variability in the causes of death. There was also a significant association between monthly mortality and average monthly precipitation in Anuradhapura district ($r = 0.623$, $p \leq 0.030$). Our results also indicate a decline in gunshot related deaths and an increase in improvised explosive related deaths over time. Worm infection (3.6%), respiratory obstruction (2.9%) and dehydration and starvation (2.3%) were the main natural causes of death. Our study shows that there is spatial and temporal variation in mortality and anthropogenic causes of mortality of elephants in Sri Lanka. While gunshot related mortality is on the decline, possibly due to stringent regulations with regards to possession of firearms, other strategies such as the use of improvised explosives are on the rise. Such information is invaluable to the formulation of effective strategies to minimize HEC related elephant deaths in Sri Lanka.

Keywords: *HEC, Wildlife, Improvised explosives, Conservation*

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Investigation of Anti-bacterial Activity of *Moringa oleifera* (drumsticks) and Assessing it as a Potential Ingredient to Increase the Shelflife of Minimally Processed *Alternanthera sessilis* (*Mukunuwenna*)

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With high preference of consumers towards the natural food ingredients, there is a high demand for natural antimicrobial agents as food preservatives. As *Moringa oleifera* is a plant having antimicrobial compounds with higher nutritional value, the objective of the study was to evaluate antibacterial properties of solvent extracts of (DMSO, ethanolic and hot water) of three varieties (*Weerawila Miti, Mahailuppallama Miti, and Mahailuppallama Jaffna*) of *Moringa oleifera* cultivated in Sri Lanka against common foodborne pathogens including *Escherichia coli, Staphylococcus aureus, Salmonella enteritica, Enterococcus faecalis,* and *Bacillus cereus.* As well as to investigate the ability of *M. oleifera* to enhance the shelf life of minimally processed green leafy vegetables. Leaves, flowers, pods, and bark from each variety were evaluated for their antibacterial activity. The activity was analyzed using agar well diffusion method at five different concentrations of eachsolvent extract of *Moringa oleifera*. The ability of extending shelf life with *Moringa oleifera* was demonstrated by analysing reduced bacterial colony count after spraying the solvent extracts on minimally processed *Alternanthera sessilis (Mukunuwenna).* For the antibacterial assay, mean growth inhibition zone diameters were ranged from 9.72 ± 0.21 to 36.82 ± 0.13 mm against all tested bacteria. The study revealed that *S. enteritica* was highly resistant to all extracts and *S. aureus* was sensitive to *M. oleifera* hot water and ethanolic extracts. Maximum antibacterial activity against *E. coli, S. aureus, E. faecalis* and *B. cereus* followed in descending order by ethanolic, hot water and DMSO extracts. The antibacterial activity was decreased with the decrease in concentration of the extract. The best antibacterial activity was shown by *Weerawila Miti* variety. As *S. aureus* was the most sensitive pathogen, the reduction of *S. aureus c*ounts in minimally processed *Alternanthera sessilis (Mukunuwenna)* was observed with the application of *M. oleifera* hot water extracts. Six hot water extracts out of seven (*Weerawila Miti* flowers, *Weerawila Miti* leaves, *Mahailuppallama Miti* leaves, *Mhailuppalama Jaffna* bark, *Mahailuppalama Jaffna* leaves, *Mahailuppalama Jaffna* flowers) were able to reduce *S. aureus* counts by >50% *in vitro*. The highest reduction of *S. aureus* colonies was shown by hot water extract of *Weerawila Miti* variety. Therefore, it can be concluded that *M. oleifera* hot water extracts can be used to reduce *S. aureus* contaminations in minimally processed green leafy vegetables as a natural antibacterial agent to increase the shelf life.

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Comparative Juvenile Play Behaviour in two Species of Monkeys, *Macaca sinica* and *Semnopithecus priam* in the Dry Zone of Sri Lanka

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Play behaviour in juvenile animals is thought to have an adaptive significance, in that it impacts the development of neuromotor function, cognition and skills necessary for survival. Studies show that the types and frequency of play behaviour are dependent on factors such as age, sex, nutritional level, and environmental influence. Nonhuman primates show significant variation in social structure, behaviour and feeding ecologies. In the case of primates, play behaviour appears to be a significant component of the daily activity budgets of juvenile monkeys. Yet our understanding of the relationship between social structure, behaviour and feeding ecologies of primates and the frequency and types of play behaviour is poor. Hence, the objective of this study is to compare the juvenile play behaviour in the predominantly folivorous grey langurs *(Semnopithecus priam)* and omnivorous toque monkeys (*Macaca sinica),* two species of Sri Lankan primates. Data collection was conducted for five months on juveniles of one group of each species using scan sampling in and around Mihintale Sanctuary in northern Sri Lanka. Sampling was conducted at 10-minute intervals from 6.00 AM to dusk for 7 days a month for each group. The type of play behaviour was organized into three broad categories, object, locomotor and social play. According to the results of five months of the study period, the proportion of time devoted for playing was 33.8% (range 18.9 - 39.5) and 36.3% (range 15.7 - 53.8) for juvenile langurs and macaques respectively. The monthly variation in the three play types within each species was statistically significant for both langurs ($\chi^2(2)$ =8.4, p≤0.015) and macaques ($\chi^2(2)$ =8.4, p≤0.015), with locomotor play being the most common play type. However, there was no significant difference in the monthly variation in play behaviour of langur and macaque (Z=7.0, p≤1.00). Similarly, there was no difference in the monthly variation in the types of play (object (Z=3, p≤0.28), locomotor (Z=7, P≤1.00) and social play (Z=4, p≤0.41)) between langurs and macaques. The lack of major differences in the frequency of play behaviour and types in these ecologically divergent species could be due to the adaptive significance of play behaviour of both species. The data generated by the present study will also be invaluable towards managing captive populations of these species. This study will also be a valuable starting point for exploring the relationship between the social organization and ecology on the ontogeny of play behaviour.

Keywords: Primates, Sri Lanka, Dry zone, Adaptive significance

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Systematics of the Shrub Frogs of the *Pseudophilautus popularis* Complex

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Alpha taxonomy and species delimitation are a cornerstone of biodiversity conservation. However, species delimitation can be convoluted in certain instances, making it relatively difficult to determine the geographic limits and population status of certain species which are essential parameters for conservation planning. This situation is exemplified by *Pseudophilautus popularis* and *Pseudophilautus regius*, two morphologically similar endemic rhacophorid shrub frogs of Sri Lanka, which are difficult to distinguish in the field. Hence, the species boundaries of these two species were evaluated using an integrative approach. Specimens, tissue samples and bioacoustic data were collected from four distinct locations covering the wet, intermediate and dry bioclimatic zones of Sri Lanka where the two species are known to occur naturally. A total of eighteen morphological features and thirty morphometric measurements were taken from the collected specimens and type specimens of the two species deposited in the National museum of Sri Lanka. Species identification was done using their original morphological descriptions. An approximately 540 base pair fragments of the mitochondrial 16S rRNA gene was sequenced from the tissue samples collected from these localities including their type localities. A bioacoustic analysis was also conducted for male advertisement calls of both species. The statistical analysis of morphometric data and bioacoustic properties showed no clear distinction between the two species. Similarly, the phylogenetic analysis of the 16S rRNA gene using both Maximum Likelihood and Bayesian methods showed no monophyletic clades corresponding to the two species and the pairwise genetic distance between all individuals sampled, ranged between 0.51-1.59%. Thus, our integrative approach does not support the existence of two distinct species. The study therefore emphasizes the importance of reconsidering some of the morphological characteristics used in the delimitation of Sri Lankan amphibians and the importance of using integrative approaches in delimiting species boundaries.

Keywords: Amphibian, Sri Lanka, Species delimitation, DNA-barcoding, Bioacoustics

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Investigation of Throat Colour Polymorphism in Relation to Sex and Body Size of the Litter Skink, *Lankascincus fallax*

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Colour polymorphism is a pervasive phenomenon in both animal and plant kingdoms. Understanding the evolution and maintenance of polymorphism is of interest to evolutionary biologists. Among the lizards of Sri Lanka, the endemic skink species *Lankaskincus fallax* shows throat colour polymorphism in which, the underlying basis in not clearly known. Hence, this study was carried out to examine the basis of three different throat colour morphs observed in this species. Live skinks were sampled from two locations in Sri Lanka representing two different bioclimatic zones for a period of four months from November 2018 to February 2019. Sex and the throat colour were determined visually and the snout to vent length (SVL) was measured in the field-collected lizards. Tail tips of some selected individuals from the two locations were taken and a fragment of the 12S rRNA gene was sequenced in representative individuals having the different throat colour morphs. Pairwise genetic distance of the three colour morphs ranged between 0.4-0.5% confirming that the three colour morphs were the same species. Three colour morphs (red, black and white) were observed in males in both locations, while only the white morph was observed in females, suggesting that the color polymorphism was confined to males. There was a significant association between throat colors and sex (χ^2 = 134.01, df = 1, p≤0.0000), albeit the possibility of data non-independence as result of non-colored males assuming color during the course of the study. There was a significant difference between mean SVL of colour throated (39.35 mm) and non-colored throated males (30.31 mm) (t = 11.458, df = 51.543, p≤0.0000). Thus, our study suggests that the throat colour in these skinks is highly associated with sex and the state of maturity in males. However, the study showed that there is no significant change (χ^2 = 5.3467, df = 3, p=0.1481) in the colour frequencies during study period. Future studies are necessary to understand the underlying drivers for the presence and maintenance of these different throat colours in *L. fallax*.

Keywords: Sexual dimorphism, DNA-barcoding, Scincidae, Endemic species, Conservation

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Development of a Mycoinsecticide to Control Mosquito Larvae
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In recent years, mosquitos have become a major challenge to public health in Sri Lanka. Dengue fever, chikungunya, zika virus, malaria are the leading among mosquito borne diseases. Unfortunately, the vaccines or drug-based treatments are not available for most of the mosquito borne diseases and therefore, vector control is still the main form of prevention. For many decades, the chemical based insecticide used to control mosquito population has leads to environmental pollution and health risks. Bio- insecticides provide an environmentally friendly option to replace the chemical insecticides. Fungal species can be used as biopesticides termed mycoinsecticides. This study was conducted to identify an unknown local fungal sample and to find out whether it could be used as a biopesticide and to compare the effects between *Metarhizium anisopliae* and unknown local fungal sample on mosquito larvae. Internal Transcribed Spacer (ITS) based sequencing technique was used for the identification of local fungal sample. Unidentified local fungal sample was grown on sabouraud's dextrose agar (SDA) medium. Genomic DNA was extracted from the unknown fungal sample using Fungal DNA Extraction Kit (wizard R genomic DNA purification kit). Ribotyping was carried out using ITS regions based NGS platforms. The unknown fungal sample was identified as *Aspergillus oryzae*. The virulent spores of *Metarhizium anisopliae* was produced in the laboratory by two methods known as surface and submerged culture. Potato dextrose broth was used as a submerged medium while Sabouroud's dextrose agar medium as a surface culture medium to grow *Metarhizium anisopliae* virulent spores. Spores were harvested from 14 days sporulated cultures of the organism on potato dextrose agar/SDA by flooding the culture with sterile saline containing 0.01% (v/v) Tween (BDH) or sterile distilled water. The number of spores was determined using Hemocytometer. Spore suspension was prepared with varied concentrations and experiment was done using same stage mosquito larvae. Oil formulation increased persistence of the fungal spores. The research is still in progress.

Keywords: *Mosquito larvae, Fungi, Metarhizium anisopliae, Bioinsecticides, Aspergillus oryzae*

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In Silico Development of Multi-Epitope Antigens as Candidate Serodiagnostic Markers for Diagnosis of Leptospirosis

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Leptospirosis is a zoonotic bacterial disease infecting both humans and animals and is caused by a group of spirochaetes belonging to the genus *Leptospira*. Diagnosis of leptospirosis based solely on clinical criteria is difficult since signs and symptoms of leptospirosis mimic many other infectious diseases such as dengue, malaria and, rickettsia. Therefore, laboratory diagnosis is essential in confirming suspected leptospirosis. However, laboratory confirmation of leptospirosis is complicated due to the presence of over 250 infecting serovars and low sensitivity in available diagnostic methods. In Sri Lanka, approximately 3000 to 5000 cases are reported annually. However, only less than 10% of the cases are laboratory confirmed, leading to suboptimal patient management. Therefore, development of a rapid and accurate laboratory diagnostic test capable of confirming leptospirosis regardless of the infecting serovar is imperative for proper patient management. Some surface-exposed outer membrane proteins (OMPs) of *Leptospira* spp. are highly conserved exclusively among pathogenic species. These genus-sp ecific OMPs has the potential to be used as universal serodiagnostic antigen markers for diagnosis of leptospirosis regardless of the infecting serovar. This study represents a series of *in silico* approaches to design high-density multi-epitope antigens using immunodominant epitopes derived from genus-specific OMPs as candidate serodiagnostic markers. A total of 1556 genes were analysed from the complete genome sequence of *L. interrogans* serovar Lai str. 56601 (NCBI RefSeq: NC_004342.2). Signal peptide prediction programs SignalP and LipoP programs were used to predict the outer membrane localization and PRED-TMBB and TMHMM programs were used to predict the β-barrel structure. Protein 3D structure analysis software RaptorX and SWISS-MODEL were used to further shortlist best TM β-barrel OMP candidates. Protein sequence homology analysis revealed a total of 19 candidates conserved across the genus *Leptospira*. Immune Epitope Database and Analysis Resource (IEDB) webserver was used for epitope analysis and found a total of 33 linear B-cell epitopes which were found to be conserved among all pathogenic *Leptospira* spp. Epitopes were assembled into single proteins using flexible linkers to produce multi-epitope antigens and their total antigenicities were analysed using ANTIGENpro tool in Scatch Protein Predicter webserver. Some of the multi-epitope antigens exhibited superior antibody binding capacity than their native counterparts. Our study showed that there are many uncharacterised hypothetical proteins conserved across the *Leptospira* genus containing excellent diagnostic potential which can be used to develop a universal diagnostic test. Furthermore, our results indicate that use of multi-epitope antigens may result in superior specificity in disease diagnosis. Therefore, this study warrants further investigation for experimental validation using immunological, biochemical and molecular methods.

Keywords: *Leptospira, Outer membrane proteins, ELISA, Multi-epitope antigen*

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Development of an Effective Pelleted Biofertilizer for Paddy (*Oryza sativa* L.) Using Co-inoculated Bacteria and Arbuscular Mycorrhizal Fungi

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Rice (*Oryza sativa* L.) is one of most important staple food in world. However due to heavy usage of chemical fertilizers, sustainability of the paddy cultivation has been collapsed and food safety became a huge challenge. In order to overcome this challenge biofertilizers are a sustainable solution. The study was aimed to develop an effective pelleted biofertilizer for paddy with co-inoculated bacteria and arbuscular mycorrhizal fungi (AMF). *Azospirullum* sp., *Pseudomonas fluorescens* and AMF mixed bioinoculum, rock phosphate and potassium feldspar nutrient supplement mixture with three compatible carrier materials such as aquatic weed, biochar and compost were used in developing pelleted biofertilizers. Each pre-sterilized, 1 kg weight of ground carrier material was inoculated with 50 g of AMF propagules and 20 ml of $1.5x\ 10^8$ (CFU/ml) of each bacterial inoculant and different types of pelleted biofertilizers were prepared as; aquatic weed and bioinoculum (P_1), aquatic weed, bioinoculum and nutrient supplement mixture (P_2), biochar and bioinoculum (P_3), biochar, bioinoculum and nutrient supplement mixture (P_4), compost and bioinoculum (P_5), compost, bioinoculum and nutrient supplement mixture (P_6). Biofertilizer pellets were tested for the microbial survivability with the time by determining viable cell count of bacteria at two storage temperatures of $4°C$ and $30°C$. Pot experiment was carried out to investigate the effects of biofertilizers on growth and yield of paddy and on some soil chemical and biological characteristics. Control (without biofertilizers) and above pelleted biofertilizers were added to the 3000 g of soil in pot with one paddy plant of variety Bg 360. The treatments were arranged in a randomized complete block design (RCBD) with five replicates. Data were statistically analysed using the Tukey's Pairwise Comparisons test. It was revealed that control and different treatments in pot experiment were significantly different for shoot height, number of seeds per panicle, 100 seeds weight and soil pH ($p \leq 0.05$). However, there was no significant difference observed for bacterial count in prepared biofertilizers and biofertilizer applied soil, relative growth rate, plant dry and fresh weights and electrical conductivity. Among different pelleted biofertilizers, application of pellets consisted of compost with bioinoculant (P_5), exceedingly enhanced the paddy growth and yield. Compost, bioinoculum and nutrient supplement mixture (P_6) added pellets were shown highest bacterial survivability at 30^0C for seven days. Although AMF colonization of paddy plants were low this was the first report of citing the presence of AMF in paddy roots in Sri Lanka. These pelleted biofertilizers have the potential to be used for improved productivity of paddy variety Bg 360. Therefore, developing such bioinoculants as biofertilizers and their efficient use could be considered as a sustainable solution for paddy cultivation in Sri Lanka and worldwide.

Keywords: *Oryza sativa L., Azospirullum sp., Pseudomonas fluorescens, Arbuscular mycorrhizal fungi, Pelleted biofertilizer*

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Transfer A Synthetic *Cry* 2ab Endotoxin Gene to Indica Rice Varieties; *Dahanala* and *Kalu Baala Wee* for the Development of Lepidopteran Pest Resistance

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Rice, being the staple diet in most of the Asian countries, plays an important role in deciding the nutritional fulfilment of people living in the continent. With the projected population upturn and the insufficiency of arable land for cultivation, there is a possibility of a food shortage arising. In order to overcome this challenge, there is a necessity of improving the crop yield by reducing the damage to crops mainly by insect pests. Bt crops, expressing insecticidal *cry* genes of *Bacillus thuringiensis* have taken over the place of many conventional crops exhibiting their potency to resist damage by insect pests. The current study was aimed at expressing a synthetic *Cry2Ab* endotoxin in Indica rice varieties to confer lepidopteran pest resistance. The efficiency of *Agrobacterium* mediated transformation and electroporation were evaluated, and the transformation efficiency of intact plantlet electroporation was also studied. Rice calli induced on MS (Murashige and Skoog) medium were transformed with the *Cry2Ab7* gene (GenBank accession: DQ119823.1), cloned in pGFPGUS*Plus* vector using *Agrobacterium tumefaciens* strainGV3101. Transformed calli were selected based on Kanamycin resistance. Regenerated plantlets were electroporated with the intact *Cry2Ab7* gene. The levels of *Cry* gene expression in transformed calli and detection of transformed plantlets were carried out using GUS assay and PCR. Electroporated rice calli and plantlets produced negative results. Positive transformants were detected in rice calli transformed with *Agrobacterium* through GUS assay and specific primer PCR. It can thus be concluded that traditional Indica rice varieties can be transformed through *Agrobacterium* mediated method.

Keywords: CRY2AB, Agrobacterium tumefaciens, Rice, Electroporation, pGFPGUSPlus

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Control of Fungal Contamination in Plant Tissue Culture Using Synthetic and Natural Antifungal Agents

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Plant tissue culture is a collection of techniques of growing plant cells, tissues or organs in an artificial nutrient medium under sterile and controlled conditions. Even under these sterile conditions, plant tissue cultures can be contaminated. Contamination has become one of the major issues in the plant tissue culture industry. Mainly bacteria and fungi cause these contaminations. This study was conducted to find out the effective synthetic and natural antifungal agents to control the fungal contaminations in plant tissue culture. Different natural antifungal agents (cinnamon oil, clove oil, ethanol garlic extraction and synthetic antifungal agents (carbendazim, mancozeb, chlorothalonil, and thiram) were screened using agar disc diffusion method against the common fungal contaminants of tissue culture media, namely, *Penicillium* sp., *Cladosporium* sp., and *Pythium* sp. The effective antifungal agents in tissue culture were tested by measuring percentage contamination against the control. Different concentrations (in the range of 50, 75, 150, 300, 600, 1200 mg/L for carbendazim, mancozeb, chlorothalonil, thiram; 100, 200, 400, 800 mg/L for cinnamon oil, clove oil and 250, 500, 1000, 2000, 4000 mg/L for ethanol garlic extraction) of effective antifungal agents were used as treatments in a Complete Block Design with twelve replicates. Sterilized shoot tips of *Musa* sp. were cultured in MS medium incorporated separately with three natural antifungal agents and four synthetic antifungal agents with above concentrations as treatments to control fungal contamination in plant tissue culture. The contamination percentage was measured for each treatment. The highest effectiveness in controlling ($p < 0.05$) was observed in 300 mg/L of carbendazim, 600 mg/L of mancozeb, 2000 mg/L ethanol garlic extraction (based on the fresh weight) for *Penicillium* sp., 300 mg/L of carbendazim, 300 mg/L of mancozeb for *Cladosporium* sp. and 300 mg/L of chlorothalonil, 600 mg/L of thiram and 4000 mg/L ethanol garlic extraction for *Pythium* sp. by incorporating to culture media, respectively. The level of plant growth and shoot production with media incorporated with antifungal agents is yet to be studied.

Keywords: Cinnamon oil, Clove oil, Garlic extraction

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Strategic Reintroduction Profile of *Alphonsea hortensis* (Annonaceae), a Plant Species Extinct in the Wild

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Human disturbances, climate change and unprecedented threats have increased the risks of extinction of rare and endangered plant species. One effective way of conserveing these species is through reintroduction to their indigenous locations. Relevant to the basic reintroduction guidelines, the priority goes to the species extinct in the wild. Submission to the basic rudiments, *Alphonsea hortensis,* which belongs to the family Annonaceae was selected. The main objective of the present study was to reintroduce *Alphonsea hortensis* to its original locations and to other suitable habitats in Sri Lanka. Nineteen bioclimatic variables were analysed using MaxEnt software to predict the suitable sites before starting the reintroduction. This study was designed as four phases. The first was to list out its past locations as indicated in herbarium specimens. The next phase was to develop a map with suitable locations using MaxEnt software. Pre-plantation trial was done to determine the growth rate in different microhabitat such as open, shade and partial shade as the third step and finally, the analysis of soil. Soil samples from top soil and at a depth of 15cm (deep soil), from Molkawa, Kabaragala, Ranwalagla, Yagirala, Morapitiya and Kalugala forest reserves were collected and checked for basic nutrients such as sodium, potassium, calcium, phosphorus, available Nitrogen and pH and the electrical conductivity. These values were used to compare soil in preplantation localities and places where this species currently occupies in Royal Botanic Garden, Peradeniya. One way ANOVA was followed by pair wise comparison of locality at RBG with test sites using Dunnett model at significant level $\alpha = 0.05$. Among the predicted hence tested locations in the present study, soil properties were much similar in Molkawa and the location at RBG. Both surface and deep soil pH, conductivity, Na, percentage of K in surface soil, percentage of P in both soil striata, were not significantly different in this pair. In all locations, percentage of Ca and deep soil percentage of K were significantly different ($p < 0.05$). The growth rates were different according to the microclimate. The growth rate was highest in partial shade, medium in open and lower in shady environments. It gives a clue that reintroducing *Alphonsea hortensis* has to be done in partially shady localities. Moreover, based on the observations of the present study, Molkawa in the south western region of Sri Lanka could be recommended as a site for reintroduction. Criteria used to the reintroduction of *A. hortensis* to the wild could be used in the future in the conservation of other Sri Lankan plants enhancing benefits of ex-situ conservation.

Keywords: Extinction, Conservation, Reintroduction, Wild-extinct, Soil analysis,

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CHEMISTRY

Removal of Residual Aluminium in Electrochemically Treated Water

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The demand for the purified water is increasing day by day. To achieve the demanded quality of the consumable water, different electrochemical methods have been demonstrated to remove hardness, fluoride and heavy metals such as Cr(VI), Cd, and Pb in water. Electrocoagulation (EC) is a proven green technology for the removal of fluoride, hardness and hazardous heavy metals from water. The residual Al in treated water is the major issue in EC. A long term consumption of aluminium in low levels may lead to several diseases, such as extreme drowsiness, tiredness or vomiting. Electrocoagulation process was carried out in batch mode at different pH values with aluminium electrodes as both anodes and cathodes. The current was adjusted to 1.0 A and the resulted precipitate of aluminium hydroxide and aqueous solution were analyzed for Al by ICP-OES as a function of electrolysis time. The removal of residual Al in aqueous phase was accomplished by two different methods. In method one, activated carbon was subjected to $Ca(OH)_2$ treatment for a time period of a day followed by CH_3COOH treatment and finally oven dried. In method two, aniline was chemically polymerized by ammonium persulfate on the surface of purified graphite powder dispersed in 0.1 mol dm^{-3} HCl. Green coloured polyaniline embedded graphite power was separated, washed with distilled water and oven dried at 60˚C for 6 hours. Both base treated activated charcoal and polyaniline embedded graphite were characterized by UV-visible and FTIR spectroscopic techniques and used for subsequent experiments. Aqueous phase of electrocoagulated system at different pH was passed through a column prepared with two adsorbents. It was found that highest removal percentage of 80% showed by polyaniline embedded graphite at pH 10 compared to that of 60% removal efficiency by base treated activated carbon at the same pH. Therefore, polyaniline embedded graphite system could be a promising material for the removal of excess Al in treated water by EC.

Keywords: Electro coagulation, Aluminium, Activated carbon, Polyaniline embedded graphite, Removal efficiency

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Feasibility Study of Separating Glucose Unit and Cyanidin from Anthocyanin Pigment

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Anthocyanins are members of the flavonoid group of phytochemicals rich in tissues of plants, including leaves, stems, roots, flowers and fruits. They have marked health beneficial effects in humans. In addition, they are popular as photosensitizer in dye-sensitized solar cells. A new approach for a convenient method of extraction and a potentiodynamic method of separating glucose unit and the cyanidin of anthocyanin was attempted. In this study, six flower verities (*Impatiens balsamina* (52%), *Rosa sp* (71%), *Ixora coccinea* (65%), *Amaranthus caudatus* (70%), *Hibiscus rosa sinensis* (84%), *zinnia sp* (48%)) which contain anthocyanin pigments were extracted. Extraction was performed with 70 % ethanol and the supernatant of ethanoic extraction was mixed with petroleum either for separating polar and nonpolar pigments. All extracts were stored at 4°C avoiding exposure to sunlight. Highest percentage of Anthocyanin was shown by *Hibiscus rosa sinensis.* Anthocayanidine was obtained by acid hydrolysis. The mixture of hydrolyzed product was allowed to run on 1% agarose gel plates under the potential of 60 V using Pt and carbon electrodes. The pH of the medium was adjusted using acetic acid and sodium acetate buffer system. The results were compared with an authentic sample of cyanidine under identical conditions. UV-Vis spectroscopic data were recorded for the crude extraction and the hydrolyzed product. The product formation was confirmed by the intensity of the absorption peak at 528 nm. In this study, it was found that Agarose gel is capable of separating cyanidin from anthocyanin under the applied conditions.

Keywords: Anthocyanin, Cayanadine, Agarose gel, Hibiscus rosa sinensis

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A Study of the Chemistry of Ravana Dark Cave, Sri Lanka

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Ravana cave is the known biggest dark cave in Sri Lanka. It is located in Karandagolla area in Ella. This was the first research attempted to explore the chemistry in this cave. The study was conducted in wet season and emphasized the cave chemistry of water, rocks and soil from different places from Ravana dark cave. Field measurements were carried out in the drip water edges and in the pond water. Samples were collected from 14 sites including water, soil, and rocks. Metal analysis was performed on Inductive Coupled Plasma Optical Emission Spectrophotometer (ICP-OES) and the anions were analyzed by ion chromatography (IC). Biological Oxygen Demand (BOD) and Dissolved Oxygen (DO) levels in the pond water were found to be a very close low average value of 1.6 suggesting very low or no biological activity taking place in the pond which in turns reveals very poor or no microbiota. The pH value of karst water is close to 7.0 due to dissolution of Calcite in natural water and the pH values measured in the water sample varied from 6.56 to 7.49. Highest conductivity of 635 μS cm^{-1} was recorded only for one site indicates a high mineralization of water and the lowest conductivity of 60 μScm^{-1} was found for other three sites. Ca is the most abundant divalent cation extending from 1.7 ppm to 71 ppm while Mg varies from 3.5 ppm to 26 ppm. Abundance of Na, Mg, Ca, Zn and PO_4^{3-} in all the soil samples with drastic variation from sites concerned possibly due to the accumulation of excrements from cave inhabited bats and Edible-nest Swiftlet (*Collocalia fuciphaga)*. In the study of stalactite concretions, white and light-yellow speleotherm were chosen and the analysis showed high level of Ca, Mg, PO_4^{3-} and Al. Chemical composition along the length of the stalactite was found to be stable but increases from the center to periphery in a cross section. This could be attributed to the rise in speed of sedimentation during stalactite formation or the change of chemical composition in recharging solution. Ravana dark cave is not like most caves that are in carbonate rocks. It is a breakdown chamber in gneiss, sitting on top of a body of dolomite rock near the pool. There must be small layers of carbonate in the ceiling for the stalactites to form. Dolomite is less soluble than Calcite. The stalactites which we sampled are Magnesium Calcite, so there could be de-dolomitization occurring above the cave ceiling.

Keywords: Ravana cave, Chemical composition, BOD, DO, Speleotherm

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Cyanidin Dye Isolated from Mangosteen Peel Waste: Higher Performance Efficiency in Dye-Sensitized Solar Cells

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Mangosteen (*Garcinia mangostana L.*) is one of the species containing a significant level of anthocyanins (0.1-1% of dry weight) which exhibits promising electron-donating and electron-accepting abilities. The major anthocyanin in mangosteen peel is cyanidin-3-glucoside having glucosyl substitution at 3-position of cyanidin. Abundance of other major bioactive compounds such as phenolic acids and xanthone derivatives, reduces the photovoltaic measurements to a considerable extent. Hence purification of an acidified methanolic anthocyanin extract was carried out using gravity column chromatographic techniques such as silica and Sephadex LH-20. Moreover cyanidin-3-glucoside was identified as the major anthocyanin in the purified fraction using LC-MS and UV-visible absorption spectra. The results demonstrated a molecular cation (M$^+$) at *m/z* = 448.9 and a fragment ion at *m/z* = 286.8 at t$_R$ = 34.08 and also a visible maximum wavelength λ_{max} at 516 nm implying that the isolated fraction is consistent of cyanidin-3-glucoside. Hydrolyzation of anthocyanins to anthocyanidins was achieved under acidic (2M HCl) and high temperature conditions (100°C). The resulting cyanidin was further isolated by partitioning with ethyl acetate and Sephadex LH-20 column chromatography and was characterized using LC-MS results exhibiting a molecular cation (M$^+$) at *m/z* = 322.70 at t$_R$ = 16.96 and also a visible maximum wavelength λ_{max} at 535 nm implying that the isolated fraction is in the form of cyanidin chloride. A solar cell prepared exhibited a promising efficiency of 0.99%, short circuit photocurrent density of 0.256 mA cm^{-2} and an open circuit voltage of 387 mV implying that further modifications in the donor structure could lead to enhanced results.

Keywords: Anthocyanin, Mangosteen, Cyanidin, Dye-sensitized solar cells

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Polyaniline Modified Fluorine Doped Tin Oxide Anode for Microbial Fuel Cells

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Microbial fuel cells (MFCs) are increasingly interest in the scientific community as a potential solution towards worldwide energy related problems and waste water purification. MFCs harness the metabolism of microorganisms and utilize the organic matter to generate electric energy. The research method used in the study is cheap, easily manufactured and environmentally friendly compared to the other MFCs. A dual chamber MFC, divided by a ceramic septum was used to separate anodic and cathodic compartments in the cell. Synthetic waste water was used as a fuel with *Saccharomyces cerevisea* as a biocatalyst and methylene blue as a mediator in anaerobic anodic chamber. Distilled water was used for aerobic cathodic chamber with platinum electrode as a cathode. Five different electrodes (i) Expanded graphite coated titanium plate (ii) Activated charcoal coated titanium plate (iii) Bare fluorine doped tin oxide (FTO) glass (iv) Polyaniline deposited FTO glass (v) Polyaniline – activated charcoal composite coated FTO glass were used as the anode material in constant operating conditions. FT-IR spectrum was used to characterize the polyaniline-activated charcoal composite. Open circuit voltage (OCV), short circuit current and voltage through series of external resistances were measured. Electrical performance of MFCs was characterized using OCV-time curves, polarization curves, Power curves, current-time curves and maximum power densities of each MFCs. The highest maximum OCV of 967 mV was shown by Polyaniline-activated charcoal composite coated FTO glass electrode. The highest maximum power densities were recorded in both expanded graphite coated titanium plate and polyaniline – activated charcoal composite coated FTO glass electrode which were 2.68×10^{-3} mW/m^3 and 2.66×10^{-3} mW/m^3 respectively. It is suggested that, polyaniline-activated charcoal composite coated FTO glass is a promising anode material for MFCs. Mainly for the polyaniline – activated charcoal composite coated FTO glass electrode can use for future developments of the research by analyzing the electrochemical performance with the different thicknesses of polyaniline – activated charcoal composite layers on FTO glass.

Keywords: Microbial fuel cell (MFC), Polyaniline, Saccharomyces cerevisea

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Polyaniline-Nano Mn$_2$O$_3$ Modified Activated Carbon for the Removal of Hexavalent Chromium

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Hexavalent Cr is a proven carcinogen by which the aquatic environment could be contaminated through Cr based applications. Therefore, much attention has been focused on various methods of the removal of Cr(VI) from contaminated water. Herein we disclose a novel Activated carbon-polyaniline-Mn$_2$O$_3$ nanocomposite (AC-PANI-MO) as a potential candidate for the removal of Cr(VI) in aqueous medium. In a well-dispersed suspension of activated carbon in 0.1 moldm^{-3} hydrochloric acid, double-distilled aniline was oxidized at 5 °C by ammonium persulphate. Resulted emeraldine salt of polyanilin was washed with distilled water and dried for ten hours at 60 °C in a muffle furnace. Mn$_2$O$_3$ nanoparticles were synthesized by co-precipitation technique. Manganese sulfate was dissolved in water and stirred at 80 °C for one hour, while stirring, NaOH was added till the pH reached to 12. The solution mixture was cooled down to room temperature followed by the addition of one gram of activate carbon-emeraldine salt composite. The mixture was stirred at room temperature for two hours, filtered and washed with ethanol. Precipitate was dried for overnight at 60 °C and kept in muffle furnace at 500 °C for 4 hrs. The brown colour AC-PANI-MO nanocomposite was characterized by UV-Visible spectroscopy in the wavelength range 200-600 nm, Fourier Transform Infra-Red spectroscopy (FTIR) in the wavelength range 400-4000 cm^{-1} and X-ray Diffraction (XRD) using CuKα1, λ=0.154 nm radiation)

From the XRD pattern, it was confirmed the crystallinity of manganese oxide nanoparticles with average particle size 30.0 nm. Size of MnO$_2$ nanoparticles was determined using Debye-Scherer equation corresponding to highest intensity peak at 2θ = 33.00. The removal of Cr(VI) by AC-PANI-MO nanocomposite at different pH was studied by UV-visible spectroscopy by monitoring the loss of optical density at 359 nm. It was found that highest removal of Cr(VI) at pH 2.00.

Keywords: Activated carbon, Hexavalent chromium, Emeraldine salt, Mn$_2$O$_3$ nanocomposite

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Study to Evaluate the Functional and Nutritional Properties of *Nymphaea pubescens* Willd. Seeds and Seed Incorporated Food Products

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Consumption of anti-oxidant rich, low GI (Glycemic index) food products minimize the risk factors of chronic diseases. This study was designed to evaluate the functional and nutritional properties of *Nymphaea pubescens* Willd. identified as hairy water lily (*Olu*), instant string hopper flour develop from *Olu* seeds and *Olu* seed bar. The shelf-life of *Olu* seed bar was determined through chemical, physical, microbiological and sensory tests. Using standard procedures whole seeds and products were tested for moisture, crude fat, crude protein, ash and total dietary fibre content (TDF). Dinitrosalicylic acid reagent (DNS) and pooled human saliva were used to determine *in-vitro* starch digestibility rate. Antioxidant activity of the methanolic extracts of seed and products were studied by its free radical scavenging property on *in-vitro* models using 1, 1-diphenyl-2-picrylhydrazine (DPPH) and 2-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) (ABTS). Total polyphenolic (TPC) and flavonoid content (TFC) were estimated. Fatty acid profile of seed, mineral and heavy metals were analysed using gas chromatography (GC), ICP-MS and ICP-OES respectively. Acceptability of food products were evaluated by panellists using seven points Hedonic scale on sensory attributes; colour, odour, taste, texture and overall acceptability. Shelf life of *Olu* seed bar was investigated for six weeks storage period with two weeks' time intervals using chemical, microbiological, physical and sensory tests. TDF of *Olu* seeds, string hopper flour mixture and *Olu* food bar were $9.09\pm0.61\%$, $5.50\pm0.37\%$ and $4.48\pm0.60\%$ respectively. *In-vitro* starch digestibility rates were 87.82 ± 0.60, 118.91 ± 0.40 and 96.64 ± 0.20 respectively. TPC (mg/g GAE) of *Olu* seeds, string hopper flour, *Olu* seed bar (0th week of storage) and *Olu* seed bar (6th week storage) were 338.67 ± 0.01, 10.33 ± 0.00, 1.08 ± 0.00 and 1.29 ± 0.00 and TFC (mg/g QE) were 40.29 ± 0.01, 2.75 ± 0.00, 0.35 ± 0.03 and 0.39 ± 0.01 respectively. In shelflife analysis, DPPH and $ABTS^{\bullet+}$ radical scavenging activities were not shown by 0th and 6th week *Olu* seed bar. DPPH IC_{50} (µg/ ml) were 23.00 ± 0.03 and 454.89 ± 0.00 for *Olu* seeds and string hopper flour respectively and for $ABTS^{\bullet+}$ IC_{50} (µg/ ml) were 17.03 ± 0.19, 229.87 ± 0.01. *Olu* seeds possess strong antioxidant activities and rich source of dietary fibre, manganese, magnesium and iron but there is no evidence for heavy metal contamination. *Olu* seed bar and 35% Olu seed flour incorporated string hopper flour mixture were accepted by the sensory panel. The *Olu* seed bar remained stable at room temperature for six weeks of storage period in terms of microbiologically, chemically, physically and sensorial. Both developed products are sources of fibre and show minor antioxidant activities.

Keywords: Nymphaea pubescens, Antioxidant activity, In-Vitro starch digestibility rate, Dietary fibre, Shelflife

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Photodynamic Action of Porphyrin Against Skin Fungi of *Candida albicans* and *Malassezia furfur*

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Porphyrins are deeply coloured highly fluorescence compounds of natural or synthetic origin with a broad spectrum of applications. Among them photodynamic therapy of cancer, dye sensitized solar cells, and electrocatalysis are much more attractive. In oxygenated media, when porphyrin is shined by visible light, Reactive Oxygen Species (ROSs) singlet oxygen and superoxide radicals are generated. These radicals are highly cytotoxic which could damage proteins, lipids, DNA etc. At present available antifungal treatments for controlling the fungi diseases are not sufficient. Some causative agents show resistant for the available antifungal products. Some antifungal treatments are toxic and irritant to humans and also harmful for the environment. In this study, the effect of several porphyrin derivatives, tetraphenylporphyrin (TPP), sodium salt of meso-tetra (4-carboxyphenyl) porphyrin and Zn (II) meso-tetra (4-carboxyphenyl) porphyrin (ZnTCP) were tested against fungi *C. albicans* and *M. furfur*. Antifungal effect of porphyrin was determined by using agar well diffusion method and disc diffusion method. For further studies serial dilution and colony count method was carried out. Sabouraud Dextrose agar (SDA) medium was used for culture the fungi samples. As a positive control clotrimazole solution (antifungal cream) was used. Inhibition zones were observed in fungi *M. furfur* samples treated with 10 ppm sodium salt of meso-tetra (4-carboxyphenyl) porphyrin. In well diffusion method 11 mm averaged inhibition zone of diameter and in disc diffusion method 10 mm averaged inhibition zone of diameter were observed. TPP did not show any inhibition zone in *C. albicans* and *M. furfur* plates were kept inside and outside of incubator. Fungal samples treated with ZnTCP showed 11 mm averaged inhibition zone of diameter in well diffusion method and 12 mm averaged inhibition zone of diameter in disc diffusion method. All tested porphyrin compounds did not show dark toxicity for fungi samples. Above results proved that sodium salt of meso-tetra (4-carboxyphenyl) porphyrin and ZnTCP have promising antifungal effect on fungi *M. furfur* under the direct sunlight and aerobic conditions.

Keywords: Porphyrin, Photodynamic action, Antifungal, Candida albicans, Malassezia furfur

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Enhancement of the Adsorption Capacity of a Raw Clay and Deduction of the Adsorption Isotherm Model for the Adsorption of Calcium and Magnesium Ions onto the Modified Clay

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Water hardness is a critical problem in many areas with varying degrees of consequences. High concentrations of calcium and magnesium cause several health problems. Many currently available techniques for the removal of hardness from water are not cost effective. Adsorption processes received much attention, due to their cost effective nature. The use of clay materials such as $Al_2H_2Na_2O_{13}Si_4$ (Bentonite), $M_{2/n}O.Al_2O_3.xSiO_2.yH_2O$ (Zeolite) to remove the hardness from drinking water is advantageous, due to their higher adsorption ability, abundance and cost effectiveness. The present study was conducted with a view to characterize and optimize the naturally available clay materials to remove water hardness. The efficiency of eight different types of clay materials to remove Ca^{2+} and Mg^{2+} ions from the aqueous solution was studied. One clay type (from *Deniyaya* clay deposit) was identified as clay which had the highest adsorption capacity and efficiency. The enhancement of the adsorption capacity of the clay was performed by cationic modification. The characterization of these clay materials was performed by means of Fourier Transform Infrared Spectroscopy (FTIR), X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM) and Particle size Analysis (PSA). The XRD results show that the main component of the *Deniyaya* clay was Kaolinite and other seven clay samples were consisted with two or three types of clay materials. The demonstration of the efficiency of the adsorption process of the modified clay (Cationic modified *Deniyaya* clay) was carried out with the aid of a column technique. The studies of the adsorption isotherms for calcium and magnesium ion adsorption onto the modified *Deniyaya* clay were explored using a batch experiment utilizing two different temperatures (303 K and 333 K). The mechanism and the characteristic parameters of the adsorption process were analyzed using two parameter isotherm models. The results showed that calcium ion adsorption isotherm is more similar to the Harkin-Jura isotherm model at room temperature and it tended more similar to the Langmuir model at higher temperature. Magnesium ion adsorption isotherms showed more similarities to the Langmuir model both at normal and higher temperatures. The Specific Surface Area (SSA) of the modified clay was calculated using the modified Harkin-Jura adsorption isotherm. Slight decrement of the SSA was observed at the higher temperature. Moreover, based on the values of standard enthalpy, Gibbs free energy change and entropy, the modified clay material showed the nature of exothermic, and non-spontaneous as well as increased randomness at solid-liquid interface at 303-333 K temperature range. The study showed that the *Deniyaya* clay can be used to develop water filter which can efficiently remove hardness.

Keywords: Water hardness, Kaolinite, Deniyaya, Isotherm, Harkin-Jura Isotherm
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Surface Modification of Montmorillonite Clay by Benzene Diazonium Cation: Ammonia Gas Sensor

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Apart from the natural origin, ammonia is produced in various chemical industries or intensive life-stock. Exposure to high levels of ammonia brings health issues in humans. Therefore, development of sensitive platforms for sensing ammonia at room temperature has been a subject of current research interest. In this study, a sensitive and highly selective benzenediazonium chloride intercalated montmorillonite clay (BDC-MMT) based sensor was developed. Before diazotization was performed on MMT, it was purified to remove carbonates and organic matters. Purified clay was activated by stirring with 0.1 moldm^{-3} HCl for 45 min followed by washing with distilled water to remove any chloride. Intercalation of benzenediazonium chloride was accomplished by allowing aniline to get adsorbed onto clay and dropwise addition of 0.1 moldm^{-3} NaNO$_2$ for a period of one hour at 5 $^\circ$C. Formation of benzene diazonium cation was confirmed by the FTIR characteristic peaks at around 1513 cm^{-1} and 1456 cm^{-1} for the presence of NO group and -N=N- group respectively. UV-Vis spectral analysis of BDC-MMT thin film showed a characteristic absorption band at 492 nm, due to conjugated structure formed by azo bond. It was observed that when BDC-MMT was exposed to dry ammonia gas the original pink colour of BDC-MMT changed to brown with concomitant decreasing in intensity of UV-visible band at 492 nm. It was interesting to note that the colour change is completely reversible. Experiments continued with sulpherdioxide, hydrogensulphide, and formaldehyde vapour showed no detectable change in colour or UV-visible spectral data. This suggests the applicability of BDC-MMT sensor with good selectivity for ammonia gas.

Keywords: Ammonia, BDC-MMT, Sensor, Selectivity

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Investigation of Biochemical Properties of *Oncosperma fasciculatum* and *Areca concinna* Seeds

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Identification of phytochemicals and investigation of their biochemical and medicinal properties play an important role towards new drug development. Present research was carried out to study the biochemical properties of two endemic palm trees in Sri Lanka: *Areca concinna* and *Oncosperma fasciculatum*. Methanol extracts of both species' seeds were UV active and the maximum absorption was at 281 nm. A considerable number of compounds were able to separate using Thin Layer Chromatography in *Oncosperma fasciculatum*, however clear separation was not observed in *Areca concinna.* Soxhlet method was used to extract the fat content in both species. Fatty acids were converted to fatty acid methyl esters and identified using Gas Chromatography (GC). The GC analysis clearly indicated that the seeds of both palm trees *Areca concinna* and *Oncosperma fasciculatum* possess oleic acid (mono unsaturated fatty acid), linoleic acid (poly unsaturated fatty acid) stearic acid, palamitic acid, myristic acid, lauric acid, capric acid and caprylic acid (saturated fatty acids). However, most of the results observed for these two species were comparable, could be of having the two species in the same family "Arecaceae" and they are endemic to Sri Lanka and share the same abiotic factors and environmental conditions. Antioxidant activities of these species were tested using 2, 2-diphenyl-1-picrylhydrazy (DPPH) method. In the assay, 1M Standard solutions of BHT and Ascorbic acid showd 99.9389% and 99.892% radical scavenging activity respectively. *Oncosperma fasciculatum* species and *Areca concinna* species have shown 86.8565% and 87.7212% inhibition percentages in 100000 ppm sample respectively and 95.92% and 96.30% inhibition percentages in lowest concentration, 1000 ppm sample respectively. Relatively high levels of DPPH radical scavenging activity suggest these seeds extracts have great antioxidant properties and that could prevent the oxidative damages in normal cells. Furthermore, these species contain saponins, tannins and flavonoids as phytochemicals which believes to support the defence mechanism against pathogens. Antimicrobial activity of the seed extracts was studied using the disc diffusion method. Antibacterial activity and antifungal activity were tested separately. Both species have shown significant antibacterial activity against *Staphylococcus aureus*. Moreover, *Oncosperma fasciculatum* showed antifungal activity against *Candida* sp. Finally, this research demonstrates potential applications in antibacterial and antifungal medications. Moreover, the two species can be applied in cosmetic production via converting the fatty acids to fatty acid methyl esters (FAME) which are known to be precursors to surfactants, detergents and lubricants.
Keywords: Areca concinna, Oncosperma fasciculatum, Antioxidant activity, Phytochemicals, Antimicrobial activity

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D-131 Dye -Sensitized Solid-State Solar Cells

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Dye-sensitized nanocrystalline TiO_2 solar cells provide a promising alternative concept to conventional p–n junction photovoltaic devices. Dye-sensitized solar cells (DSC) based on liquid electrolytes have shown high efficiency. However, the evaporation of the liquid when the cell is imperfectly sealed, and corrosion by the volatile redox mediator may limit the device stability. In here dye-sensitized solid-state solar cells (DSSC) were prepared and obtained higher efficiencies by changing the amount of dye absorbed. FTO (fluorine-doped tin oxide) glasses were used as the substrate for subsequent deposition and sintering of the TiO_2 colloidal suspension solution. A layer of TiO_2 nanoparticles was deposited on FTO glass plates by drop coating followed by sintering. TiO_2 coated electrodes were preheated and dipped in a 0.3 mM solution of D-131 dye for 12, 15, 24, and 48 hours for varying the amount of dye absorbed. CuI in acetonitrile and triethylamine thiocyanate solution was deposited on a 0.25 cm^2 of the oven-dried D-131 dye sensitized TiO_2 electrode. Pt-coated glass plate was attached to the TiO_2 photoanode to construct the solid state dye sensitized solar cell. The DSSC prepared by dipping the TiO_2 electrode in KI solution for 24 hours showed a higher overall efficiency (η) of 2.579 % compared to that of other different dipped times. Highest values for V_{OC} = 0.466 V, and J_{SC} = 10.293 mA/cm^2 were observed. The incident photon-to-current conversion efficiency (IPCE) measured by a xenon light source showed a maximum IPCE value of ~57% at ~425 nm. HOMO and LUMO energies calculated by cyclic voltammetry and UV absorption spectra of D-131 dye were -5.30 eV, and -2.98 eV respectively. A general trend of increasing short circuit current density, fill factor and efficiency was noticed as a function of dipped time. But after 24 hours the value of above were found to decrease. DSSC gave high short circuit current density, fill factor and efficiency that suggest a mono layer formation of sensitizer (dye) on TiO_2.

Keywords: Dye-sensitized solid-state solar cell, Fluorine-doped tin oxide, monolayer formation, higher efficiency

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High Photoresponse 5,10,15-Tris(Phenyl)-20-(4-Hydroxyphenyl)porphyrin Sensitized N-Cu₂O Photodetector

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There has been an increasing interest for non-toxic, earth-abundant and self-powered materials in photodetector industry. This demand increased due to the issues arises with currently available high toxic and high fabrication cost materials. Mostly, state-of-art photodetectors tend to use these toxic and rare earth inorganic materials due to their high performance. Even though, organic materials had the ability to reduce toxicity and fabrication cost, but their optoelectronic and stability performance still in a primary level. Hence, addressing these drawbacks in a cross approach, an organic-inorganic hybrid photodetector was fabricated and characterized. Environmental friendly n-Cu$_2$O layer was selected to fabricated on top of Cu substrate and 5,10,15-tris(phenyl)-20-(4-hydroxyphenyl)porphyrin dye was used as an organic sensitizer. The device was fabricated by using atmospheric hydrothermal method followed by a step of immersing in the dye. The sensitivity and detectivity were calculated using IV characterization. The observed highest responsivity was 11.21 mA W^{-1} to blue (near UV, 465 nm) light at 0 bias. The sensitivity reached to 6.601×10^3 value and the highest detectivity of 2.182×10^{11} was observed under blue (465 nm) LED at 0 bias. The photodetector at its self-powered mood demonstrated fast rise and fall times of 862.9 and 855.6 µs at 35 kHz, respectively. These results show up this photodetector is more responsive toward near UV range with a medium level stability. Furthermore, with these results it can be consider that FTO/Cu/n-Cu$_2$O/5,10,15-tris(phenyl)-20-(4-hydroxyphenyl) porphyrin photodetector has considerable potential towards optoelectronic applications with having self-powered, green and low cost properties.

Keywords: Organic-inorganic hybrid, Photodetector, n-Cu$_2$O, Porphyrin

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The Graphite-Bentonite Composite Electrodes for General Electrochemical Purpose and High-Temperature Applications

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The binder free graphite-clay based electrodes are essential for high-temperature applications due to the high stability over existing binder incorporated graphite electrodes. Although the recent developments of graphite-clay based electrodes are mainly confined to kaolin type clays, the present study proves the feasibility of incorporating bentonite clay in the fabrication process. The fabrication of Graphite-Bentonite Composite Electrodes (G-BCEs) (cylindrical) was achieved by mixing raw materials in distilled water (graphite to bentonite clay ratio of 20:80, 40:60, 50:50, 60:40 and 80:20), stirring the content for 1h at 800 rpm, sonicating for 15 minutes and finally pressing the dry composite material (1.00×10^{-2} kg) under 1.03×10^4 N ram force to obtain the electrodes with 4.00×10^{-2} m longer and 1.00×10^{-2} m in diameter, respectively. The compressed electrodes were fired in between 773 K and 873 K temperature for 1 h and resistivity of fired electrodes was estimated subsequent to the resistance measurements. Characterization of electrodes was achieved by Scanning Electron Microscope (SEM), resistivity measurements and Modulus of Rupture (MOR) measurements and it carried-forward the graphite80%-Bentonite20% (G80-B20) electrode over other G-BCEs. Furthermore, the resistivity values of G-BCEs are decreased exponentially (according to the first order exponential decay) with the increased amount of graphite and the strength of the electrodes normally depends on the composition and linearly increased with the amount of graphite. Results indicate that fired electrodes are very stable in both molten salts and aqueous solutions. The resistivity of G80-B20 electrode has decreased from 1.00×10^{-3} Ωm to 0.87×10^{-3} Ωm when modified the clay with polyaniline and it implies the success of the modification of G80-B20 electrode. The working temperature range up to 1098 K, low resistivity, electrical and mechanical stability, lightweight and durability are the key attributes that confirm the capacity of fabricated electrodes for high temperature applications. Additionally, cyclic voltammograms reveal the suitability of fabricated G80-B20 electrode as an alternative over the working (Glassy Carbon Electrode) and counter electrodes (Pt electrode) typically used in general electrochemical applications. The development of fabricated electrodes for sensing applications will be achieved in the future.

Keywords: Graphite, Bentonite, Composite electrode, High-temperature applications, General electrochemical application

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Opto-Electronic Property Evaluation of Synthesized Organic Dyes Using Dft/Tddft Computational Strategies

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Mixed computational and experimental approaches were used in elucidating opto-electronic properties of seven organic dyes, with respect to their potential use in electronic devices. By comparing with reported values, the computer calculations were validated. Property elucidation of some synthesized compounds anthracen-9-ylethylanthracene-9-carboxylate, pyren-1-ylmethyl-4-bromobenzoate, pyren-1-ylmethyl-4-(9-hexyl-6-{4-[(pyren-1-ylmethoxy) carbonyl] phenyl}-9H carbazole-3-yl), 3, 6-di (anthracen-9-yl)-9-hexyl-9H-carbazole, 9-10-di (pyren-1-yl) anthracene , 2,5-bis(anthracene-9-yl)-3-hexylthiophene, and 3, 6-bis (phenanthren-9-yl)-9-phenyl-9H-carbazole. HOMO-LUMO gap of all dyes was calculated using Gaussian software at the DFT/ TDDFT level using B3LYP functional and 6-31G (d) basis set. Density functional strategies were applied to avoid the expense of the more traditional methods, deriving the energy directly from the electron probability density, rather than the molecular wave function. The DFT/TDDFT calculations were mainly done to investigate the electronic structure accounting the highest occupied molecule orbital (HOMO) and the lowest unoccupied molecular orbital (LUMO) energies and the gap in between changes with respect to the different kind of molecules. The calculated HOMO-LUMO energies for systems given above are 2.59 eV, 2.93 eV, 2.73 eV, 2.93 eV, 2.74 eV, 2.65 eV and 3.46 eV, respectively. Compounds with solvent effect in Acetonitrile and 6-bis (phenanthren-9-yl)-9-phenyl-9H- satisfied the main requirement for efficient electron injection, where the LUMO level is higher than the conduction band other systems and the HOMO level is sufficiently lower than the redox couple. According to TDDFT studies, this is an efficiency indicator of naval energy conservation method utilizes the Opt-Electronic Devices.

Keywords: Organic dyes, DFT, TDDFT, HOMO-LUMO, Energy gap

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Montmorillonite Clay Catalyzed Preparation and Characterization of 5-Phenylazo Salicylic Acid and Recyclability
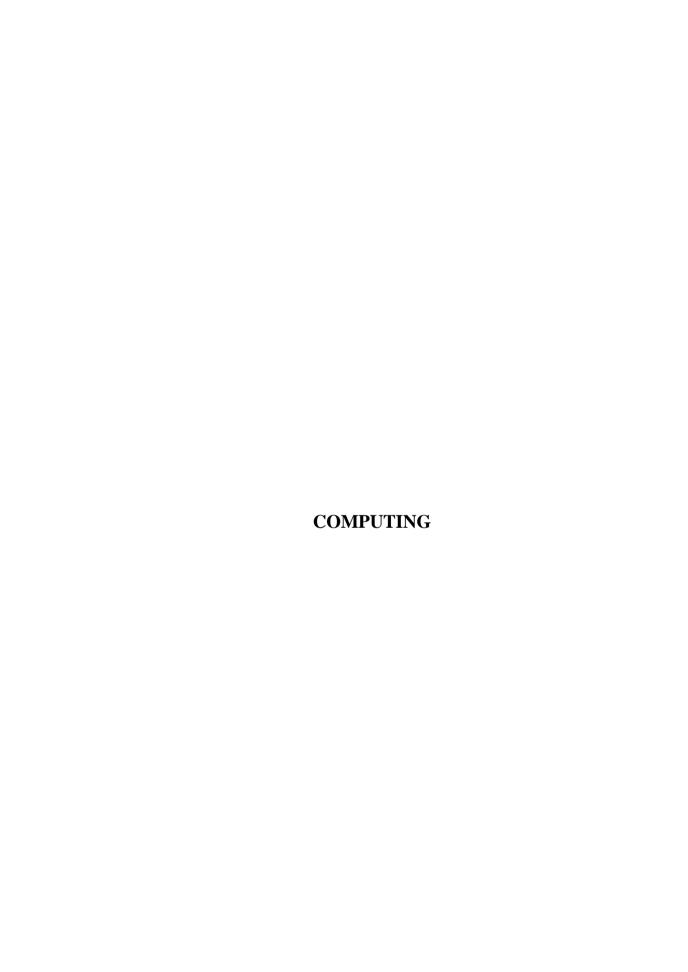
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Montmorillonite is a naturally-occurring clay mineral, typically composed of crystalline aluminosilicate layers (around 1.0 nm) superimposed on interlayers on hydrated ions. Therein, each aluminosilicate layer generally consist of one (for 1:1 type) or two (for 2:1 type) Si-O tetrahedral sheets and Al-O (or Mg-O for some clay minerals) octahedral sheet. Clay minerals provide distinct nanometer scaled layers and interlayers for engineering them as active catalysts. As such, strategic design and preparation has led to a variety of catalysts, including ion-exchanged catalysts, pillared clay catalysts, clay supported catalysts, inorganic and inorganic-organic composites and hybrids. The modifications of montmorillonite clay result novel properties with potential applications in vast variety of fields. X-ray Diffraction Spectrometry (XRD) and Fourier Transform- Infrared Spectroscopy (FT-IR) analysis showed that MMT contains impurities such as calcite, humic acids, and quarts in addition to the presence of characteristics functional groups Si-O, Al-OH and Si-O-Al as the major constituents. Therefore, the clay was purified prior to use as a catalyst. Azo dyes are made by diazotization of a primary aromatic amine followed by coupling with an electron rich coupling agent. This work describes the facile and modified synthesis of 5-phenylazo salicylic acid azo dyes without using conventional acid or base in the presence of montmorillonite clays. Diazotization and diazo coupling reaction of benzene diazonium salt with salicylic acid were performed over ecofriendly clay catalysts. The diazonium salt intercalated activated montmorillonite and 5-phenylazo salicylic acid intercalated activated montmorillonite were characterized using FT-IR and UV- Visible Spectroscopy. The FTIR data confirmed that the products are associated with characteristic functional groups of -N=N-, aromatic C-H & C=H, phenolic O-H, C-O & C=O groups. The –N=N- vibration appeared at 1523 cm^{-1} and vibration bands at 3020-3040 cm^{-1} correspond to vibration of aromatic C-H bonds. Phenolic O-H vibrations appeared at 3450 cm^{-1}. Further, FTIR data supported for the confirmation of the presence of C=O (COO-) as asymmetric and symmetric stretching at 1652-1670 cm^{-1} and 1386 cm^{-1} respectively. After two consecutive cycles of the diazotization followed by diazo coupling the product was extracted from the catalyst to acetone. Diazotization followed by coupling was performed on the same catalyst and showed the ability of the montmorillonite catalyst to be used repeatedly. Conventionally, the amount of mineral acid required for the preparation of azo-dye would be thrice the amount of reactants. This study showed that the montmorillonite catalyst could avoid the utility of mineral acid making the process environmentally benign.

Keywords: Montmorillonite, Diazotization, Diazo-coupling, 5-Phenylazo, Salicylic Acid, Green Chemistry

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COMPUTING

Developing a Novel Method to Map Proteins Identified by NGS, to Signalling Pathways

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For better understanding of complex conditions in biological systems, it is important to determine the sequence of nucleotides and the variations they show while responding to those conditions. The process of determining the sequence of nucleotides is called RNA/DNA sequencing. The most recent set of DNA sequencing technologies are collectively referred to as Next Generation Sequencing (NGS). This research was conducted to map the up or down regulated genes found in NGS to their representative signalling pathways, once the differential expression patterns are determined in different experimental conditions. Data was collected using KEGG (Kyoto Encyclopaedia of Genes and Genomes) Database. It is a collection of databases dealing with genomes, biological pathways, diseases, drugs, and chemical substances. It is utilized for bioinformatics research and education. KEGG API was used to access the signalling pathway's data programmatically. KEGG API (Application Programming Interface) allows us to customize KEGG-based analysis, such as searching and computing biochemical pathways in cellular processes or analysing the universe of genes in the completely sequenced genomes. KGML files of signalling pathways enable automatic drawing of KEGG pathways and provide facilities for computational analysis and modelling of gene/protein networks and chemical networks through KEGG API. XML files of signalling Pathways were collected using KEGG API. An R program was developed for data extraction from the XMLs, and save them in the database. Once the differential expression patterns are determined, signal pathways in which these proteins are involved were analysed by linking those databases, and P value of ultra-geometric distribution was counted. The mutuality of pathways and proteins were affirmed based on these results.

Keywords: Next generation sequencing, Kyoto encyclopaedia of genes and genomes, Signalling pathways

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Game Based Learning as an E-learning Strategy in Programming Education for School Children

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Learning the syntax and understanding the basic concepts have been identified as the most difficult aspects in the learning of computer programming. The Digital Game Based Learning approach has gained successful outcomes at several studies attached with programming and other subjects. In order to overcome the problems owing to the examination minded competitive classrooms, lack of computer facilities and insufficient time for practical sessions, the Game Based Learning approach is considered the best way of studying computer programming in Sri Lankan context. Thus, this study was conducted to assess the effectiveness and motivational appeal of a computer game for learning programming concepts within context of Sri Lankan schools. This study demonstrates a Game Based Learning (GBL) approach applied in a collaborative E-learning environment to motivate students in learning programming languages and to enhance their programming skills. Primary data was collected using subject evaluation questionnaires, interviews with students and teachers who are involved in learning and teaching programming languages at three different schools. In this experimental study an educational game was mapped with the basic programming concepts in which the students were guided by each game level to understand programming concepts by playing a game. The core study was conducted as illustrative case studies employing Information and Communication Technology (ICT) students in three different schools in different areas of the country. The students' performance was recorded and observed before and after the application of Game Based Learning approach. Summative evaluation of the results suggests that Educational Games can be utilized as an effective and motivational learning tool. The recommendation is to blend the Game Based Learning approach as a supplementary learning and teaching material to the conventional instructional designs in computer programming education. This study contributes to the use of Educational Games for current development of innovative pedagogies in teaching and learning.

Keywords: Game Based Learning, Educational games, E-learning strategy

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Prediction of Academic Performance of Undergraduate Students Based on Psychological and Social Well-being

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Prediction of academic performance of undergraduates can provide a good idea of what a student will be able to achieve later in life. If we could ensure that the undergraduates receive the proper care and guidance during their academic years, it would help them pursue a successful career later. Measuring the ability of undergraduates to perform better in academic activities is a challenging process since it depends on diverse factors like social and psychological well-being. The traditional teaching environment has limited resources to identify those factors and the students who need additional teaching support. This research suggests a personalized tool to predict the academic performance considering the social and psychological well-being of the students using machine learning techniques. The undergraduates are failing to reap full benefits, even with a proper education system, because of the different factors they face during the academic years. The proposed research directs towards this particular problem of achieving educational success in undergraduate level. The scope of this research is to find out the best predictive analytical solution for prediction of academic performance, based on social and psychological well-being of the undergraduates and to motivate them towards better academic performance. The research used cloud-based machine learning platform using Microsoft Azure to analyse data and create the predictive model. The Study demonstrated capability of using processing power and scalability of cloud computing. At the end of the research, a web service has been developed using an Application Programming Interface on Microsoft Azure for the undergraduates to practically use the model as a predictive application.

Keywords: Academic performance, Machine learning, Microsoft Azure, Predictive model

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Li-Fi Based Indoor Object Localization and Authentication Protocol

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Li-Fi (light fidelity) utilizes the visible light spectrum for data communication. But visible light signals cannot penetrate through walls and the same barrier has been used to develop location based applications. GPS can be used for localization but it cannot be used indoors. Wi-Fi technology can be used for indoor localization. Although low-cost, it offers lower accuracy, and complex multi-path cancellation techniques are required to improve the accuracy. Visible Light Communication (VLC) is a promising technology that can be used for accurate indoor localization. Though VLC enabled light sources have developed as transmitters, incorporating receiver's capabilities are still under research. If the light source can receive data it can be used for more secure data transmission such as authenticating the device before sending data. Therefore, this research aims at developing a bi-directional communication link using Li-Fi technology and use it for indoor object localization and authentication. Once this is successful, it can be used for applications like checking the availability of an object/person in a given location without moving physically or transferring secure data to a person in a given location. Although Li-Fi is said to be a promising technology for wireless communication since visible light cannot penetrate through walls, mobile data access needs replacement of all the LEDs with Li-Fi enabled LEDs and sophisticated communication hand over mechanism, which is not within the scope of this research, as we are considering only on location-based service. Literature reveals that multitudes of research work has been carried out to design VLC systems and most of them have successfully completed downlink communication but uplink communication is still under research. The limitations in VLC has been used in a beneficial way to implement the secure location based communication. Although many applications possible with VLC has been identified, less real implementations are available. VLC enabled light source can transmit and receive Li-Fi signals and new USB modules have been designed to be connected to laptops. Downlink communication is through visible light and uplink communication uses Infra-Red (IR) signals to avoid signal jams. This protocol is using Elliptic Curve Diffie Hellman for secure data communication. It can be concluded that VLC based bi-directional channel developed in this research can be used for location based secure data communication. This paper presents only a proof of concept implementation and therefore future researchers can focus more on reducing the line of sight requirement by improving the sensitivity of devices and developing a low-cost sustainable solution.

Keywords: Visible light communication (VLC), Elliptic Curve Diffie Hellman, Li-Fi (light fidelity)

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Augmented Reality Based Interactive Learning Mobile Application for Children to Overcome Boredom in Classroom

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Children often get distracted in their learning environment. Therefore, it's important for teachers to use different interactive methods to keep the attention of the child on the lesson. This study aims to develop an Augmented Reality (AR) based mobile application that increases the interaction of the primary level students with the lesson while reducing their boredom in classroom. Rapid development of technology has improved teaching and learning process by enabling us to combine technology with education. Augmented Reality is an emerging technology that has the capability to combine virtual objects with the real world. Using AR technology we can create applications that allow us to connect and engage with lessons in a more interactive way.The application was developed by first identifying the interactive teaching methods. Then the techniques of combining AR with the above methods were identified. Then the application was developed. The developed application enables children to interact using both on-screen and physical objects. The real world objects have unique printed markers which can be recognized by the application through device's camera. If the marker detected by the camera has a mapping for a predefined 3D object, that 3D object will be displayed on the device's screen. A feature available in the application is the ability to solve simple mathematical equations using physical objects and getting a response from the application indicating whether the solution is correct or incorrect. Another feature that the developed application has is the ability to view 3D models and animations of 2D images which are relevant to the lessons. The proposed solution can be further improved to increase learning performance of secondary level and undergraduate students.

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Robot Controlling Application to Efficiently Arrange the Objects on Table and Stack Objects in Right Sequence

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Clean and clear surrounding is one of the main valid components that helps to maintain good physical and mental health throughout the human history. It has been one of the concrete factors that directly influenced on every achievement in various disciplines. Acquiring the awareness about benefits of tidiness since the very first stage of the life, helped humans achieves a tremendous development as a species. It has been revealed that maintaining the tidiness improves the work efficiency in an office environment through many studies. To obtain the tidiness of a workspace there are a number of conventional methods, which involve a considerable amount of time and manual labour. Practicing a scientific approach to obtain a tidy workspace can address many drawbacks of a conventional method. Moreover, an optimized solution for maintaining the tidiness in the office environment is hard to achieve by following the conventional practice. In this scenario, using AI and robotic manipulators can become handy specially in optimizing space and time. Application of robotic manipulators and AI to efficiently arrange the objects in a workspace and stack objects in right sequence has been implemented in this study as a proof of concept. The robotic application can detect the objects on the table, identify them and able to place them in a location, so that the workspace becomes more organized compared to the previous step. Furthermore, this application consists of four major implantation components, namely, Robot arm, Power supply, Camera, and microcontroller. The object detection algorithm is used to detect objects on the table using the camera. The coordinate conversion component is able to convert image pixel coordinates into real-world coordinates and the objects can be identified using trained TensorFlow object identification model. Once the coordinates of the location are provided, inverse kinematics is used to operate the robot arm. Finally, a robot arm which consists of four servo motors picks a given item and places improving the tidiness of the workspace.

Keywords: Tidiness, Object detection, Object identification, Robot arm, Inverse kinematics

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Approach for Automatic Labelling of Segmented Coronary Artery Vasculature

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According to the WHO statistics the most common form of heart disease which causes 34% of deaths in Sri Lanka is Coronary Artery Disease. The standard diagnostic tool for Coronary Artery Disease is Coronary Angiogram, also referred to as Cardiac Catheterization. It is a minimal invasive medical imaging technique. This procedure is performed in a special catheterization laboratory. First, the catheter is inserted through a small incision made in the lateral groin area of the patient. After the radiopaque medium has been injected into the catheter, the x-ray images are acquired by a fluorescent screen. These angiogram images have many flows. Despite all, it has been found that arterial overlaps are more common on angiogram images. Therefore, Images have to be taken from different angles and it takes time to find the best view. In such cases manual identification of arteries is difficult and error prone. The proposed method consists of an algorithm to track and label coronary artery vasculature. The segmented image is used as the input image. Pre-processing techniques were applied to the segmented image to obtain a one-pixel skeleton of the arterial network. Then the tracking algorithm is applied to track and label the main coronary arteries. Ground truth images are used to validate the tracked samples. The main objective of this study is to provide an acceptable visualization of the artery network and to label them. In addition, this study can be extended into a real time tracking and labelling system for coronary arteries.

Keywords: Coronary artery tracking, Artery labelling

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HEALTH PROMOTION

Health Promotion Approach in Addressing Selected Determinants of Bullying Behaviours at a Rural School Setting: A Quasi Experimental Study

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Bullying at schools is a major public health problem, which causes detrimental impacts on the overall wellbeing of students. The role of students in addressing determinants has to be improved as they are the people who are affected and involved in bullying. However, little is known about bullying in rural schools and assessments on the effectiveness of interventions that have been led by school community to reduce bullying at schools are scarce. Therefore, the main objective of this study was to evaluate the effectiveness of health promotion approach in identifying and addressing the determinants of bullying behaviours among grade 09 students in a rural school setting in Anuradhapura district. A quasi experimental study was conducted with 68 students in the Intervention Group (IG) and 56 students from the Control Group (CG) studying in grade 09. Two separate self-administered questionnaires for students and teachers were used to assess their level of knowledge, attitudes and responses regarding bullying behaviours, before and after the intervention. The health promotion intervention was carried out only with the IG through interactive discussions while identifying the most important and more changeable determinants that affect for bullying. Simple and cost-effective activities were developed together with students to address the selected determinants of bullying. Students implemented activities to change those determinants and measured the progress of the process using simple indicators developed by them. The determinants prioritized to be changed by students were "Lack of harmony among students", "Most of the time students are being in angry moods", "Poor knowledge of students about the scope of harms of bullying", "Accepting bullying as a heroic act" and "Poor responses of students towards bullying". Intervention was able to improve harmony among students through increasing the level of helping each other in academics by 4.4%, helping each other in troubles by 5.8%, listening to each other's problems by 5.9%, helping each other in illnesses by 13.3% and concerning on friends' tidiness by 16.2% in IG, showing significant change ($p<0.05$), only in the category of caring about tidiness of each other, while none of such improvements was observed in CG. After the intervention, the percentage of students in IG, who believed that there are harms on both victims and bullies due to bullying, was increased significantly ($p<0.001$)than CG. After the intervention, none of the students in the IG believed that bullying can be used as a method to become a hero (Before the intervention, it was 13.2%). The response of hitting back the bully was significantly reduced by 23.5% and the response of telling someone about bullying was increased by 11.8% in IG, after the intervention. Within 03 months, health promotion intervention was able to significantly reduce the percentage of students who faced bullying at Thammannawa Welusumana Maha Vidyalaya during the past 30 days (by 33.8 %, $p<0.001$),with compared to CG and improved the role of students in addressing the determinants affect for bullying through simple measures. More importantly, giving the ownership of the process to students has led to gradual and significant changes in the process of reducing bullying at rural school.

Keywords: Bullying, Rural-schools, Determinants, Health-Promotion, Effectiveness

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Effectiveness of a Health Promotion Intervention in Changing Determinants of Adolescent Mental Wellbeing in Selected Schools in Gampaha District: a Quasi-Experimental Study

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Mental wellbeing plays a key role in the overall development of the wellbeing of adolescents. Determinants such as violence, bullying, substance abuse, excessive use of mass media and private supplementary tutoring negatively influence on adolescent mental wellbeing which results inirritability, mood swings, and problematic behaviors. This study aims to assess the effectiveness of a health promotion intervention to change major determinants of mental wellbeing among school-going adolescents in Gampaha District. A quasi-experimental study with a control group and pre and post assessment was conducted with Students in grade 8 and 9 who were sampled through multistage sampling. Study was conducted under three phases. Data were collected using mixed methods in pre and post phases. Quantitative data collection method was using a pretested self-administered questionnaire. Qualitative data collection methods were Focus group Discussions and unstructured observation. Intervention period was 3-months. The intervention consisted of a sequence of interactions linked to each other and developed based on health promotion principles. The major activities of the intervention focused on improving knowledge on adolescent mental wellbeing and major determinants. Then by increasing their enthusiasm to engage with health promotion activities, students were facilitated to develop determinant web for adolescent mental wellbeing and mutually prioritized determinants to address through specific activities. Students were also facilitated to develop tools to record their activities, to assess changes and identify obstacles. Activities were modified accordingly to address them. Steps to ensure the continuation of process was taken. Descriptive statistics were used to summarise and compare the socio-demographic characteristics of the groups. Pearson chi-square test was used to test the association between frequencies and level of significance. SPSS version software 25 was used as the analysis tool. Qualitative data were thematically analyzed and presented under sub-themes and themes. Prior, informed, written assent and consent were obtained from participants. This study proposal was approved from the ethics review committee of Faculty of Applied Sciences of Rajarata University. There were 193 and 201 adolescents in grade 8 and 9 in the intervention and control group respectively. There were no differences in terms of socio-demographic characteristics between groups prior to the intervention. Improvement in knowledge on consequences and determinant identification related to major determinants were statistically significant ($p<0.001$) between groups. Positive attitudes related to major determinants showed a statistically significant change into negative attitudes ($p < 0.001$). Practices related to major determinants also showed a significant change ($p < 0.001$), except for attendance to private supplementary tutoring. Qualitative analysis showed changes under themes such as peer influence, misconceptions among adolescents and features of community empowerment among students. Unexpected changes on themes such as positive image on love affairs among students, positive image on expensive fashion trends showed a positive change. The health promotion intervention which was delivered to adolescents in grade 8 and grade 9 in a school setting was effective in changing knowledge, attitudes and behaviours in relation to adolescent mental wellbeing and major determinants. This intervention should be scaled up and embedded to school health progamme to improve adolescent mental wellbeing.

Keywords: Adolescents, Mental wellbeing, School based interventions, Health promotion intervention, Gampaha district
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Effectiveness of a Health Promotion Intervention in Addressing Determinants of Tobacco and Alcohol Consuming Culture among Workers in a Constructing Site at Mahakanadarawa

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Construction industry is one of the stable growing industries in the world where the work consists of hard physical and often under difficult conditions like adverse weather conditions. It is considered as a hazardous industry in both developed and developing countries. Due to all these factors, construction workers are more likely to smoke than the general people. Also drinking alcohol is a social norm within site workers and intoxication is accepted among them. This study aimed to address determinants that contribute to increase and maintain tobacco and alcohol usage among construction workers as a group and change "*users' group culture*". Study was conducted at a selected site in Mahakanadarawa, Mihintale where the sample comprised of 48 workers. Base line data were collected by interviewer administered questionnaire. Community based health promotion intervention was conducted. *"Users' group culture changing"* was established as a core of the intervention. Workers planned and implemented the intervention to address determinants affecting their usage through the researcher's facilitation. Discussions were the main intervention and video clips, creative tools, presentations and posters were used to facilitate the discussions. Post intervention data were collected through audio recordings and data were entered to questionnaires on same day. Changes were assessed through same questionnaire which was used for pre evaluation data collection and focus group discussions. Quantitative and qualitative data were gathered and analysed accordingly. SPSS version 22 was used to analyse the quantitative data and thematic analysis was used to analyse qualitative data. Peer forcing, having parties at night, force to drink within the group, use because of the necessity of few members and availability were identified as determinants for their usage by themselves. Percentage of daily smokers dropped from 34.2% to 17.8%. Average number of cigarette sticks smoked per day, dropped from 4 to 1. Weekly usage of alcohol was reduced from 27.4% to 8.2%. Overall public smoking at the site was reduced 28.8% to 5.5%. Public alcohol usage in the site was reduced 4.2% to 0%. Awareness on disease caused by smoking and awareness on industrial strategies improved significantly (p<0.001). Level of happiness due to smoking, at the time of alcohol use and after (30-60) min of alcohol use were reduced significantly (p<0.001). Additionally, attraction towards smoking (p< 0.034) and alcohol usage was reduced from moderate (0) to (-10) among 72.9% and 79.2% of workers. As qualitative changes of *'group culture'* there were improvements in reduction of peers who force to drink others (n=21), workers started to save money (n=10), workers started to use alcohol to the amount they want (n=15). Health promotion approach is effective to 'change users' group culture' as workers were empowered to identify and address the determinants of their usage by themselves, measuring changes of their using group and the process was developed naturally through a participatory approach.

Keywords: Tobacco, Construction workers, Intervention, Determinants, Culture

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Reducing Substance Promotion Among Youths Through Social Media: A Health Promotion Study of University Students in Rajarata University of Sri Lanka

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Social media provide a wide forum to promote substances such as tobacco, alcohol, heroin, and cannabis. Young people are more vulnerable to substance promotional activities that happen through social media as they are more active within the social media networks. Globally, the most commonly used social media is Facebook and 86.07% of social media users engage with Facebook in Sri Lanka according to the global status report 2018. Although there are different approaches to address the extensive use of social media to promote substances, there is no health promotion approach implemented within the online community. The purpose of this study was to evaluate the effectiveness of health promotion approach designed to improve the ability of young groups to deglamourize promotion of substances within social media platforms by changing the associated knowledge, attitudes and behaviours related to substance promotion. The quasi-experimental study was used with a control group. The sample comprised of 97 students from the Faculty of Applied Sciences which was selected as the intervention group and 82 students from Faculty of Agriculture which was selected as the control group. Participants were recruited to six messenger groups according to academic year and separately based on the gender. Online discussions were conducted with participants and determinants were identified and prioritized with them during the discussions. The identified determinants were the "trends to share promotions on substance use", "attractiveness given to the substance use", "lack of knowledge and awareness that social media promotes substance use", "strategies used by commercial groups and industry to promote substance through social media and the being a substances user." Their understanding on determinants was broaden using online discussions and interventions were developed with the students to address selected determinants. The understanding improved on the commercial and industrial influences on substance promotion, the attractive image created for substance use within social media and the short term and long term hams of substance use. In terms of results, the knowledge, attitudes, and behaviours related to substance promotion was improved significantly within the intervention period of 14 weeks. Behaviours related to social media such as liking, sharing, ignoring, disliking and reporting were significantly changed among the participants in the intervention group ($p < 0.001$). After the intervention ,30.9 % of students in the intervention group started to respond with angry mood for the substance promotion posts when they observe substance promotion posts and started to share posts to counteract or deglamourize substance use. Students were empowered to initiate a Facebook page to deglamourize substance promotion through social media. The evaluations conducted prior and after the intervention suggested that the health promotion intervention is effective in reducing substance promotion activities among students in intervention group and improving their ability of deglamourizing substances promotion.

Keywords: Substance- promotion, Social -media, De-glamorization, University- students, Determinants

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Effectiveness of a Health Promotion Intervention in Improving Academic Engagement Among Schooling Adolescents in Grade 6 to 8 in Selected Schools in Kandy District: a Quasi-Experimental Study
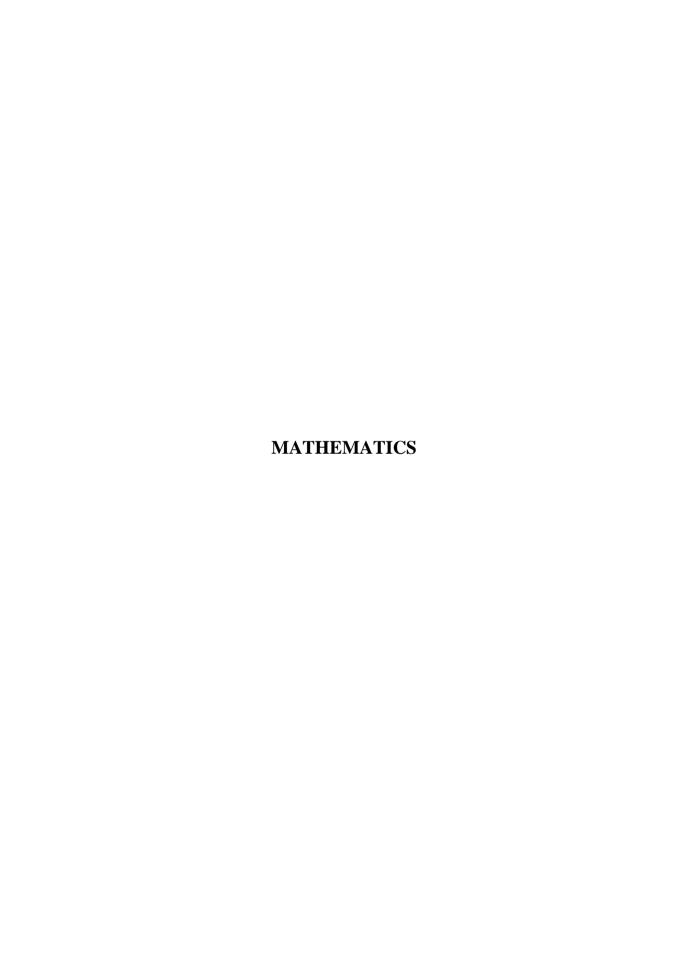
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Academic engagement can be defined as a combination of improved level of active participation, investment and commitment of students towards academic endeavors. High academic engagement acts as a nurturing factor for positive psychosocial and cognitive development during adolescence and its positive consequences last throughout the life course. Investing in improving academic engagement among adolescents is vital due to its considerable level of health and psychosocial impacts on life. But utilization of health promotion approach is scares in both globally and locally in this regard. This study was conducted to fulfil this gap with the aim of evaluating the effectiveness of a health promotion intervention in improving academic engagement among schooling adolescents in grade 6, 7 and 8 in selected schools in Kandy district, Sri Lanka. Study was a quasi-experimental study. Two schools as intervention group and one as the control group were selected. Both male and female schooling adolescents in grade 6, 7 and 8 were considered as the study population. Multi staged cluster sampling method was used to select the sample. A total 534 students were selected as the sample for the study. Pre assessment was conducted with both groups using pre tested self-administered questionnaire prior to the health promotion intervention. Then a health promotion intervention was developed with the intervention group. Determinants of poor academic engagement were identified and prioritized with them and collective activities were developed and carried out to address those. Progress of the intervention was monitored by both the principal researcher and study participants. Post data collection was conducted using self-administered questionnaire, focus group discussions, and recordings of statements of students. Quantitative data were analyzed using inferential and descriptive statistics. Significance of those changes were assessed between intervention and the control group. Qualitative data were analyzed using thematic analysis based on a manual coding system. In terms of results, seven determinants of poor academic engagement were prioritized by study participants including poor peer support for the academic work, not having a supportive physical environment in the class, addiction to the television, not practicing interesting methods for academic work, lack of active participation during lessons, lack of collective efforts towards academic work and lack of happiness among students. After the intervention, selected practices related to active participation in academic endeavors and academic related autonomy has been significantly improved among students in the intervention group (P<0.001). Selected practices of disruptive behaviors during academic endeavors has been significantly reduced (P<0.001). Selected behaviors of peer relationships also significantly changed into academically supportive way (P<0.001). Positive attitudinal change was observed in intervention group towards engaging with disruptive behaviors, media influences and having personal goals. After the intervention, intervention group showed improved resistance towards disruptive behaviors of their classmates. Students showed an improved immunity towards negative media influences as well. According to findings of the study, Health promotion intervention which was conducted under this study is effective in changing knowledge, attitudes and selected behaviors related to academic engagement among school going adolescents.

Keywords: Academic- Engagement, Health-Promotion, Adolescents, Determinants, Effectiveness

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MATHEMATICS

An Application of Queuing Theory to Minimize the Traffic Congestion

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Traffic congestion on roads in many urban areas is a widely growing problem in Sri Lanka. It increases the time of travel and transportation. Since vehicles take much time to travel on roads, the usage of fuel is increasing and causing various environmental issues. The traffic flow prediction is a difficult task due to several reasons such as sudden incidents and the variation of traffic flow over time etc. Otherwise, the normal traffic flow can be predicted by studying historical traffic data.

In this study we identified four major types of different queuing models such as (M/ M /1) :(∞/∞/FIFO), (M/ M /1):(N/∞/FIFO), (M/ M /P):(∞/∞/FIFO) and (M/ M /P):(N/∞/FIFO). These four models have Poisson arrivals and Poisson Departures with single service channels for first and second model and multiple service channels for third and fourth models. In the first and third models the queue has infinite capacity and in the second model and fourth models it has finite value for the System capacity. High Level- Base Line junction was selected for the study, which is situated in Colombo district of Sri Lanka and consists of the roads from Colombo, Narahenpita, Nugegoda and Robert Gunawardane road towards the junction and the roads towards Colombo, Narahenpita and Nugegoda from the junction. The number of arrivals and departures of the vehicles was obtained and using them, the arrival and the service rates were calculated. As observed, this junction acts as a single service station and the area of a vehicle is negligible compared to the area of the road system. Then the service rate and arrival rate were calculated and since service rate is less than the arrival rate, it was determined that the existing road system is not stable. Then, assuming that the road capacity is increased, and same calculation process was carried out using increased service rates, and as a result, the system becomes stable. Then (M/ M /1): (∞/∞/FIFO) queuing model was selected and by applying the calculated values for the arrival rate and the service rate, the mean number of customers in the queue, mean number of customers in the system, mean time spend in the queue and mean time spent in the system were calculated for all stable queues. Then it could be concluded that, in order to minimize the traffic congestion at the selected junction, an extra lane should be added to the above mentioned roads except the roads from Narahenpita and towards Narahenpita.

Keywords: Traffic congestion, Waiting time, Queuing theory, First In First Out (FIFO), Poisson process

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Diabetes Model Comparison and Simulation Towards Performance Analysis

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Today, Diabetes is a disease of many people without age limit. In this study, different mathematical models in the literature which were developed for diabetics have been analyzed. All the undertaken models are formulated considering the equilibrium levels of Glucose, Insulin, Hormone and Epinephrine. The model equations have been formulated to describe the performance of Blood Glucose Regulatory System (BGRS) during Glucose Tolerance Test (GTT) and their solutions. The solutions have been analyzed for equilibrium and stability provide the blood glucose concentrations for diabetics. This provides a better knowledge about the mathematical models on diabetes. Models consist in the form of first order linear differential equations where parameters are unknown. Estimating of this parameter is the main aim of this study and analysis the performance of different models using numerical simulations. The related patient data associated with Glucose Tolerance Test (GTT) have been taken from standard literature. They were used to fit the model parameters and the simulations are designed by using Euler method and Runge-Kutta methods. As the simulation software, MATLAB computational environment has been used. The results show that the model is capable of describing the observed stability for diabetes patients and as such used to simulate behavior under the experimental conditions. Those models obtained relatively good fit for the insulin plasma sub model on most patients. Further, different models are performed differently under various circumstances. According to model results , we conclude that the estimated parameters give a good indicator of diabetes.

Keywords: System of linear differential equations, MATLAB, Diabetes, GTT, Stability, Runge-Kutta methods, Eigenvalues

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Monitoring Network Traffic Based on Queuing Theory

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This study was to develop a Queuing model to analyse the network traffic in a computer network, based on Queuing Theory. In this particular case, the queuing model (M/M/1): ((C+1)/FCFS) was applied, assuming that the arrival process and service process demonstrate a Poisson distribution and an Exponential distribution respectively. The data packet transferring process in the computer network was also assumed to be a Markov process. The developed model was applied to an existing computer network system and important variables such as waiting time, processing time, etc., related to computer network traffic were monitored. The network congestion rate of this study is approximately equal to 1 and the packet loss rate is of 0.05%, as obtained from this model. Therefore, with the results obtained we conclude that this model is inappropriate model for the network management. Further, this mode is also useful for network administrators when it comes to managing networks and for network designers when designing a network system.

Keywords: *Queuing theory, Packet loss rate, Congestion rate, Markov process*

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Quay Crane Scheduling Problem at Container Terminals to Minimize the Maximum Crane Working Time

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With the recent increase in ship size and number of containers, the development of Quay Crane Scheduling demands a need for new modelling approaches. This is the motivation for this paper which focuses on developing a new simple formula to solve the Quay Crane Scheduling Problem (QCSP). The purpose of this problem is to determine the sequence of unloading and loading operations for ships that will perform a certain number of quay cranes, thereby minimizing the completion time of the operations. This paper has proposed an integer programming model for reducing make span by minimizing the maximum work time of cranes, which has been validated through multiple test runs with different parameters. We let the objective function of the model to be the minimum of the maximum work time of a crane, and for constraints in this model, each bay is handled by one crane, number of bays to be handled by i^{th}crane, interference constraint it means two cranes cannot cross each other, and total number of bays to be worked in the vessel. As a conclusion, the second crane shows 46.05% accurate successful result and first and third cranes show 74.67% and 14.88% accurate unsuccessful results, but the complete process shows 5.56% of accurate successful result on proposed model. So, it can be concluded that the proposed solution is successful.

Keywords: Quay Crane Scheduling Problem (QCSP), Integer programming (IP), Container terminals

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Analysis of Inventory Management of the Company XYZ by Using the Economic Order Quantity Model Under Planned Stock-Out Situation for a Family of Items with Complete Backordering and Capital Constraint

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Economic Order Quantity (EOQ) model has been adopted successfully for many years, in many sectors of the economy. The classical EOQ model excludes the possibility of back-orders and the restriction on the average capital tied up with the inventories. Inappropriate or poor decisions related to the inventories will lead to unnecessary costs. Therefore, it is very important to manage inventories of the company in an effective and efficient way, in order to minimize the total inventory-related costs. In this study, two EOQ models under planned stock-out situation are developed, with and without a capital constraint in order to recommend the best inventory control model for the company XYZ. Those two EOQ models are developed with the assumption that all the shortages will be back-ordered (complete back-ordering) and that there will be no loss of sales. Demands which are forecasted using the Simple Moving Average Method and the Least Square Method are applied with the developed EOQ models, in order to determine the EOQ, the optimum percentage of back-orders and the total minimum inventory cost for a family of five items. The performances of the demand forecasting techniques were evaluated using the concept of Mean Average Deviation. By comparing the total inventory costs under different models, the results showed that the EOQ model under the planned stock-out situation with complete back-ordering and without a budget constraint gives the lowest value of minimum inventory cost for the company XYZ. Nevertheless, with the maximum available capital of the company, the company XYZ should utilize the EOQ model under the planned stock-out situation with complete back-ordering and capital constraint.

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Winner Predictor and Winning Strategy Generator for Indian Premier League

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This study provides an in-game prediction of winners of games played at Indian Premier League Cricket. For the analysis, data were collected from 2008 to 2014 for 308 games. Initially, several candidate features were identified, and LASSO feature selection method was then applied to identify the most significant set of features. Based on those significant features, three classification models were formed for the prediction using naïve Bayes, logistic regression and Support Vector Machines (SVM). According to the formed models, the eventual winner of a game is predicted at the end of the first innings and the accuracy of each model indicates the ratio between the number of correctly predicted instances and the total number of instances. The models showed accuracy levels of 72.53%, 63.74% and 70.33%, under the naïve Bayes, logistic regression and SVM respectively. Further, a strategy generator that assists the team that bats second to devise winning strategies, was also developed. An interactive web-based application has been developed to provide the predictions and to assist in decision making based on the generated winning strategies.

Keywords: Cricket, Feature extraction, LASSO, Naïve Bayes, Logistic regression

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Solving Method for Integer Interval Multi-Objective Transportation Problem

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The single-objective Transportation Problem is not adequate to handle real-life decision making problems owing to our present competitive market scenario. In this research, we investigate a fully integer interval multi objective transportation problem (FIIMOTP) and a fully fuzzy integer multi objective transportation problem (FFIMOTP). Then we present two solution approaches for solving the fully integer interval multi objective transportation problem and the fully fuzzy integer multi objective transportation problem. These methods are easy to handle and apply them for the studied problems of this research. Numerical examples are provided to validate these two approaches.

Keywords: Upper bound, Lower bound, Fully interval integer, Compromise optimal solution, Triangular fuzzy numbers.

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A Cobweb Algorithm for Attaining an Upper Bound on Minimal Transportation Problem with Varying Supplies and Demands
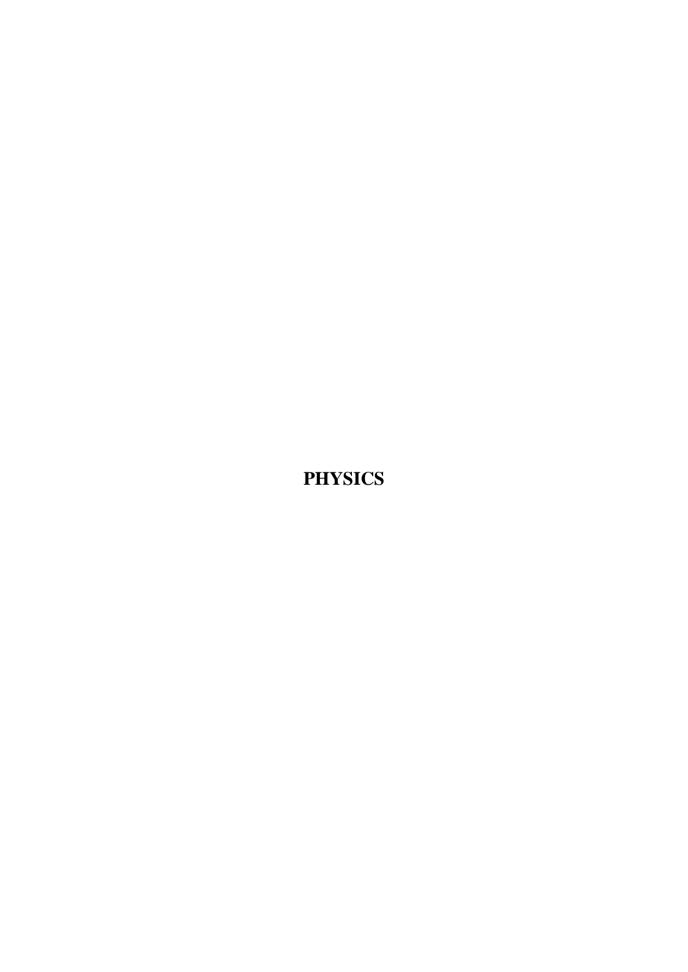
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This paper investigates the transportation problem (TP) when the demand and supply quantities are varying. Determination of the exact upper bound for this transportation problem with varying demands and supplies (TPVDS) is an NP-hard problem. There exist three heuristic solution approaches in the literature to find the exact or near-optimal upper bound on the minimal total cost of the TPVDS. This research project finds an easy-going alternative solution technique to attain an alternative upper bound solution to the TPVDS. Here, we introduce two new approaches, namely "Hybrid Cobweb Algorithm" and splitting algorithm (SA) for solving large sized and small sized instances respectively. It can easily be observed from the comparative study that both our SA and the recent approach provides the same upper bound solution to a set of small sized numerical instances. SA provides better upper bound solution to the other set of small sized ones compared to the very recent one. The recent approach gives a better solution to another set of small sized instances compared with SA. So, both our SA and recent approach can be considered better ones in solving small sized ones. However, our SA takes less average computational time compared to the recent one. Further, in case of large sized instances, although the recent finds 15.8% of improvement in the upper bound solutions over modification of our Hybrid Cobweb Algorithm reduces the solutions time by 99.95% compared to the recent one. Finally, it can be noted that solution time taken by Cobweb reduces with the problem sizes. That is, large sized one takes less time. Hence, for practitioners it is advisable to apply our Hybrid Cobweb algorithm for the large sized instances.

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PHYSICS

Measurement of Anisotropic Magnetoresistance, Giant Magnetoresistance and Exchange Bias of Magnetic Thin Films and Spin Valves Using a Home Made Setup

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Magnetoresistance can be defined as the dependence of a material's electrical resistance on an external magnetic field. Anisotropic Magnetoresistance (AMR) represents the dependence of resistance on magnetic field direction and can be observed in all the ferromagnetic materials. The giant magnetoresistance (GMR) is a special effect observed only in magnetic-nonmagnetic heterostructures known as spin valves. Invention of GMR leads to a remarkable expansion of magnetic storage capacity, making such materials a potential candidate for various applications. Exchange bias or exchange anisotropy is also an extremely important phenomenon used extensively in applications with AMR and GMR. Exchange bias is the shift of hysteresis loop of ferromagnetic materials once coupled with an antiferromagnetic material. This effect is widely used in magnetic storage devices to pin ferromagnetic layers. Thus, understanding the phenomenon of exchange bias is useful to increase the performance and efficiency in such devices. The objective of this research is to identify the magnetoresistive property, and the exchange bias effect of materials in the presence of an external magnetic field. This study was mainly based on developing an experimental setup and a program to measure above mentioned properties. The experimental setup was built using an electromagnet, bipolar power supply, 7.5 digit digital multimeter and an arbitrary waveform generator. The electrical resistance of different samples were measured using the digital multimeter while the magnetic field was varied using the bipolar power supply connected to the electromagnet. The data were simultaneously sent to a computer using Universal Serial Bus (USB) and the user interface was designed by the National Instrument LabVIEW software. The AMR, GMR and the exchange bias were successfully measured on several ferromagnetic samples and spin valves using this setup. Comparison of the obtained data with those in the literature exhibited similar behavior for all the materials and the spin valves tested. This suggests that the setup can be successfully used to measure the magnetoresistances of different materials and devices.

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Design and Build of a Low-Cost Metal Object Detecting Scanner Using Microcontrollers

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Metal detection is an important and commonly used technique in different industries. In addition to the detection, imaging is also required for numerous advanced applications. The imaging is usually done by a scanning process and the commercially available scanners are out of reach for most of the industries due to their high cost. In this study, a low-cost metal scanning system was designed and built to construct images of metal objects, which are covered by a layer of polymer. In the setup, an array of proximity sensors was mounted on a moving cart with 8mm distance from the metal object. Then the current was applied to the sensors and the outputs were connected to input channels of a microcontroller board (Arduino). Then the data were taken while the cart was moving on top of the polymer layer. The system generated variable voltages with the detection of the metal objects. The data generated by the sensor array was simultaneously sent to a computer through a Universal Serial Bus (USB) port. The interface was developed using CoolTerm and Arduino software. The data were simultaneously uploaded to the OriginPro software and the voltage was plotted as a function of time. Finally, a 2D grayscale contour plot was generated with the above data and the functionality of the setup was confirmed by detecting, scanning and constructing images of different metal objects with different shapes covered by the layer of polymer.

Keywords: Metal detection, Proximity sensor, Microcontroller

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