ASURS | 2023

Applied Sciences
Undergraduate Research Sessions

ABSTRACTS

Organized by

Faculty of Applied Sciences
Rajarata University of Sri Lanka

Applied Sciences Undergraduate Research Sessions

ASURS 2023

10th May 2023

Faculty of Applied Sciences
Rajarata University of Sri Lanka

Contents

Message from the Vice Chancellor

I am really happy to write this message for the Faculty of Applied Sciences' 5th Applied Sciences Undergraduate Research Sessions (ASURS). Undergraduate students present their research findings in the areas of biology, chemistry, computing, health promotion, mathematics, and physics during this event, which is a very noteworthy day in our university's academic calendar.

Universities play an important role in knowledge generation by conducting applied and pure science research and disseminating the results of that research. The development of research abilities in undergraduate students is an essential component of this. Despite the fact that very few students will pursue jobs in academia, hands-on research experience, particularly the abilities developed in developing and carrying out research investigations, data analysis, and writing and presenting research, are of tremendous value across a variety of sectors. The ability to solve problems, think creatively, and efficiently manage time, people, and resources are all considered to be part of what is meant by "research skills" in their broadest definition. Considering the variety of abilities required, having first-hand knowledge of "doing research" is unquestionably quite valuable.

I'd want to congratulate the students who will be giving presentations at ASURS 2023 as well as the faculty who have guided and helped them. Despite the many difficulties and problems that have faced the nation over the past few years, the effort and dedication of these young people and their supervisors have paid off. Congratulations and appreciation!

The Dean and Staff of the Faculty of Applied Sciences, as well as the organizing committee, are also to be thanked for putting this symposium together and making the day productive and interesting.

Professor (Mrs) G. A. S. Ginigaddara
Vice Chancellor
Rajarata University of Sri Lanka
Mihintale

Message from the Dean

I am delighted to write this message for the 5th Applied Science Undergraduate Research Symposium (ASURS) of the Faculty of Applied Sciences, Rajarata University of Sri Lanka.

This is an important day for the faculty because it marks the occasion when our undergraduate students present the results of the research they have carried out at a public forum. ASURS 2023 is especially significant because of the difficulties and challenges that both students and staff have had to overcome since the outset of the covid-19 pandemic in 2020. This year, 51 students will be giving oral presentations and 11 students will be presenting posters. For these students, ASURS 2023 will be a major milestone in their undergraduate career. These students will have the opportunity to share their findings and insights with experienced researchers from other institutions as well as our own university. They will also gain valuable feedback on their research and its presentation, and they will, no doubt, inspire both students and staff.

My congratulations and thanks to the students presenting at ASURS 2023 and to the staff who have supervised and supported them. I would also like to thank the evaluation panel and the reviewers for their vital contributions. The organizing committee, together with other members of the faculty and our nonacademic support staff have worked tirelessly to make this event a successful one—thank you to you all. Finally, my gratitude to the Vice Chancellor, Professor Sanjeewani Ginigaddara, for her generous support and encouragement.

My best wishes for a successful, fruitful and enjoyable symposium.

Professor E. M. R. K. B. Edirisinghe
Dean
Faculty of Applied Sciences
Rajarata University of Sri Lanka
Mihintale

Message from the Programme Chair

It is with great pleasure, I welcome you all to the Applied Sciences Undergraduate Research Sessions 2023 (ASURS 2023) to be held on 10 May 2023 at the Faculty of Applied Sciences, Rajarata University of Sri Lanka.

ASURS is an annual symposium organized by the faculty of Applied Sciences and aims to give undergraduates in the fields of Biology, Chemistry, Computing, Health Promotion, Mathematics and Physics a first-hand experience of a professional conference setting and the opportunity to present the findings of their research projects to an academic audience.

Sixty-two students from the five departments of the Faculty of Applied Sciences will present their research findings at ASURS 2023 and these studies represent new contributions to the respective disciplines. To promote scientific communication to non-specialist/popular audiences, this year's conference featured a 3MT competition, a format introduced by the University of Queensland, Australia. The 3MT competition was held as a pre-conference event on 21 April 2023 at the Faculty of Applied Sciences, and I am pleased to say that 31 science students presented their diverse research findings to a wide audience.

I thank the Chief Editor, Dr Dinazarde Raheem, and the editorial team, Mr P. S. Palliyaguruge, Dr Kaushlaya Premachandra, Dr Lalith Senarathna and Dr Suchithra Senevirathne, for their invaluable efforts in reviewing and editing the abstracts and abstract book. I am grateful to the organizing committee, Dr Uthpala Ekanayake, Dr Naleen Jayaratne, Mrs Prabuddhika Kandegedara, Mr Wiraj Wickramaarachchi and Dr Malaka Wijayasinghe, and symposium secretary, Mrs Ishantha Hewarathna, who did a tremendous amount of work to make ASURS 2023 a success. My thanks also to our sponsors, Bank of Ceylon, People's Bank, BaseHP (Pvt) Limited and the IEEE Student Branch of the Rajarata University of Sri Lanka, for providing the financial support required to hold this event on a grand scale.

I wish you a stimulating and memorable conference.

Dr K. A. S. H. Kulathilake
Programme Chair, ASURS 2023
Faculty of Applied Sciences
Rajarata University of Sri Lanka
Mihintale

Profile of the Keynote Speaker – Professor Anjana Silva
MBBS, M.Phil, PhD, FRCP Edin

Professor Anjana Silva graduated from the University of Peradeniya with an MBBS in 2007 and M.Phil in 2013. He obtained his PhD in toxinology at Monash University, Australia, in 2017 winning the Vice-Chancellor's award for thesis excellence. He was elected a Fellow of the Royal College of Physicians, Edinburgh, in 2020.

Professor Silva received the National Science Foundation and Third World Academy for Scientists' Award for the Best Young Researcher in 2013. He was selected as one of the 20 Global Young Physicians Leaders by the Intra-Academy Medical Panel in Berlin, Germany, in 2013. He received best researcher awards from all three major associations of clinical toxicologists in the world (European, North American and Asia-Pacific). He received the Health Research Prize from the Kandy Society of Medicine in 2019 and CVCD Excellence Award for the Most Outstanding Young Researcher in Medical, Dental, Veterinary and Health Sciences in 2020, both being once-in-lifetime awards. He has won six Presidential Awards for scientific publications.

Professor Silva started his research career as a young biodiversity researcher and an explorer during his undergraduate days. He contributed in discovery of 11 new species of freshwater fishes and reptiles to his credit. He is a world-renowned expert of snakebite and venom toxinology: investigating the how the snake venoms harm humans and the role of antivenom treatment. His research provided key evidence for improving the diagnosis to treatment of snakebite patients. He has authored 62 international publications and has 1,300 citations. His Google H-index is 23.

Professor Silva is currently the head of the Department of Parasitology, Faculty of Medicine and Allied Sciences, Rajarata University and an Adjunct Senior Research Fellow at Monash University. His research leadership led to the establishment of the Anuradhapura Snakebite Cohort in 2012, which is the world's largest such initiative and the country's only venom pharmacology lab at Rajarata University, facilitating seven ongoing M.Phil and PhD projects and one completed PhD.

Keynote Speech by Professor Anjana Silva: Four Pieces of Advice for Young Scientists (from a Former Young Scientist)

You and I are from science-based fields. The scientific method is the foundation for the wealth of knowledge in Western science. Sharing what you found in your research with other humans is a key step in the scientific method. However, we need transparency in sharing findings because it is important for others to fully understand how your research was designed, conducted and concluded, and to replicate your study. Unfortunately, many student projects in Sri Lanka end up as abstract presentations and not as full research papers. Having peer-reviewed journal articles during the undergraduate period is very important for shaping the future career path of a science student. **Therefore, my first advice is to publish full papers from your undergraduate research.**

We are in an era of a lot of scientific information as well as misinformation. A science graduate should be able to filter out what is science and what is pseudoscience. The number of scientific publications increases exponentially with the number of scientific papers published is doubled every nine years. This means we get unimaginable amounts of scientific information so fast, that we are simply unable to be updated with it. There are too many poorly designed, impossible-to-replicate, poorly peer-reviewed studies that include genuine human errors, falsified data, bias and inaccurate interpretation of data. A science graduate should be competent enough to read a research article, carefully analyse the content and come to his or her conclusion. **Therefore, my second piece of advice is to not believe everything published in science is divine truth.**

One of the biggest issues in our science education, from schools to universities, is that we do not encourage students to study the philosophy of science. Because of that, many believe in science like a religion, rather than understanding the limitations of the scientific method hence the limitations of the scientific conclusions. For example, developing a hypothesis and designing an experiment is based on current human knowledge, current observation methods and instruments, hence what is true now may not have been true in the past or the future. **Therefore, my third piece of advice is to understand the limitations of the scientific method and interpret scientific evidence accordingly.**

Science and technology change so fast, that we cannot even predict what the world will look like 20 years from now on. Now, no one can guarantee that the knowledge and skills current graduates possess at the time of graduation will have any demand after five years. Artificial intelligence is replacing humans in some fields rapidly. Fields that involve repetitive work will have fewer and fewer jobs for humans, while fields that need more human touch will have more opportunities. Yuval Noah Harari, in his bestseller book Homo deus states "…Traditionally, life has been divided into two main parts: a period of learning followed by a period of working. Very soon, this traditional model will become utterly obsolete, and the only way for humans to stay in the game will be to keep learning throughout their lives and to reinvent themselves repeatedly….." **So, my fourth piece of advice for young scientists is you all better be prepared for lifelong learning if you want to survive in science, or you will be outdated and useless very soon!**

Members of the Abstract Review Panel

Biology

Professor C. L. Abayasekera, Department of Botany, Faculty of Science, University of Peradeniya, Peradeniya

Professor T. M. W. J. Bandara, Department of Physics, Faculty of Science, University of Peradeniya, Peradeniya

Professor K. M. G. Gehan Jayasuriya, Department of Botany, Faculty of Science, University of Peradeniya, Peradeniya

Dr Shalika Kumburegama, Department of Zoology, Faculty of Science, University of Peradeniya, Peradeniya

Professor Sumedha Madawala, Department of Botany, Faculty of Science, University of Peradeniya, Peradeniya

Dr B. S. Nanayakkara, Department of Botany, Faculty of Science, University of Peradeniya, Peradeniya

Dr P. Subramanium, Environmental Technology Section, Industrial Technology Institute, Colombo

Dr Chaminda Wijesundara, Department of Zoology, Faculty of Science, University of Peradeniya, Peradeniya

Chemistry

Dr Tharani Dilshara, Department of Bio-Process Technology, Faculty of Technology Rajarata University of Sri Lanka, Mihintale

Dr H. A. N Dharmagunawardhane, Department of Materials Technology, Faculty of Technology, Rajarata University of Sri Lanka, Mihintale

Dr R K Ahinsa, Department of Food Technology, Faculty of Technology, Rajarata University of Sri Lanka, Mihintale

Dr W. M. Mithila D. Bandara, Department of Food Technology, Faculty of Technology, Rajarata University of Sri Lanka, Mihintale

Dr W. Perera, Panasonic Energy of North America, USA

Dr D. Siriwardena, Biologics, USA

Dr S. Alahakoon, Institute for Combinatorial Advanced Research & Education, General Sir John Kotelawala Defence University, Kandawala, Ratmalana, Colombo

Computing

Dr G. P. H. Kandambi, Department of Information Systems, Faculty of Management Studies, Rajarata University of Sri Lanka, Mihintale

Mr P. G. Munasinghe, Department of Information Systems, Faculty of Management Studies, Rajarata University of Sri Lanka, Mihintale

Dr H. M. B. P. Ranaweera, Department of Information Systems, Faculty of Management Studies, Rajarata University of Sri Lanka, Mihintale

Mr N. S. Weerakoon, Department of Computing, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale

Health Promotion

Dr P. H. G. J. Pushpakumara, Faculty of Medicine and Allied Sciences, Rajarata University of Sri Lanka, Saliyapura, Anuradhapura

Dr Y. P. J. N.Warnasekara, Faculty of Medicine and Allied Sciences, Faculty of Medicine and Allied Sciences, Rajarata University of Sri Lanka, Saliyapura, Anuradhapura

Dr Shobha Gunathilake, Faculty of Medicine and Allied Sciences, Faculty of Medicine and Allied Sciences, Rajarata University of Sri Lanka, Saliyapura, Anuradhapura

Mathematics and Physics

Mr R. N. B. Dissanayake, Department of Physical Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale

Dr N. T. S. G. Gamachchige, Department of Science & Technology, Faculty of Applied Sciences, Uva Wellassa University, Badulla.

Dr K. M. Nilan Manoj Chathuranga, Department of Mathematics, Faculty of Science, University of Peradeniya, Peradeniya

Dr L. S. Nawarathne, Department of Statistics & Computer Science, Faculty of Science, University of Peradeniya, Peradeniya

Dr P. L. A. Kasun Piyumal, Department of Physics and Electronics, University of Kelaniya, Kelaniya

Mrs D. S. Rodrigo, Department of Mathematics, Faculty of Applied Sciences, University of Sri Jayawardenepura, Gangodawila, Nugegoda

Dr Niluka Rodrigo, Department of Mathematics, Faculty of Science, University of Peradeniya, Peradeniya

Dr R. D. N. Thilakrathne, Department of Mathematics, Faculty of Science, University of Colombo, Colombo

Members of the Presentation Evaluation Panel

Biology

Professor K. M. G. Gehan Jayasuriya, Department of Botany, Faculty of Science, University of Peradeniya, Peradeniya

Dr Shalika Kumburegama, Department of Zoology, Faculty of Science, University of Peradeniya, Peradeniya

Dr K. R. E. Padmathilaka, Department of Plant Sciences, Faculty of Agriculture, Rajarata University of Sri Lanka, Puliyankulama

Dr A. Rathnayake, Faculty of Technology, Rajarata University of Sri Lanka, Mihintale

Chemistry

Dr H. A. N. Dharmagunawardhane, Department of Materials Technology, Faculty of Technology, Rajarata University of Sri Lanka, Mihintale

Dr R. K. Ahinsa, Department of Food Technology, Faculty of Technology, Rajarata University of Sri Lanka, Mihintale

Computing

Mr P. G. Munasinghe, Department of Information Systems, Faculty of Management Studies, Rajarata University of Sri Lanka, Mihintale

Dr H. M. B. P. Ranaweera, Department of Information Systems, Faculty of Management Studies, Rajarata University of Sri Lanka, Mihintale

Mr N. M. A. P. B. Nilwakka, Department of Computing, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale

Health Promotion

Professor N.K. Anjana Silva, Department of Parasitology, Faculty of Medicine, Rajarata University of Sri Lanka, Saliyapura, Anuradhapura

Dr Shobha Gunathilake, Senior Lecturer, Department of Microbiology, Faculty of Medicine, Rajarata University of Sri Lanka, Saliyapura, Anuradhapura

Dr D. Rathish, Senior Lecturer, Department of Family Medicine, Faculty of Medicine, Rajarata University of Sri Lanka, Saliyapura, Anuradhapura

Mathematics and Physics

Dr A. K. Amarasinghe, Department Mathematics, Faculty of Science, University of Peradeniya, Peradeniya

Dr D. M. M. B. Dehideniya, Department of Statistics and Computer Science, Faculty of Science,
University of Peradeniya, Peradeniya

Mr S. Kuhanesan, Department of Physical Science, Faculty of Applied Science, University of Vavuniya, Vavuniya

Dr Lakmal Jayarathne, National Institute of Fundamental Studies, Kandy

List of Abstracts

BIOLOGY

MARINE PHOTOSYNTHETIC MICROBIAL FUEL CELLS FOR ENHANCED RENEWABLE POWER PRODUCTION

IMPACTS OF ABIOTIC STRESSORS ON SEED GERMINATION AND EARLY SEEDLING TRAITS OF SONNERATIA CASEOLARIS

ISOLATION, IDENTIFICATION AND DETERMINATION OF COMPARATIVE RELEASE KINETICS OF PHOPHATE SOLUBILIZING BACTERIA AND FUNGI TO DISCOVER THEIR EFFECT ON VEGETATIVE GROWTH OF LACTUCA SATIVA AND ALLIUM CEPA

ANTIFUNGAL ACTIVITY OF HERBAL EXTRACTS AGAINST THE YEAST CANDIDA ALBICANS AND THE DERMATOPHYTE MICROSPORUM GYPSEUM AND THEIR POTENTIAL APPLICATIONS IN COSEMECEUTICALS

EVOLUTION IN MOUNTAINS: PATTERNS OF DIVERSIFICATION OF SRI LANKAN DAY GECKOES (CNEMASPIS)

DETERMINATION OF ANTIBACTERIAL PROPERTIES OF SECONDARY METABOLITES EXTRACTED FROM FUNGAL ENDOPHYTES ISOLATED FROM AZADIRACHTA INDICA AND RICINUS COMMUNIS AGAINST PECTOBACTERIUM CAROTOVORUM

QUANTIFICATION OF POTENTIAL CONTRIBUTION OF NITROGEN FIXING CYANOBACTERIAL BIOFERTILIZER FOR RICE (ORYZA SATIVA L.) IN THE DRY ZONE OF SRI LANKA

HABITAT PREFERENCES AND FORAGING BEHAVIOUR OF SELECTED BULBUL SPECIES IN TWO DIFFERENT LANDSCAPES WITHIN THE DRY ZONE OF SRI-LANKA

USE OF NANOMATERIALS-MODIFIED CARBON MICROFIBER ELECTRODE MATERIAL FOR SUPERIOR ELECTROCHEMICAL PERFORMANCE OF LAKE SEDIMENT INOCULATED MICROBIAL FUEL CELLS

INVESTIGATION ON ANTIMICROBIAL ACTIVITY OF SKIN SECRETIONS OF SELECTED FROG SPECIES IN SRI LANKA AGAINST FUNGAL AND BACTERIAL PATHOGENS OF HUMANS

ISOLATION AND CHARACTERIZATION OF POLYHYDROXYALKANOATE BIOPLASTIC PRODUCING BACTERIA FROM PUTREFIED RICE

DEEP LEARNING BASED SOLUTION FOR ANALYSIS OF BATTING STROKE TECHNIQUES OF CRICKET

FLOOD PREDICTION USING MACHINE LEARNING BASED ON METROLOGICAL AND TOPOGRAPHICAL FEATURES OF KALU GANGA RIVER BASIN, SRI LANKA

FAKE NEWS DETECTION APPROACH FOR SINHALA TWEETS

AN EFFICIENT BREAST CANCER DETECTION ALGORITHM BASED ON DEEP LEARNING

HEALTH PROMOTION

EFFECTIVENESS OF A HEALTH PROMOTION INTERVENTION TO IMPROVE ADOLESCENTS' PSYCHOSOCIAL WELLBEING IN THIRIWANEGAMA VILLAGE DURING THE ECONOMIC RECESSION IN THE POST-PEAK PERIOD OF COVID-19 PANDEMIC IN SRI LANKA

EFFECTIVENESS OF A HEALTH PROMOTION INTERVENTION IN REDUCING DIGITAL SCREEN USAGE OF CHILDREN AGED 3–5 YEARS BY IMPROVING KNOWLEDGE, ATTITUDES AND PRACTICES AMONG MOTHERS IN SELECTED PRESCHOOL SETTINGS IN THE MATALE DISTRICT

EFFECTIVENESS OF A HEALTH PROMOTION INTERVENTION ON IMPROVING WORK-LIFE BALANCE AMONG NURSES IN SELECTED HOSPITALS IN THE UVA PROVINCE: A QUASI-EXPERIMENTAL STUDY

EFFECTIVENESS OF A HEALTH PROMOTION INTERVENTION TO IMPROVE SOCIAL WELLBEING AMONG OLDER ADULTS IN "SAMAGI" ELDER SOCIETY, THARIYANKULAMA VILLAGE, ANURADHAPURA DISTRICT

EFFECTIVENESS OF A SCHOOL-BASED HEALTH PROMOTION INTERVENTION TO PROMOTE HOUSEHOLD MONEY MANAGEMENT BY TARGETING GRADE 09 STUDENTS OF THALDENA NATIONAL SCHOOL, BADULLA

MATHEMATICS

AN IMPROVEMENT TO THE INITIALLY BASIC FEASIBLE APPROACH TO THE TRANSPORTATION PROBLEM

A NEW FOURTH ORDER APPROXIMATION FOR ONE DIMENSIONAL DIFFUSION EQUATION

OFFLINE SIGNATURE VERIFICATION BY USING PROPER ORTHOGONAL DECOMPOSITION

PHYSICS

BIOLOGY

MARINE PHOTOSYNTHETIC MICROBIAL FUEL CELLS FOR ENHANCED RENEWABLE POWER PRODUCTION

B. R. C. M. Basnayaka* and E. Y. Fernando

Department of Biological Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
*asb1617007@as.rjt.ac.lk

Microbial fuel cells (MFCs) generate energy from biodegradable substances using microorganisms. They are used for wastewater treatment, remote sensing device operations and bioremediation. Because of the rapid ionic movements and superior electrical conductivity of seawater, it is a suitable electrolyte for operating bio-electrochemical devices. The anode compartment's mixed consortium of marine microorganisms can perform robust extracellular electron transfer. In conventional MFCs, the cathode has to be coated with an expensive noble metal to efficiently catalyze the oxygen reduction reaction (ORR) and it requires active aeration. Biofilm-forming marine photosynthetic microorganisms (MPMs) serve as electron donors and can replace the typical cathode catalyst in this marine photosynthetic MFC (mpMFC). This study examined the use of seawater as a conducting medium in a two-chambered MFC to enhance power production in conjunction with a marine photosynthetic bio-cathode as an alternative to the abiotic chemical cathode. Using a modified BG11 seawater medium, MPMs were effectively grown and maintained in the MFC cathode compartment. After a significant quantity of biomass had formed, it was prepared for use as an extracellular feeding substrate. The effectiveness of this marine MFC (mMFC) was evaluated in three phases:(1) before adding MPMs, (2) after adding MPMs and (3) while feeding ready-to-use substrate. Isolated MPM's were identified using 16s rRNA and Sanger DNA sequencing. Power-current plots and polarization curves were used to evaluate the efficiency of the MFC. For the mMFC, maximum power density (P_{max}) was 147.84 mW/m^2 and maximum current density (J_{max}) was 1311.82 mA/m^2. For the mpMFC, P_{max} was 104.48 mW/m^2 and J_{max} was 1107.27 mA/m^2. P_{max} was 53.14 mW/m^2 and J_{max} was 501.81 mA/m^2 in the freshwater MFC, which proves that mMFC & mpMFC worked better. *Dapis pleousa* and *Synechococcus moorigangaii* were identified as MPMs. We conclude that our mpMFC, which was fully driven by seawater along with a biocathode, produced one of the best electrochemical performances hitherto reported in the literature for a two-chambered MFC system.

Keywords: *Marine MFC, Renewable energy, Photosynthetic biocathode*

IMPACTS OF ABIOTIC STRESSORS ON SEED GERMINATION AND EARLY SEEDLING TRAITS OF *SONNERATIA CASEOLARIS*

P. D. N. Deepamali* and M. M. Wijayasinghe

Department of Biological Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
*nisansala.d21@gmail.com

Understanding the impact of abiotic factors on seed germination and early seedling development is critical for the successful restoration and management of mangroves. This study aimed to investigate the impacts of abiotic stressors on seed germination and early seedling traits of *Sonneratia caseolaris*, a true mangrove species from Sri Lanka. A standard germination test was carried out to ascertain the dormancy or non-dormancy of the seeds; this was done by treating seeds with Gibberellic acid (GA_3) and distilled water (DW) as the control. Seeds were exposed to different levels of salinity (0, 5, 10, 15, 20, 25, 30 and 35 ppt), osmotic potential (0, -0.1, -0.3, -0.5, -1.0, -1.5, -2.0 and -2.5 MPa) and light intensity (light, shade and dark), and for different durations of anoxic conditions (0, 1, 7, 14 and 30 days) at 30 °C in light (14h)/dark (10h) condition. Radicle emergence (seed germination) and subsequent cotyledon emergence (early seedlings) were recorded for each treatment. In addition, the first 10 seeds to show cotyledons in each treatment were selected for a study of early seedling traits (leaf width, leaf length, leaf surface area, shoot length, root length, shoot dry mass, root dry mass and amount of photosynthetic pigments in the cotyledons). Seeds germinated more than 80 % with DW or GA_3 treatments, indicating non-dormancy. However, GA_3 treatment did reduce mean germination time. While seed germination and cotyledon emergence percentages decreased significantly with increasing salinity, osmotic potential and prolonged anoxic conditions; a similar result was not obtained for increased levels of light intensity. Seed germination percentages were higher than cotyledon emergence percentages when salinity and osmotic potential was high and anoxic conditions were prolonged. While a similar result was not obtained for high light intensities, our results do suggest that a significant proportion of seeds cannot develop into healthy seedlings under stressed conditions. The measured early seedling traits performed well under low salinity, low osmotic potential and high light intensity. These traits performed significantly well in the 7-day anoxic treatment, indicating the potential for seeds to develop anoxic tolerance. We found that the study species can germinate and develop into a healthy seedling under different types and levels of abiotic stresses. Overall, the study provides valuable insights into the impacts of environmental stresses on seed germination and early seedling traits, and highlights the importance of having this information when developing strategies for the conservation and management of this species.

Keywords: *Anoxic condition, Gibberellic acid, Light intensity, Osmotic potential, Salinity*

ISOLATION, IDENTIFICATION AND DETERMINATION OF COMPARATIVE RELEASE KINETICS OF PHOPHATE SOLUBILIZING BACTERIA AND FUNGI TO DISCOVER THEIR EFFECT ON VEGETATIVE GROWTH OF *LACTUCA SATIVA* AND *ALLIUM CEPA*

O. N. Dissanayake* and P. N. Yapa

Department of Biological Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
*onashanirmanidissanayake@gmail.com

Phosphorus (P) holds a vital position in the growth and development of plants, being indispensable for energy transfer, DNA synthesis and cell division. Phosphorus deficiency can cause stunted growth, poor root development and reduced yields. To ensure healthy and robust plant growth, it is necessary to provide adequate amounts of P, which is an essential nutrient for agriculture and the global food supply. Phosphate solubilizing microorganisms (PSMs) have the potential to convert insoluble forms of P in the soil into plant-available forms, enhancing P uptake. Additionally, PSMs generate organic acids, enzymes and other metabolites that promote nutrient mobilization and plant growth, thereby reducing dependence on chemical fertilizers. In this study, four fungal and twelve bacterial strains were identified as PSMs capable of solubilizing both tricalcium phosphate and Randenigala rock phosphate. Plant height and dry mass are commonly used as key indicators of vegetative growth, a critical aspect of plant development. To assess vegetative growth, five different treatments were employed, including the application of isolated PSM strains. The substantially identified PSM strains were *Aspergillus* spp., *Penicillium* spp., *Bacillus* spp. and *Pseudomonas* spp. The pH levels of the PSM strains were significantly lower than the control, indicating the production of organic acids. The optimal pH for p-nitrophenol analysis was found to be 6.5 and the amount of p-nitrophenol released increased with longer incubation times. These PSMs effectively released soluble phosphates from organic substances in soil, with the b2 bacterial isolate releasing the largest amounts of p-nitrophenol (0.0004985 ± 7) after constant incubation for 4 hours. In comparison to the control and the other treatments, the rock phosphate + isolates treatment significantly increased ($P < 0.05$) both the height and dry mass of *Lactuca sativa* and *Allium cepa*.

Keywords: *Phosphate solubilizing microorganisms, P-nitrophenol phosphatase assay, Vegetative growth of plants, Randenigala rock phosphate*

ANTIFUNGAL ACTIVITY OF HERBAL EXTRACTS AGAINST THE YEAST *CANDIDA ALBICANS* AND THE DERMATOPHYTE *MICROSPORUM GYPSEUM* AND THEIR POTENTIAL APPLICATIONS IN COSEMECEUTICALS

C. P. S. Fernando* and S. Hettiarachi

Department of Biological Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
*csewwandi1997@gmail.com

Fungal infections are among the most challenging diseases to treat in humans and other animals. Eukaryotic fungal pathogens have many parallels with their host cells, making selective antifungal compound synthesis difficult. Also, multidrug resistance (MDR) phenotypes have been found for a number of pathogenic fungi, which may be a result of widely used medications having shared mechanisms of action. Fungal resistance depends on fungi employing various molecular mechanisms to counteract the inhibitory effects of the antifungal drugs. Investigation of the antifungal effects of different plant extracts, essential oils and herbal distillates is one possible avenue for developing antifungal drugs rich in pharmaceutical properties. In the present study, *in vitro* antifungal activity of twenty-six plant extracts, five essential oils and four herbal oils against the yeast *Candida albicans* and the dermatophyte *Microsporum gypseum* was examined using the agar well diffusion method. For testing the effect of volatile compounds, a newly developed technique was used. The agar dilution method was used to determine the minimum inhibitory concentrations (MICs). Plant extracts were made using three methods: maceration, decoction and Soxhlet hexane extraction. Soxhlet hexane extraction gave the lowest activity against *C. albicans* and moderate activity against *M. gypseum*, while aqueous extracts obtained by maceration and decoction methods gave higher activity against both organisms. The present study revealed that *Allium sativum*, with MICs ranging from 21 to 25 g/l, and clove oil, with MICs ranging from 5 to 7.8 ml/l, had greater antifungal potential against *C. albicans* and *M. gypsum.* Interestingly, the MIC value of combined extracts of clove oil and *A. sativum* decreased compared to the individual extracts, showing a synergism in inhibiting pathogenic fungi. The antidermatophytic activity of herbal extracts and their synergistic effect makes them ideal for fungal therapy and this will be both safe and cost-effective. Due to the different modes of action of different active ingredients in plant extracts, the chances of developing resistance against formulations of herbal origin are very low.

Keywords: *Essential oils, Synergistic effect, Medicinal plants, Fungi, Minimum inhibitory concentration*

EVOLUTION IN MOUNTAINS: PATTERNS OF DIVERSIFICATION OF SRI LANKAN DAY GECKOES (*Cnemaspis*)

K. M. R. K. T. Herath* and K. D. B. Ukuwela

Department of Biological Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
*kalpaniherath366@gmail.com

Why certain lineages and regions are species-rich is a fundamental question in biology. Sri Lanka, along with the Western Ghats of India is a biodiversity hotspot. The island is home to a diverse assemblage of reptiles with 60% of the island's being endemic to it. The day geckoes of the genus *Cnemaspis* are the most diverse reptile lineage in Sri Lanka comprising 44 species with 100% endemism. Among them, day geckoes of the alwisi group (*C. alwisi*, *C. gunasekarai*, *C. hitihamii*, *C. kohukumburai*, *C. nilgala*, *C. punctata*, *C. gunawardanai*, *C. jayaweerai*, *C. nanayakkarai*, *C. rajakarunai* and *C. rammalensis*) dwell on boulder-strewn mountains in Sri Lanka's wet, dry and intermediate zones, and each species is restricted to a single mountain. In this study, we evaluated their phylogenetic relationships to determine the patterns and processes of diversification. Tail tissue samples of day geckoes were collected from several isolated mountainous areas of the wet, dry and intermediate zones. DNA was extracted from the tissue samples and mitochondrial ND2 and nuclear RAG1 genes were amplified and sequenced. The DNA sequences generated were placed in an already available DNA sequence dataset for the South Asian *Cnemaspis* radiation. The aligned sequences were analysed using Bayesian and maximum likelihood approaches. A time-calibrated analysis was done to estimate the timing of diversification. A Spearman's rank correlation test was performed to test whether the observed pattern of genetic divergence corresponds to geographic distance. Phylogenetic analyses indicated two distinct evolutionary radiations for members of the alwisi group in the wet zone (*C. gunawardanai*, *C. rajakarunai* and *C. rammalensis*) and in the dry and intermediate zones (*C. alwisi*, *C. gunasekarai*, *C. hitihamii*, *C. kohukumburai*, *C. nilgala*, *C. punctata*, C. *jayaweerai* and *C. nanayakkarai*). The time-calibrated analysis indicated that the alwisi group diversified in the late Miocene to early Pliocene epochs. The Spearman's rank correlation test indicated a significant positive relationship between genetic distance and geographic distance ($r = 0.294$, $P \leq 0.029$). These results indicate that the two lineages of *Cnemaspis* in the alwisi group have independently diversified in the wet and dry–intermediate zones of the island. The findings further suggest that Miocene–Pliocene climate change has driven isolation in mountains and thus may be a driver of speciation in these diminutive geckoes.

Keywords: *Molecular phylogeny, Genetic distance, Bioclimatic Zones, Speciation, Climate change*

DETERMINATION OF ANTIBACTERIAL PROPERTIES OF SECONDARY METABOLITES EXTRACTED FROM FUNGAL ENDOPHYTES ISOLATED FROM *AZADIRACHTA INDICA* AND *RICINUS COMMUNIS* AGAINST *PECTOBACTERIUM CAROTOVORUM*

J. A. D. K. N. N. Jayakody[1]*, N. N. Wijayawardene[2,3] and P. N. Yapa[1]

[1]Department of Biological Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
[2]Section of Microbiology, Institute of Research and Development in Health and Social Care, Battaramulla, 10120, Sri Lanka.
[3]Center of Yunnan Plateau Biological Resources Protection and Utilization, College of Biological Resource and Food Engineering, Qujing Normal University, Qujing, Yunnan, 655011, P.R. China.
*kumuthu1995@gmail.com

Endophytic fungi are an important mode of life that live in host plant tissues without causing any damage. During colonization, these endophytes produce different metabolites which are known for their promising uses in the pharmaceutical industry and in novel drug discovery. In this study, endophytic fungi were isolated from the leaves and roots of *Azadirachta indica* (Neem) and *Ricinus communis* (Castor oil plant) using the surface sterilized method. Fungal hyphae were transferred to Potato Dextrose Agar and pure cultures were obtained. All fungal endophytes were grown in liquid potato dextrose media to extract the secondary metabolites using ethyl acetate as the solvent. The ethyl acetate extracts and non-extracted compounds in the spent culture media were tested seperately on freshly isolated *P. carotovorum*. During the study, eight fungal endophytes were isolated in pure cultures that included three fungal isolates from *A. indica* leaves (IS1, IS2 and IS3) and another three isolates from the roots (IS4, IS5 and IS6). Two fungal isolates (IS7 and IS8) were identified from *R. communis* roots. All fungal endophytes were characterized using their morphological features and selected four isolates were subjected to genetic identification. Megablast at NCBI of the ITS gene region, IS1, IS2 IS6 and IS8 were identified as the closest homologs of *Neopestalotiopsis* sp., *Colletotrichum* sp., *Alternaria* sp. and *Penicillium* sp., respectively. The ethyl acetate extracts of all isolates, except IS6, showed positive inhibition against *P. carotovorum* with inhibitory zones (diameter of inhibition zones: IS1, 1.1 ± 0.0924 cm; IS2, 1.033 ± 0.324 cm; IS3, 1.2 ± 0.0924 cm; IS4, 1.667 ± 0.0533 cm; IS5, 1.3333 ± 0.0533 cm; IS7, 1.0 ± 0.185 cm; IS8, 1.3 ± 0.16 cm; at 95% confidence level) while the spent culture media containing non-extracted compounds in IS2 also showed inhibition (1.5667 ± 0.0533 cm) against *P. carotovorum*. It was clearly evident from the results that the secondary metabolite extracts obtained by most of the isolates are capable of showing inhibitory properties against the test organism. Thus co-cultivation or any other suitable agricultural methods utilizing the plant parts of the *A. indica* and *R. communis* could possibly prevent plant diseases that are caused by the test organism (e.g. soft rot). These findings could be further developed to identify specific biocontrol methods against *P. carotovorum*. These extracts can also be tested on various other pathogenic organisms to explore their effects.

Keywords: *Fungal Endophytes, Secondary Metabolites, Antibacterial Activity, Isolation, Extraction*

QUANTIFICATION OF POTENTIAL CONTRIBUTION OF NITROGEN FIXING CYANOBACTERIAL BIOFERTILIZER FOR RICE (*ORYZA SATIVA* L.) IN THE DRY ZONE OF SRI LANKA

S. D. P. N. Jayasinghe* and P. N. Yapa

Department of Biological Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
*prashansanijayasinghe@gmail.com

Rice is the staple food for half the world's population and is one of the most significant cereal crops in the world. To maximize the potential yield benefit of high-yielding rice cultivars, proper nitrogen (N) management is essential. The present study was aimed at producing nitrogen-fixing cyanobacterial biofertilizer as an ecofriendly approach to minimize the environmental threats, due to the heavy usage of synthetic chemical fertilizers. Cyanobacterial samples were collected from the dry zone (Anuradhapura, Kurunegala and Dambulla) in Sri Lanka and cultured in BG110 medium, specific to nitrogen-fixing cyanobacteria. *Anabaena* sp., *Nostoc* sp. and *Oscillatoria* sp. were identified based on morphological characters with the aid of *Bergy's Manual of Systematic Bacteriology* and an inverted phase contrasting microscope. Culturing was done using 1.5×10^8 CFU/ml from each identified cyanobacterium in a photobioreactor at 100 rpm for 7 days by adjusting various parameters. A pot experiment was carried out for rice variety Bg 300 using sterilized soil. The control was 100% urea, while the treatments consisted of five different ratios of cyanobacteria and organic fertilizer, with four replicates per treatment. The total N content of the cyanobacterial biofertilizer, which was prepared with the addition of equal amounts of the identified species, was 2.52%. There was no significant difference ($P > 0.05$) in pH and electrical conductivity between the tested treatments. The highest total N content (1.40%) observed in rice roots was from the treatment with equal ratios of organic fertilizer and cyanobacterial biofertilizer, while N% in the soil (0.29%) and in the shoots (2.38%) was highest when cyanobacterial biofertilizer was used as the sole N source. A significantly higher chlorophyll content was observed in the 100% urea added control. One-way ANOVA and Tukey's pairwise comparisons were done for the analysis of the growth parameters and yield-attributing characters. Plant height, the number of panicles and the number of effective tillers were not significantly different ($P > 0.05$) between the tested treatments. The maximum harvest index (29.99%) was observed in the treatment of 100% cyanobacterial biofertilizer. It can be concluded that the nitrogen fixing cyanobacterial biofertilizer used in the present study can be further tested at field level and introduced to farmers as an alternative for urea, as it enhances the growth and yield of rice.

Keywords: *Biofertilizer, Nitrogen fixation, Microscope, Photobiorector, Total nitrogen content*

HABITAT PREFERENCES AND FORAGING BEHAVIOUR OF SELECTED BULBUL SPECIES IN TWO DIFFERENT LANDSCAPES WITHIN THE DRY ZONE OF SRI LANKA

K. W. D. H. H. Kumarasinghe[1]*, S. Wickramasinghe[1] and R. Dissanayake[2]

[1]*Department of Biological Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.*
[2]*Department of Physical Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.*
*hashikahiruni@gmail.com

The Red-vented bulbul (RVBB; *Pycnonotus cafer*) and White-browed bulbul (WBBB; *Pycnonotus luteolus*) are two widespread species found in the dry zone of Sri Lanka. Our study sought to understand the habitat preferences, foraging behaviour and ecology of the RVBB and WBBB in the dry zone of Sri Lanka. The study was conducted from October 2022 to February 2023 in the Mihintale Sanctuary and on the grounds of the Faculty of Applied Sciences, Rajarata University of Sri Lanka. Focal sampling, opportunistic observations and mist netting were used to obtain data. Both species demonstrated significant differences in sub-habitats, showing P values <0.05. The WBBB prefers the proximity of water hole habitats (99.00%) while RVBB has no preference. Both bulbul species prefer twigs as their main foraging substrate. Gleaning was the major food-handling technique of both species (RVBB: 70.00%; WBBB: 73.63%). The observed foraging height of the RVBB and WBBB was 7 ± 0.21 m and 5 ± 0.20 m above the ground, respectively. RVBB spent most of their time on top (70.78%) of the tree while WBBB spent most of its time on the mid-branches (76.08%) of the tree. Both bulbul species consumed fruits as their major food type (RVBB: 93.17%; WBBB: 98.18%). There was no significant difference in the food preference indexes of fruit, insect, flower and worm between the two species. Both the RVBB and WBBB utilized 10 and 7 species of foraging plants, respectively. *Grewia helicterifolia* was the major foraging plant of both bulbul species (RVBB: 49.85%; WBBB: 48.96%) Minimum foraging observations were recorded for RVBB (37% of the time) on *Croton* sp. and for WBBB (92% of the time) on *Hugonia mistax*. Statistical analysis of measurements from 6 individuals each of the RVBB and WBBB indicated the absence of a linear correlation between gape width and average fruit size ($r = -0.21$, $P = 0.69$). The standardized dietary and habitat niche breadths of the two bulbul species reveal that in the context of our study area in Mihintale, these birds are both dietary specialists and habitat generalists. Pairwise dietary (0.9854) and habitat (0.9800) niche overlap values indicate a strong overlap between the two species. The findings of the present study indicate that the RVBB and WBBB utilize different sizes of fruits from different plant species at different foraging heights. This suggests that the two species prefer different foraging habitats.

Keywords: *Pycnonotus cafer, Pycnonotus luteolus, Foraging behaviour, Food preferences, Habitat preferences*

USE OF NANOMATERIALS-MODIFIED CARBON MICROFIBER ELECTRODE MATERIAL FOR SUPERIOR ELECTROCHEMICAL PERFORMANCE OF LAKE SEDIMENT INOCULATED MICROBIAL FUEL CELLS

B. M. C. Somasiri* and E. Y. Fernando

Department of Biological Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
*asb1617135@as.rjt.ac.lk

Microbial fuel cells (MFCs) have emerged in recent years as a promising technology for renewable alternative energy and wastewater treatment. MFC technology faces numerous challenges when applied to real-world applications. This is one reason why this technology has yet to be widely used for practical applications, despite its discovery many decades ago. The cathodic overpotential of the oxygen reduction reaction (ORR) in MFC cathode-based carbon is a barrier to the widespread adoption of the technology. In general, cathode performance can be improved in one of two ways: by using a catalyst to lower activation energy or by increasing the specific surface area of the cathode material. When used as a catalyst, precious metals such as platinum reduce overpotential, but platinum catalysts are expensive. The use of novel and inexpensive catalysts as replacements for platinum is therefore desirable. In this study, we used nanomaterials-modified carbon microfiber electrodes to improve the performance of lake sediment inoculated MFCs. As research has shown that the ORR performance of the carbon electrode can be improved through pretreatment, we used a variety of nanomaterial pretreatment methods. KOH, HNO3, MnO2, MnO2/PANI (Polyaniline), ZnO/NiO and ZnO/NiO/PANI treatments were applied to the carbon material and used as cathode electrodes; the performance was compared using power-current and polarization plots. The maximum power densities recorded for the different treatments were as follows: KOH, 51.71 mW/m^2; HNO3, 71.40 mW/m^2; MnO2, 78.5 mW/m^2; MnO2/PANI (Polyaniline), 141.6 mW/m^2; ZnO/NiO, 67.6 mW/m^2; and ZnO/NiO/PANI, 129.4 mW/m^2. Maximum power cyclic voltammetry and FTIR data were taken to characterize the pre-treated electrodes. SEM images were taken to study the morphology of cathodic electrodes. The outcome of this study demonstrates that nanomaterials-incorporated carbon microfiber cathodes bring about significant enhancements to power densities, and thus that the use of noble metal catalyst materials, such as platinum, can be avoided.

Keywords: *Sediment MFC, Pretreatments, Carbon-microfiber electrode*, *Nanomaterial-modification*

INVESTIGATION ON ANTIMICROBIAL ACTIVITY OF SKIN SECRETIONS OF SELECTED FROG SPECIES IN SRI LANKA AGAINST FUNGAL AND BACTERIAL PATHOGENS OF HUMANS

W. M. C. S. Wanasingha*, S. Hettiarachi and K. D. B. Ukuwela

Department of Biological Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
*chathurisudeepa9@gmail.com

Amphibians have immune systems that include both innate and adaptive immunity like higher vertebrates. Numerous mechanisms of innate immunity allow them to broadly and immediately respond to many pathogens. Their defensive mechanisms involve the production of various molecules and secretions. These include antimicrobial peptides (AMPs). AMPs are a good source of novel antimicrobial agents because they are less likely to interact with particular types of microbial receptors and thereby reduce the risk of microbes developing antibiotic resistance. The present study aims to (i) isolate skin secretions from selected frog species and test their antimicrobial activity against representatives of Gram-positive and Gram-negative bacterial strains and fungal species, (ii) screen frog skin secretions for active agents with antimicrobial properties and (iii) determine the minimum inhibitory concentrations (MICs) of frog skin secretions against selected bacteria and fungi. Skin secretions of the frog species *Duttaphyrynus melanostictus*, *Minervarya agricola*, *Microhyla mihintale*, *Polypedates maculatus* and *Hydrophylax gracilis* were investigated for the first time in Sri Lanka. Amphibian skin secretions were collected using a non-lethal method with chemical stimulation. Antimicrobial activity was evaluated using the agar well diffusion, broth and broth macro dilution methods. The secretions collected were concentrated by freeze-drying and re-dissolved in lower volumes of water. Skin secretions of *Hydrophylax gracilis* exhibited antimicrobial activity against *Staphylococcus aureus* and Methicillin-resistant *Staphylococcus aureus* (MRSA), which are Gram-positive bacteria. The MIC was 50% and negative results were obtained for *Escherichia coli*, which is a Gram-negative bacterium. Small inhibition-like zones were observed for the fungus *Candida albicans* as compared with the control solution. These findings suggest that the skin secretions of Sri Lankan frogs can be promising sources of animal-derived antimicrobial agents, and are important because no previous study has examined the presence of such agents in Sri Lankan amphibians.

Keywords: *Amphibian, Antimicrobial peptides, Hydrophylax gracilis, MRSA*

ISOLATION AND CHARACTERIZATION OF POLYHYDROXYALKANOATE BIOPLASTIC PRODUCING BACTERIA FROM PUTREFIED RICE

M. R. A. Ahsan* and E. Y. Fernando

Department of Biological Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
*asb1617003@as.rjt.ac.lk

Polyhydroxyalkanoates (PHAs) are internal microbial polyesters that are produced when there is an abundance of carbon sources and a scarcity of nutrients like nitrogen. They function as energy storage carbon reservoirs and give prokaryotes stress tolerance. These biopolymers are viable substitutes for carbon-based synthetic polymers (plastics) and have been previously isolated from bacteria growing on putrefied rice. The objective of this work was, to isolate and characterize PHA and PHA-producing bacteria from the natural environment and synthesize PHA-type biopolymer through a laboratory-scale procedure. Boiled and putrefied rice samples were used to collect, grow and isolate the bacteria for this study. It was then screened for PHA production capability. Sudan III dye staining was done to confirm the presence of PHA accumulation in the bacteria. When provided with a complex growth medium, bacteria growing in the medium exhibited diauxic growth. Molecular identification based on the 16S rRNA marker gene and Sanger DNA sequencing confirmed the identity of the isolated PHA producing bacterium as *Bacillus tropicus* strain MCCC 1A01406. PHA produced from a cultured bacterial sample was characterized using Raman spectroscopy. Results from Raman analysis confirmed that the PHA produced was a copolymer between 3-hydroxybutyrate (3HB) and 3-hydroxyvalerate (3HV) units. Characteristic Raman markers that confirm the presence of this copolymer PHA simultaneously occurred at the spectral positions 436 cm^{-1}, 837 cm^{-1} and 1,726 cm^{-1} in the Raman spectra. The diauxic growth together with the production of a copolymer confirms that the bacteria used in our study were feeding on more than one carbon substrate. This study clearly demonstrated that free-living environmental organisms can be isolated and conveniently used for the purpose of polyhydroxybutyrate (PHB) bioplastics production.

Keywords: *PHA, PHA copolymer, Raman spectroscopy, microbial polyesters, Bacillus tropicus*

CHEMISTRY

PERFORMANCE ENHANCEMENT OF CATHODE IN MICROBIAL FUEL CELLS (MFCS)

P. S. T. Amandani[1], **N. P. W. Rathuwadu[2] and A. M. C. Herath[1]***

[1]*Department of Chemical Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.*
[2]*Institute for Combinatorial Advanced Research and Education, General Sir John Kotelawala Defence University, Colombo, Sri Lanka.*
*ajithch037@gmail.com

The foundation of a very likely energy crisis in the next two or three decades is growing global energy consumption, issues with shortage and environmental effect related to traditional sources and other factors. Microbial fuel cells (MFCs) are a promising method for harnessing sustainable energy because they use microbial metabolism to change chemical energy into electrical energy. In situ polymerization of double distilled aniline (PANI) in three electrode system (Pt counter electrode, Ag/AgCl reference electrode, carbon foam (CF) as working electrode and 0.1 M Na_2SO_4 as electrolyte) was used to synthesize PANI@CF electrode. Co-deposition method used to deposit MnO_2 on the CF. Ni doped ZnO microparticles were deposited on the CF via hydrothermal methods. FE-SEM, EDX, FTIR and XRD techniques were used to characterize the bare and modified electrodes. According to the results of FE-SEM and EDX the microparticles were successfully deposited on the surface of CF electrode. Electrochemical characterization of modified electrodes was assessed using Open Circuit potential (OCP), Electrochemical Impedance Spectroscopy (EIS), cyclic voltammetry (CV) and linear sweep voltammetry (LSV) techniques using three electrode system in 0.1M Na_2SO_4 electrolyte solution. OCP shows the extent of stability of modified electrodes which is appreciable, evident by 0.2755 V and -1.009V of bare CF and MnO_2@PANI@CF electrodes respectively. EIS demonstrates reduction in charge transfer resistance and improved diffusion upon modification. CV shows increase in the current. Tafel slopes obtained from LSV showed more electrocatalytic activity in Mn series compared to Ni-Zn series. This study shows that the MnO_2@PANI@m-CF electrode gives better performance in MFCs. In addition, performance of MFCs was characterized using polarization curves and power density curves. The highest power density (135.24mWm^{-2}) and current density (1312.5mAm^{-2}) were recorded for MnO_2@PANI@CF electrode.

Keywords: *Microbial fuel cell, Carbon foam, Power density, Current density*

IN VITRO ASSESSMENT OF SUN PROTECTION FACTOR (SPF) AND ANTIOXIDANT ACTIVITY OF LEAF AND BARK EXTRACTS OF *NEOLITSEA CASSIA*

M. G. A. K. Bandara[1]*, W. G. D. Wickramasingha[2] and A. M. C. Herath[1]

[1]*Department of Chemical Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.*
[2]*Department of Biochemistry, Medical Research Institute, Colombo, Sri Lanka.*
*anupamabandara183@gmail.com

The harmful effect of sunlight on the skin has triggered studies that are concentrated on the use of synthesized or extracted natural compounds that can absorb ultraviolet (UV) radiation. Antioxidants are dynamic substances that have the capability to protect the body from the damage caused by free radical-induced oxidative stress. Plants are an excellent source of phytochemicals with potent antioxidant and photo-protective activities. On the other hand, plants of the genus *Neolitsea* have been reported to possess potent antioxidant activity. The purpose of this study is to assess the antioxidant activity and sun protection factor (SPF) of bark and leaf extracts of *Neolitsea cassia*. The air-dried leaves and bark of *N. cassia* were extracted using a mixture of methanol and dichloromethane (50:50 v/v %) and concentrated. Both extracts were screened (in triplicate) for antioxidant activity by using 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging assay and SPF values were determined by spectroscopic method (20, 30, 40, 50, 100 ppm) using the Mansur equation between 290 and 320nm range. The bark extract of *Neolitsea cassia* reported significant antioxidant activity ($p < 0.05$) with a lower IC_{50} value of 64.792 ppm compared to the positive control, ascorbic acid (IC_{50} 50.70 ppm). However, the leaf extract showed only moderate antioxidant activity of IC_{50} 252.87 ppm. The significantly highest SPF value was observed by leaf extract as 2.185 ± 0.0015 compared to bark extracts (1.345 ± 0.0013) at 100 ppm concentration. The results indicated that the bark and leaf extract of *Neolitsea cassia* contains antioxidants and sun protective activity which can further develop to use as a sunscreen agent associated with antioxidant activity.

Keywords: *Antioxidant activity, Sun protection factor, DPPH assay, Neolitsea cassia*

ASSESSMENT OF HEAVY METAL ACCUMULATION IN FRESHWATER TANK ECOSYSTEMS IN ANURADHAPURA, SRI LANKA

H. M. C. D. Gamagedara[1]*, R. L. Jayaratne[2] and E. M. R. K. B. Edirisinghe[1]

[1]*Department of Chemical Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.*
[2]*Department of Biological Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.*
*dinushi.gamagedara@gmail.com

Heavy metal contamination in freshwater aquatic ecosystems is one of the major environmental concerns in dry zone Sri Lanka due to its adverse effects on both environment and human health. Both natural and anthropogenic activities like weathering of metal-bearing rocks, mining, industrial activities, runoff water, and agricultural practices contribute to exceeding the permissible concentration levels of heavy metals in these tanks. Heavy metals, unlike organic pollutants, are nonbiodegradable, persist in the environment, and tend to accumulate in living organisms and biomagnified. These metals enter the body through the food chains and magnify inside the higher organisms like humans who rely on aquatic fish species and aquatic plants as a food source. However, there have been few investigations on heavy metal accumulation through food chains in freshwater aquatic ecosystems in Sri Lanka. So, the current study aims to investigate the accumulation of heavy metals (Cd, As, Pb, and Hg) in water, sediment, Lotus (*Nelumbo nucifera*), and freshwater fishes, Tilapia (*Oreochromis sp.)* and Striped snakehead (Lula, *Channa striata*) from freshwater tanks in Anuradhapura, namely Hammillewa, Kirindegama, Kammalakkulama, and Madawalagama. Also, this study aims to evaluate the relationship of each component in the freshwater aquatic ecosystem with the presence and absence of Lotus plants. The concentrations of heavy metals were determined by using inductively coupled plasma mass spectrometry (ICP-MS). The highest concentration of Hg (2.015 mg/kg) was found in the muscles of Lula in the Madawalagama tank. The highest Cd (1.0659mg/kg), As (2.3040mg/kg), and Pb (18.0001mg/kg) were detected for the liver of Lula Madawalagama, Lotus roots of the Madawalagama and, Lotus roots of the Kammalakkulama tanks respectively. The resulting values were compared with WHO/FAO guidelines. The results indicate that all the studied tanks were contaminated with at least one of these four heavy metals. Therefore, immediate actions are required to mitigate the heavy metal accumulation in aquatic ecosystems to ensure environmental sustainability and human health in the Anuradhapura area.

Keywords: *Heavy metals, ICP-MS, Bioaccumulation, Freshwater fish, Lotus*

REDUCED GRAPHENE OXIDE (rGO) MODIFIED ALUMINUM CATHODE FOR THE ELECTROCOAGULATION

M. S. F. Innasa* **and A. M. C. Herath**

Department of Chemical Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
*innasa1996ms@gmail.com

The electrocoagulation (EC) method has recently attracted a lot of interest due to its effectiveness. It is one of these methods used to remove ions, organic matter, colloidal and suspended particulates, dyes, surfactants, oil, and heavy metals from aqueous habitats. This procedure stands out for its simplicity of use, decreased sludge generation, and lack of chemical handling requirements. The process includes dissolving the sacrificial anodes in order to generate an active metal hydroxide, which acts as a potent coagulant to destabilize and aggregate particles before removing them by precipitation or adsorption. Graphene oxide (GO) was successfully synthesized using a modified Hummer's method. Graphene oxide was then reduced to reduced graphene oxide (rGO) using the chemical method and electrodeposited on the surface of the Aluminium electrode at constant voltage of 5.0 V for 8 hours. The resultant newly developed cathode electrodes were used for the electrocoagulation process at 0.03A for 1 hour in the sodium sulphate, magnesium sulphate, and calcium chloride electrolyte medium. pH and conductivity affect the efficiency of electrocoagulation. Remarkable increase in pH and conductivity of electrolyte containing rGO was significantly higher than that of bare Aluminium cathode. The random white spots were observed on the reduced graphene oxide surface. Characterization of these spots by Scanning Electron Microscopy (SEM), Energy-Dispersive X-ray Spectroscopy (EDS), revealed that they were composed of magnesium and calcium. The removal efficiency of hardness by EC was compared with reduced graphene coated aluminium electrode and bare aluminium electrode using complexometric EDTA titration, showing higher removal efficiency than bare aluminium electrode. These results reveal that the reduced graphene-modified cathode has the potential for electrocoagulation.

Keywords: *Electrocoagulation, Electrodeposition, Graphene oxide, Reduced graphene oxide, Aluminium electrode*

PHYTOCHEMICAL PROFILING OF *CALOTROPIS GIGANTEA* AND EVALUATION OF ANTIOXIDANT AND ANTIMICROBIAL EFFECT `

P. K. R. S. Kumari* and **E. M. R. K. B. Edirisinghe**

Department of Chemical Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka
*pkrsamankumari@gmail.com

Natural compounds derived from medicinal plants are crucial for pharmaceutical research and medication development as sources of therapeutic agents. *Calotropis gigantea* is latex bearing medicinal plant and belongs to the family Apocynaceae. Two forms of *C. gigantea* white-flowered form and purple-flowered form can be found in native to Sri Lanka. The objectives of the study were to investigate the antioxidant and anti-microbial activities and to conduct preliminary phytochemical screening to identify the presence of different phytoconstituents. Methanolic extracts of the leaves and flowers of both white-flowered and purple-flowered forms of *C. gigantea* were prepared and different phytoconstituents were separated by two-dimensional Thin Layer Chromatography (2-D TLC) Further, specific phytochemicals were determined using Gas Chromatography Mass Spectrometry analysis. The antioxidant assay was carried out by DPPH (2,2-Diphenyl-1-picrylhydrazyl) free radical scavenging method. The flower extract possesses significant antioxidant activity compared to Ascorbic acid as the standard. The findings of leaf and flower extracts of the purple-flowered form showed a lower IC_{50} value than the white-flowered form. The antimicrobial activity was determined by an antimicrobial susceptibility test against selected bacterial and fungal strains. The results revealed that leaves and flower extracts of *C. gigantea* showed a significantly higher zone of inhibition against *Candida albicans* followed by *E-coli* and *Staphylococcus aureus.* Phytochemical screening discovered both leaf and flower extracts contain Alkaloids, Phenols, Tannins, and Carbohydrates. While Flavonoids, Terpenoids, and reducing sugars were found only in flower extracts. Proteins and amino acids, Saponins, and Steroids were found to be absent in both extracts. The solvent system, Toluene: Acetone - 4:1 provided the best separation in the 1-D TLC approach. The 2-D TLC offers the finest separation of extract into its components. The results of the GC-MS analysis showed that the combination of methanolic and dichloromethane extracts contains numerous important phytochemicals including some fatty acids and fatty acid methyl esters. The findings of the study conclude that *C. gigantea* is an important herbal plant and could be used in investigations on the development of medicinal drugs.

Keywords: *Calotropis gigantea, Antioxidant, Anti-microbial, Phytochemical screening, Thin Layer Chromatography, GC-MS Analysis*

COMPARATIVE STUDY ON THE PHYSICOCHEMICAL AND MECHANICAL PROPERTIES OF BIODEGRADABLE POLYMERS PREPARED USING MANGO SEED STARCH AND COCOA POD HUSK POWDER

D. D. Liyanage*, **S. A. Senevirathne and N. B. Jayaratna**

Department of Chemical Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale.
*liyanatha@gmail.com

There is a great public concern with issues such as reducing carbon footprint and the disposal of products manufactured using nondegradable petroleum-based plastics. Plastics are a substantial contributor to an increased level of pollution to the environment. As a result, governmental legislation has driven researchers to find alternatives for plastics. One of the alternatives to nondegradable plastic is biodegradable polymer-based products. Thus, the demand for these biodegradable materials is increasing around the globe. The aim of this research is to study starch-based biodegradable polymers using non-edible sources which can be used in industrial applications. Starch has been widely used in the synthesis of bioplastics. Mango seed kernel contains a considerable percentage of starch that can be used to synthesize biodegradable polymers. On the other hand, an excessive amount of waste is disposed to the environment as byproducts or non-edible parts generated from the fruit processing industries. During cocoa processing, cocoa pods are disposed as agro-waste in bulk amounts. These cocoa pods can be ground to cocoa pod husk powder (CPHP) and used as a natural filler in the preparation of mango seed starch-based polymer. The polymer film is prepared using Glycerol as a plasticizer. Using mango seed starch and CPH powder in the preparation of biofilms to manufacture industrial products mitigates the issues created from agro-waste generation. Different compositions were prepared by containing various percentages of CPHP. The Mango seed starch-based polymer films incorporated with CPHP were tested for various properties, such as Tensile strength, Dry Matter Density, Water Absorption capacity, Water Solubility, Moisture Content, Biodegradability, and morphological characterizations by using Scanning Electron Microscope analysis. Data showed that mango seed starch and CPHP composites have a great potential for utilizing in industrial application as more environmentally conscious use of waste and creation of plastics.

Keywords: *Biodegradable polymer, Mango seed starch, Cocoa pod husk, Glycerol, Composite*

CASSAVA STARCH POLYMER COMPOSITES USING TEAK WOOD DUST AND BEESWAX FOR PACKAGING APPLICATIONS

K. H. M. D. Maheshika*, **N. B. Jayaratna and S. A. Senevirathne**

Department of Chemical Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale.
*dewnimaheshika96@gmail.com

Increase of severe environmental pollution due to accumulation of significant amount of noxious waste has brought the use of synthetic polymers into a critical stage. As a result, development of biopolymers derived from natural sources has become a successful option to mitigate these negative environmental impacts. One of the most promising raw materials for production of biopolymers is starch, which is an abundant, cheap and renewable polysaccharide. Starch is mainly composed of two main polysaccharides as amylose and amylopectin. Wood dust, chemically consists of cellulose, hemicellulose and lignin can be collected from sawmill residues and used as a reinforcement filler in the polymer matrix. Incorporation of wood dust into starch polymer can increase mechanical strength and dry matter density, decrease water solubility, water absorption capacity, moisture content and biodegradation Beeswax, comprised of esters of long-chain fatty alcohols, acids, long-chain hydrocarbons, free fatty acids, can be extracted from beehive combs. Beeswax is hydrophobic in nature and further enhances water resistivity. The main aim of this polymer composite is to be used as an eco-friendly packaging material with desired properties to replace synthetic plastics. The polymer composites were prepared using cassava starch, water, acetic acid and glycerol. Glycerol act as a plasticizer to overcome brittleness and hydrophilicity. Acetic acid is used as an anti-fungal agent. Teak wood dust, chemically modified by alkaline treatment was added to starch by varying the composition in the preparation of polymer composites. Beeswax modified with zinc stearate to increase its thermal stability as it has a low melting point. The starch wood dust polymer composites modified with beeswax were characterized by means of scanning electron microscopy, FTIR analysis, tensile strength, water solubility, water absorption capacity, dry matter density, moisture content.

Keywords: *Starch, Wood Dust, Beeswax, Plasticizer, Filler*

PHYSIOCHEMICAL PROPERTIES OF CROSS-LINKED CASSAVA STARCH POLYMER WITH TRISODIUM PHOSPHATE

N. D. S. U. Naulla*, **N. B. Jayaratna and S. A. Senevirathne**

Department of Chemical Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
*ndsunaulla@gmail.com

Environmental pollution due to synthetic polymers has dramatically increased in recent years. Recently, considerable attention has been gained in scientific community to mimic petroleum-based polymers by biodegradable, ecologically friendly products. Recently, starch and its derivatives have become a viable and renewable substitute for petroleum-based polymers as they are highly available and biodegradable. The objective of this research is to examine the change in physiochemical properties of modified cassava starch compared to native cassava starch. Cassava is regarded as one of the main sources of starch that grows quickly in a variety of soil conditions. In order to create biodegradable plastic that is isotropic, odorless, tasteless, colorless, nontoxic, and biologically degradable, cassava starch has been widely used. Glycerol used as plasticizer and acetic acid used as a solvent and fungicide. The native starches are structurally very weak and functionally very restricted for industrial applications. Cassava starch modification by cross-linking using different Trisodium Phosphate percentages was performed. Functional properties like Water Absorption capacity, Water Solubility, Dry Matter Density, Tensile strength, Moisture Content, Scanning Electron Microscope analysis and Biodegradability of the modified starch were compared those of native cassava starch. The effect of glycerol plasticizer was explored using different glycerol content and mechanical properties were compared. Modification of starch altered functional characteristics and provide insights into the development of some biodegradable packaging made from petroleum-based products.

Keywords: *Biodegradable polymer, Modified cassava starch, Trisodium Phosphate, Glycerol*

STUDY AND FORMULATION OF STARCH POLYMER NITRO CELLULOSE BIODEGRADABLE COMPOSITE

K. P. D. C. M. Perera*, **N. B. Jayaratna and S. A. Senevirathne**

Department of Chemical Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka.
Mihintale, Sri Lanka.
*Kpdcm1996@gmail.com

Polymeric materials obtained from petroleum resources are non degradable. Therefore, they have become a threat to the environment. Plastics are one of the dominant engineering materials for the past few years. However, in the recent trend bio polymer composites have found a vast application in numerous fields due to their proven worth in cost, weight, durability, toughness and ecofriendly in nature. Bio polymers can be widely used to mimic synthetic polymers. Researchers are quite interested in nitrocellulose since it is used in many different products such as paint and gun propellant. Nitrocellulose can be obtained from cellulose, which can be derived from a variety of sources. In this research starch-based nitrocellulose biodegradable polymers have been studied. Nitrocellulose is highly flammable material and has no odor or taste. Glycerol used as plasticizer in starch-based bio polymer preparation. Typically, plasticizer are added to starch to increase its flexibility, workability, and decrease brittleness. Addition of the nitro cellulose, fibers increase the tensile strength due to the interfacial adhesion and the strong interaction between starch and nitrocellulose. Pure starch-based films have higher water absorption ability. When increasing the starch percentage, the water solubility and biodegradability have been decreased and the tensile strength has been increased. Also, when the cellulose fiber content increases, water absorptivity, water solubility and biodegradability have been decreased however, tensile strength has been increased. Pyhsical parameters were conducted using Scanning Electron Microscope and Fourier Transform Infared Spectrscopy. The biocomposite films were characterized using biodegradabilty, water solubilty, water absorption Capacity, moisture content, tensile strength and dry matter density tests.

Keywords*: Nitrocellulose, Plastcizer, Cassava Starch, Biodegradable polymer, Characterization*

GRAPHENE OXIDE-POLYANILINE SUPPORTED NANO ZERO VALENT IRON (GO-PANI-nZVI) NOVEL COMPOSITE FOR AQUEOUS NITRATE REMOVAL

J. U. Sanjula* and A. M. C. Herath

Department of Chemical Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
*sanjulachemrc6@gmail.com

Over various methods of water treatment processes, use of nano zero valent iron (nZVI) has been a promising approach to remove a wide range of organic and inorganic contaminants in water. However, the rapid aggregation of nZVI disrupts its activity resulting low progress of activity. In order to overcome aggregation, nZVI was embedded on polyaniline supported by graphene oxide sheets. Polyaniline acts as a capping agent which enhances the stability of the novel composite. A variety of characterization techniques were used to study morphological and structural properties of the novel composite. This novel composite was synthesized by a liquid-phase reduction method under anaerobic conditions and investigated the ability of the composite for nitrate reduction and removal in aqueous solution. The Batch experiment was conducted to determine the kinetics and thermodynamic parameters as well as the effects of contact time, initial pH level, initial nitrate concentration and composite dosage on nitrate reduction. Experimental results show that reduction efficiency of nitrate decreases with increasing initial pH from 3 to 9 and with initial nitrate concentration. This novel composite reduces 80% of 50 ppm nitrate solution within an hour at optimum pH of 4.0. The nitrate reduction by the GO-PANI-nZVI composite was fitted well with pseudo-second-order kinetics model. For isotherm study, linear Langmuir model was a better fitted model than Freundlich model. The GO-PANI-nZVI composite shows maximum adsorption capacity of 204.08 mg/g. Endothermic and spontaneous nature of nitrate adsorption on composite are attributed by positive values of ΔH (change in enthalpy) and ΔG (change in Gibbs free energy) respectively. The mass titration technique was employed to determine the pH $_{pzc}$ (8.5) of the composite which gives information about the attraction and repulsion between adsorbents and adsorbates. The cyclic voltammetric experiments carried out for nitrate at pH 4.0 on composite modified glassy carbon electrode showed reduction of nitrate at -1.2 V vs. Ag/AgCl reference electrode. The GO-PAN-nZVI composite is a promising adsorbent for nitrate removal and ground water remediation.

Keywords: *Adsorption, GO-PANI-nZVI, Nitrate reduction, Composite, Polyaniline*

REMOVAL OF PHOSPHATE USING ELECTROCHEMICALLY MODIFIED Fe(OH)$_2$- Al(OH)$_3$ MONTMORILLONITE COMPOSITE

W. K. D. Upamalika* and A. M. C. Herath

Department of Chemical Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
*asb1617141@as.rjt.ac.lk

Phosphate is a naturally occurring and that is an important element for the growth of plants and animals. However, excessive amounts of phosphate in water can cause a number of environmental problems. Therefore, in this study, Montmorillonite clay (MMT) modified with Fe(OH)$_2$ and Al(OH)$_3$ was used as an adsorbent to remove phosphate in water, simulating the practice of a field trial, such as in wastewater. Accordingly, modified Fe(OH)$_2$/Al(OH)$_3$-MMT composite was prepared using electrocoagulation with aluminium and iron as electrodes and characterized by Fourier-transformed infrared spectroscopy (FTIR). Batch experiments were conducted to investigate the effect of solution pH, adsorbent dosage, initial phosphate concentration, and contact time on the Phosphate removal by Ferrous hydroxide-Aluminium Hydroxide modified Montmorillonite (Fe(OH)$_2$/Al(OH)$_3$-MMT(III)) composite . The point of zero (pH$_{PZC}$) charge was found to be 3.86. Fe(OH)$_2$/Al(OH)$_3$-MMT(III) composite had a maximum removal efficiency of 70.9 % at an optimum condition of phosphate concentration of 20 mg/L, adsorbent dosage of 112.15 mg at a contact time of 138 minutes at pH 3.5. In comparison to the use of the pseudo-first order kinetic model, the pseudo-second order kinetic model best fit the acquired phosphate adsorption data with the R^2 of 0.9833. According to the isotherm studies, Langmuir model appeared to fit the adsorption process better than the Freundlich model and the maximum phosphate adsorption capacity is 33.795 mg/g. Thermodynamic parameters (ΔG^o, ΔH^o, and ΔS^o) were also determined, revealing that the phosphate adsorption process was endothermic and spontaneous in nature. The findings of this study show that Fe(OH)$_2$/Al(OH)$_3$-MMT(III) composite can be used as a cost effective and environmentally friendly adsorbent for removing phosphate from wastewater.

Keywords: *Adsorption, Phosphate, Modified Montmorillonite, Adsorption capacity, Isotherm*

NANO-CELLULOSE REINFORCED MODIFIED STARCH BIODEGRADABLE POLYMER COMPOSITES FOR PROPERTY ENHANCEMENT

A. J. Weerasinghe*, S. A. Senevirathne and N. B. Jayaratna

Department of Chemical Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale.
*ashwinijithendri@gmail.com

The use of synthetic polymer manufacturing from non-renewable petroleum resources have caused negative impact on the environment. Therefore, the attentiveness in producing bio-degradable polymers has increased as a result of the growing environmental problems due to synthetic plastics. Because of the seriousness of the issue, it has been identified the need of shift away from petroleum-based polymers and toward sustainable and renewable alternatives. In recent years, interest in polymer nanocomposites has grown due to their greatly improved mechanical and thermal durability compared to synthetic polymer composites. Aside from the performance and qualities of these polymer nanocomposites, products should be biodegradable, reusable, recyclable, or disposed in the end. By producing a modified starch based nanocellulose polymer, it is expected to obtain a biodegradable polymer film with increased barrier and mechanical properties with the variation of the reinforced nanocellulose percentages. Starch extracted from *Manihot esculenta* is employed as the matrix in this context as a potential replacement for plastics made from fossil fuels, especially because it is cheap, abundant, and renewable in nature. The most common renewable, biodegradable polymer on earth cellulose was extracted from an invasive plant in Sri Lanka, *Panicum maximum*. The starch based nanocellulose polymer was obtained by reinforcing the nanocellulose with different percentages into the starch aqueous solution with the use of glycerol as a plasticizer and with the use of citric acid as a starch modifier. The presence of nanocellulose was confirmed by Dynamic Light Scattering. The properties of the prepared nanocomposites were compared using the characterization methods such as water absorption capacity, water solubility capacity, moisture content, biodegradability, dry matter density, tensile strength, Scanning Electron Microscope (SEM) and Fourier Transformer Infrared Spectroscopy (FTIR). Increasing the nanocellulose percentage tend to show a positive effect on water absorption capacity and a decreasing effect on water solubility as well as on moisture content. The work can be further developed for making bio-degradable and affordable food wrapping with the incorporation of essential oils to avoid microbial growth.

Keywords: *Nanocellulose, Nanocomposite, Reinforcement, Starch, Biodegradable*

QUANTIFICATION OF HEAVY METALS AND DETERMINATION OF PHYSICOCHEMICAL CHARACTERISTICS OF BEE HONEY COLLECTED FROM VARIOUS GEOGRAPHICAL LOCATIONS IN SRI LANKA

S. A. I. D. Weerasinghe[1]*, D. K. Hettiarachchi[2] and E. M. R. K. B. Edirisinghe[1]

[1]*Department of Chemical Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.*
[2]*Department of Biological Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.*
*imalshadilshani@gmail.com

Bee honey has an extremely complicated makeup that primarily consists of both organic and inorganic ingredients. Depending on its botanical and geographic origin, both natural and manmade forces have different impacts on the composition of honey. The geographical floral origin, season, ambient variables, and treatment of beekeepers all affect the characteristics and content of bee honey. Even though the percentage is minuscule when it comes to composition minerals, and heavy metals are crucial in defining the quality of bee honey. This study is the first to examine the heavy metal content and some physicochemical parameters of bee honey in Sri Lanka. The Inductively Coupled Plasma Mass Spectroscopic (ICP-MS) method was used to quantify the heavy metals (As, Cd, Pb and Hg) in Sri Lankan bee honey. The Cd, As, Pb and Hg levels in the collected samples ranged from 0.02 µg/kg to 68.89 µg/kg, 2.17 µg/kg to 340.00 µg/kg, 0.40 µg/kg to 11.50 µg/kg and 0.04 µg/kg to 12.50 µg/kg respectively. The colour of the samples varied from white to amber colour. Moisture contents of the samples were in between 24.71% - 12.79% from its weight while the total solid content from 75.29% - 87.21% from its weight. Brix values, which indicate the sugar content, were in the range between 68.00 °B - 80.00 °B. pH was in the range of 2.46 - 5.18. The conductivity (180.4 µs/cm - 1517 µs/cm) indicated that the mineral salt content is in the normal range. The specific density of the samples was in the range between 1.15 g/cm^{-3}-3.06g/cm^{-3}. Even though there are a few cases with marginally higher levels of heavy metals compared to the standard levels, consumption of bee honey may not pose a significant effect on human health as daily consumption is extremely low in Sri Lanka.

Keywords: *Bee honey, Heavy metal, ICP-MS, Physicochemical characteristics*

COMPUTING

DOCUMENT INTEGRITY VERIFICATION USING BLOCKCHAIN TECHNOLOGY

H. M. Y. Fonseka[1]*, **W. U. Wickramaarachchi**[2], **I. J. Hewarathne**[2] **and C. Maldeniya**[3]

[1]*Department of Physical Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.*
[2]*Department of Computing, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.*
[3]*Department of Software Development, Techlabs Global (Pvt) Ltd, Colombo 07, Sri Lanka.*
*manurayasasvin@gmail.com

The fabrication of confidential and important documents is a significant problem in today's world due to the availability of advanced technology. Forged documents pose a threat to society, and a reliable method of verifying the authenticity of important documents is imperative. Fact-checking services are time-consuming, and centralized systems have the potential for corruption, leading to a lack of trust in the documents. To address these issues, a blockchain technology-based solution has been proposed to detect forged documents. This ensures the verification and authentication of essential and confidential documents in every field. In this research, a model is developed that is more transparent and accurate than existing document integrity verification systems. The Ethereum platform of blockchain technology is used, and a smart contract is created to store the hash value of each document. Storing the hash value in a smart contract ensures decentralization and immutability. In the proposed system, the smart contract has an owner and focuses on extra security and reliability for the service. Only the owner of the smart contract can add authorities to the smart contract. A smart contract allows storing hash values only for registered authorities. The verification process can be done by anyone, including the document owner or a third-party company that needs to verify the document's integrity. The proposed system verifies the document's hash value stored in the smart contract and the authority entering the hash value. Further, a unique index number of documents is also mapped with each hash value. The proposed solution has potential applications in various industries where document authenticity and integrity are critical. The use of blockchain technology solutions can ensure a high degree of confidence in a document. Blockchain-based solutions can also streamline document validation processes and reduce fraud and data tampering. The use of smart contracts further enhances the security and authenticity of the documents. However, it is important to note that blockchain technology is still in its early stages of adoption, and there are still technical and regulatory challenges that need to be addressed before it can be widely implemented. Therefore, Blockchain technology has led to innovations in security.

Keywords: *Blockchain Technology, Immutability, Decentralization, Smart Contract, Hash Value*

DEEP LEARNING MODEL TO PREDICT HOUSEHOLD DAILY ENERGY CONSUMPTION

R. K. K. A. L. Lomitha* and I. J. Hewarathne

Department of Computing, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
*llomitha775@gmail.com

Around the world, households consume a sizable quantity of electrical energy, which has risen annually. The capacity of electricity generation is constrained, so finding innovative ways to conserve energy outside the box is necessary. With the significant uncertainty and volatility involved compared to the total electrical demand in the area, forecasting the energy use of individual households is a real challenge. According to earlier studies, predictions made by deep learning and machine learning models are especially erroneous, suggesting room for improvement. This study proposes and evaluates three main deep learning frameworks, which were built on convolutional neural network (CNN), long short-term memory (LSTM) and a combination of CNN and LSTM. The study seeks to answer four key questions related to improving the performance and accuracy of the deep learning model, detecting local patterns and long-term dependencies in energy consumption, determining the optimal data sample rate and time duration for data gathering, and identifying the suitable deep learning architecture with improved accuracy and performance. This study's purpose is a novel approach to using a timestamp to create six new features to improve model accuracy. Furthermore, layers such as Conv1D, ConvLSTM1D and Time Distributed will be evaluated, and the application of those as accuracy-improving strategies will be discussed. The three models suggested in this study have shown their potential in different areas. CNN model with Conv1D shows great accuracy (MSE: 994.17), and it is the best option if the dataset has a lot of data points (more than one year) and is lightweight and fast (6s per epoch). The hybrid model was great if data points were low (MSE: 0.07), but at the expense of drastic model training time due to the complexity of the model. In such cases, the LSTM model is better than the hybrid option at the cost of accuracy. In conclusion, when considering the training time, CNN with Conv1D is the best option while the hybrid model is the best option when considering the precision. Also, in order to have higher accuracy in the deep learning model, data must be captured in intervals of 1–10 minutes for at least 6–8 months. In the future expansion of this study, the prediction accuracy can be increased by clustering and training the representative models using a significant amount of data considering the behaviour of the energy users.

Keywords: *CNN, Conv1D, ConvLSTM1D, LSTM, deep learning, energy consumption forecasting, Load modelling*

DEEP LEARNING BASED SOLUTION FOR ANALYSIS OF BATTING STROKE TECHNIQUES OF CRICKET

W. M. D. H. Bandara* and **T. C. Irugalbandara**

Department of Computing, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
*dilan.harshana.739@gmail.com

Cricket is a very popular sport, particularly in the South Asian region. Batting is a crucial part of this game. A player's overall performance can be improved by identifying areas for improvement and studying their batting technique. Even though it is important to learn and train the basic techniques under an experienced coach, there are several barriers such as lack of good trainers, high cost of private coaching, and limited access to tools for learning the basics and getting evaluated. We have identified the importance of the system which can teach and analyse the strokes of a batsman without the help of a physical coach. As a solution to this problem, a deep learning-based automated system has been proposed to analyse batting techniques and provide feedback to improve the player's stroke-playing technique. The system utilizes a combination of Convolutional Neural Network and Long Short-Term Memory models, with the ConvLSTM architecture as the deep learning model. The proposed system uses newly recorded video footage from two different angles as the dataset, which has been validated by a professional cricket coach to ensure that those are up to their standards. Individual frames from the input video are separated by the frame divider module and sent into the feature extractor module. The feature extractor module extracts features from the frames using the InceptionV3 architecture, which are then passed through a ConvLSTM model for analysis. A collection of cricket batting videos of forward drive shots was gathered and tagged with batting technique labels to evaluate the suggested system. The deep learning models were then trained to evaluate their performances using the annotated dataset. The findings of this research work indicate that the front-view angle model has a training accuracy of 97.59% and a testing accuracy of 85.7%. Side-view angle model has a training accuracy of 96.34% and a testing accuracy of 80%. These accuracies demonstrate that if the model detects incorrect batting techniques, it will offer feedback on how to improve the player's technique. Conversely, the system will provide supportive and motivating feedback if the player's technique is correct and up to the standard. The proposed system is a useful tool for coaches, players, and analysts to evaluate and enhance their batting techniques.

Keywords: *Batting Technique Analyse, Deep Learning, Convolutional Neural Network, Long Short-Term Memory, ConvLST*

FLOOD PREDICTION USING MACHINE LEARNING BASED ON METROLOGICAL AND TOPOGRAPHICAL FEATURES OF KALU GANGA RIVER BASIN, SRI LANKA

A. Mahaganapathy[1]*, W. U. Wickramaarachchi[1] and R. M. K. T Rathnayaka[2]

[1] Department of Computing, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
[2] Department of Physical Sciences and Technology, Sabaragamuwa University of Sri Lanka, Belihuloya, Sri Lanka.
*ahranemahaganapathy525@gmail.com

Floods are frequently happening disaster that causes severe damage to lives and properties. Kalu Ganga river basins are the most prone to floods in Sri Lanka. According to flood prediction studies, machine learning approaches produce higher accuracy than conventional methods. This study aims to develop an ensemble technique with enhanced accuracy for flood prediction in the Kalu Ganga river basins and focuses on six catchment areas such as Kalawana, Ayagama, Kuruwita, Pelmadulla, Elapatha and Kahawatta. The methodology involves collecting rainfall, elevation, and flood data from secondary data sources such as Meteorological Department of Sri Lanka, OpenMeteo API and Disaster Information Management System Sri Lanka, imputing missing values using K Nearest Neighbours imputer, detecting outliers using moving average and percentile methods that are evaluated against bagging classifier, imbalance class handling using Synthetic Minority Over-sampling Technique algorithm , comparing feature Selection techniques such as Principal Component Analysis and Wrapper Method Backward feature selection by using f1-score obtained through models implementing ensemble of techniques such as voting of Support Vector Machine, Logistic regression, Naive Bayes and Decision Tree that were chosen based on their proven effectiveness in previous studies of flood prediction, stacking the above models with final estimation logistic regression, blending of above models, bagging with decision tree as base estimator decision tree and boosting and evaluating them using f1-score. The results shows both percentile and moving average methods results in 99% f1 score with bagging classifier. Wrapper Method Backward Feature Selection resulted in high f1 scores for most of the predictive models compared to PCA. Bagging classifier with decision tree as the base estimator that is feature selected through wrapper method backward feature selection has high f1 score of 99% compared to other models. According to the results, it can be concluded bagging classifier with decision tree as base estimator with wrapper method feature selection has high accuracy than any other ensemble and single machine learning methods. As future directions of the research, hydrological features can be considered.

Keywords: *Flood prediction, Machine learning, Ensemble, Feature selection, Pre-processing*

FAKE NEWS DETECTION APPROACH FOR SINHALA TWEETS

T. S. Somarathne and A. Gunathilaka

Department of Computing, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
*tashiniav@gmail.com

Fake news is an invented form of news to deceive people. With the rapid growth of Internet technologies, social media has become an essential component in people's lives. This has led traditional print media news to be published in online portals such as Facebook and Twitter. Therefore, billions of users sharing a news item with malicious or misleading content will spread rapidly among a large community. This will reason for occurring severe issues among the community. Therefore, it is vital to solve the problem of spreading of fake news items through the social medias. There are some approaches that have been already implemented to detect fake news items in English news tweets which are shared on Twitter. To the best of our knowledge, there are no more evidence of detecting fake news items which are published in Sinhala Language. Considering the massive number of Sinhala news shared, in this research we are proposing an approach to detect fake news items published in Sinhala using Natural Language Processing concepts. As the initial step, two distinct datasets were created by personally examining headlines of each tweet, including true and fake Sinhala news tweets. Preprocessed tweets are learned through n-gram analysis to identify the most popular news in the dataset and five classifiers were trained for the combined datasets to identify the Sinhala fake news. Naïve Bayes provided 90.83% accuracy with the dataset, while Support Vector Machine provided 91.90% accuracy. The Logistic Regression, Decision Tree, and K-nearest Neighbor provided accuracies of 91.57%, 89.61%, and 86.79%, respectively. Since this study has focused on detecting the fake news items using headlines, it is expected to improve the approach to identify the fake news by referring to the contents further.

Keywords: *Twitter, Sinhala, Fake news, Social media, Classifiers*

AN EFFICIENT BREAST CANCER DETECTION ALGORITHM BASED ON DEEP LEARNING

K.G. Rajapaksha* and W. U. Wickramaarachchi

Department of Computing, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
*rajapaksekavindya@gmail.com

Millions of women worldwide are impacted by the common and deadly disease known as breast cancer. For a successful course of therapy and better patient outcomes, early identification of breast cancer is essential. Many researchers have developed breast cancer detection algorithms using various preprocessing, feature extraction, and classification techniques. However, it is still challenging to identify the optimal algorithm that can achieve higher accuracy and speed, which will prevent patients from getting frustrated with false positive results. As a result, the goal of this research is to evaluate and compare existing algorithms to find the best breast cancer detection algorithm to bypass the limitations of the existing algorithms, such as lower accuracy, lower speed, and being semi-automatic, where the involvement of a human expert is required. Through a thorough assessment of the literature, the study investigates the preprocessing strategies, feature extraction techniques, and classification techniques employed in various algorithms. Furthermore, experimental analysis is done to determine the best strategy for each of these stages. The results of the study indicate that the optimal breast cancer detection algorithm includes preprocessing techniques such as the CLAHE technique, which is a histogram equalization method. The feature extraction techniques that produce the most effective results include feature extraction using the shape feature. For classification, artificial neural networks (ANNs) were found to be the most accurate methods. Further improvements were made to this model to enhance its accuracy by increasing the number of sample images by cropping and rotating the existing images and changing the architecture of the convolutional neural network. The proposed breast cancer detection algorithm, based on the best techniques found during the experimental process, achieved an approximate accuracy rate of 90%, which is significantly higher than the state-of-the-art algorithms. The study concludes by providing an extensive review of current breast cancer detection algorithms to determine the most effective methods for every stage of the detection procedure. The suggested method yields positive results and could help breast cancer detection systems become more precise and quicker.

Keywords: *Convolutional Neural Network, Artificial Neural Networks, Histogram Equalization, Feature Extraction, Classification*

POSTERS

CROP ADVISOR - AN AI CHATBOT FOR ASSISTING FARMERS
<u>M. Krishnika</u>, S. Srichangavi, K. Tharanya, M. K. Ayesha and N. M. A. P. B. Nilwakke

A FLOATING ROBOT – COLLECTS PLASTIC WASTE IN FLOWING WATER
<u>D. S. D. Kuruppu</u>, M. P. M. R. Maduprabha, W. M. W. G. C. I. Wasala, A. G. A. Tharushi, A. K. U. P. Jayanayaka and N. S. Weerakoon

SNAKE IDENTIFICATION IN SRI LANKA BY USING IMAGE PROCESSING
<u>S. S. Dharmawanse</u>, G. K. G. S. Jayawardana, D. M. A. K. Bandara, W. I. S. Fernando, R. S. G. Jayaweera and K. H. A. Hettige

HEALTH PROMOTION

EFFECTIVENESS OF A HEALTH PROMOTION INTERVENTION TO IMPROVE ADOLESCENTS' PSYCHOSOCIAL WELLBEING IN THIRIWANEGAMA VILLAGE DURING THE ECONOMIC RECESSION IN THE POST-PEAK PERIOD OF COVID-19 PANDEMIC IN SRI LANKA

M. A. H. Kaushani[1]*, R. Ferdinando[2] and H. P. Reyal[1]

[1]Department of Health Promotion, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
[2]National Institute of Health Sciences, Nagoda, Kaluthara, Sri Lanka.
*hansikakaushani1996@gmail.com

Psychosocial wellbeing is a combination of psychological and social components of the general wellbeing. It is an essential aspect in adolescents' survival and development which determines the psychological and social functioning in their future life. Adolescents' psychosocial wellbeing was negatively influenced during the economic recession in the post peak period of COVID 19 pandemic in Sri Lanka. Hence, the general objective of this study is to assess the effectiveness of a health promotion intervention to improve adolescents' psychosocial wellbeing in terms of lifestyle practices, mental health condition, and social relationships in Thiriwanegama village in Gampaha district. Thiriwanegama is a semi-urban area consisting of 461 families. A quasi-experimental study was conducted selecting two villages randomly with similar socio-demographic characteristics as the intervention and control settings. Fifty-eight adolescents from the intervention group and fifty-five adolescents from the control group who were from 15 to 19 years of age were purposively recruited in the sample. A health promotion intervention was implemented only with the intervention group for five months. The steps of the intervention included; identifying improving psychosocial wellbeing as a goal, identifying and analysing determinants of poor psychosocial wellbeing, identifying actions to address selected determinants and implementing those actions while monitoring the progress. Data were collected at both pre and post-intervention phases from adolescents in both settings through pretested interviewer-administered questionnaire. It included data on status, factors and interventions on adolescents' psychosocial wellbeing. Only in the intervention group focus group discussions with parents and in-depth interviews with key informants were conducted. Quantitative data were analysed using descriptive statistics and inferential statistics while qualitative data were analysed thematically. Results showed that before the intervention mean score for lifestyle practices among adolescents remained 25.69 (SD = 3.6) out of 35 marks. Perceived happiness score remained 3.7 (SD = 2.4) and 1.8% (N = 113) of adolescents was having depressed symptoms and 14.2% was having psychological problems. Mean score for social relationships was 27.78(SD = 3.08) out of 45. When comparing the post intervention data of the intervention and control groups, there was a significant improvement in the mean score for lifestyle practices (t = 11.424, p = 0.009), mental health condition (t = 3.547, p = 0.001) and social relationships (t = 6.479, p = 0.000) in the intervention group. Psychosocial wellbeing of adolescents was seen moderate in terms of lifestyle practices, mental health condition and social relationships and this health promotion intervention has been effective in addressing some selected determinants of adolescents' psychosocial wellbeing during the economic recession in Sri Lanka.

Keywords: *Adolescents, Economic recession, Health Promotion, Psychosocial, Wellbeing*

EFFECTIVENESS OF A HEALTH PROMOTION INTERVENTION IN REDUCING DIGITAL SCREEN USAGE OF CHILDREN AGED 3–5 YEARS BY IMPROVING KNOWLEDGE, ATTITUDES AND PRACTICES AMONG MOTHERS IN SELECTED PRESCHOOL SETTINGS IN THE MATALE DISTRICT

E. H. S. Abeyratne[1]*, H. H. G. J. Pushpakumara[2] and L. Senarathna[1]

[1]Department of Health Promotion, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
[2]Department of Family Medicine, Faculty of Medicine & Allied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
*sandaniabeyratne68@gmail.com

Excessive engagement in digital screen (DS) usage by children has become a global problem, and it causes several health and developmental implications. Pediatric guidelines suggest that the use of screen-based devices by children younger than 18 months be avoided except for video chat, whereas for children aged 2 to 5 years, should be limited to 1h/day of quality programming. Despite these recommendations, the proportion of children who fail to adhere to the guidelines is high. The purpose of this quasi-experimental study was to evaluate the effectiveness of a health promotion intervention in reducing digital screen usage among children aged 3–5 years by improving mothers' related knowledge, attitudes, and practices. The study was conducted using the principles of community-based health promotion approach. It was conducted with mothers in purposively selected preschools in the Matale district. 59 mothers were in the intervention group (IG) and 57 mothers were in the control group (CG). The existing level of children's DS time, mother's DS time-related knowledge, attitudes, and practices were assessed using an interviewer-administered questionnaire, and the children's behaviors in the classroom of both groups were assessed using a behavioral checklist with the help of the preschool teacher. Determinants related to DS usage of children were identified, prioritized and the activities were designed, developed, and implemented with the mothers of the IG group through facilitated discussions. Progress was mutually monitored using indicators and redirected accordingly. Post-intervention evaluation was done by using the same study instruments with both groups and, post-evaluation exploration was done through FGD and in-depth interviews only with the mothers and teachers of the IG.118 participants (*n* = 59 intervention; *n* = 57 control) participated. Approximately 97% of households from IG and CG have televisions and smartphones respectively. In IG, television time of children reduced by 1.15 hours (p < 0.001) and 27% of children shifted their smartphone usage duration from more than one hour to less than one hour (p < 0.005).Improvements in mothers' knowledge, attitudes, and practices were significant compared to their pre-Intervention level (<0.005).This study concludes that improving mother' knowledge, attitudes, and practices using Health Promotion approach can be used to reduce digital screen usage of young children.

Keywords: *Digital screen time, Aged 3–5 children, Health Promotion intervention, Mother's knowledge, Preschool*

EFFECTIVENESS OF A HEALTH PROMOTION INTERVENTION ON IMPROVING WORK-LIFE BALANCE AMONG NURSES IN SELECTED HOSPITALS IN THE UVA PROVINCE: A QUASI-EXPERIMENTAL STUDY

J. P. M. S. Jayasinghe[1]*, Y. P. J. N. Warnasekara[2] and Prabuddhika Kandegedara[1]

[1]Department of Health Promotion, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
[2]Department of Community Medicine, Faculty of Medicine and Allied Sciences, Rajarata University of Sri Lanka, Saliyapura, Anuradhapura, Sri Lanka.
*jpmsjayasinghe@gmail.com

The work-life balance (WLB) is an important concept for employees to work healthily and productively. Research evidence reveals that nursing is a prominent occupation that experiences poor WLB. A limited number of experimental studies were conducted to improve the WLB among nurses. The objective of the study was to assess the effectiveness of a health promotion intervention on improving the WLB among nurses in selected hospitals in the Uva province. The study was a quasi-experimental design and was conducted in three phases. Nurses from two separate hospitals were selected as the intervention (IG) and the control group (CG). The existing level of WLB, knowledge, attitudes, and practices related to selected variables of WLB was assessed using a pre-tested self-administered questionnaire (SAQ) during the pre-intervention phase. The health promotion intervention was designed and delivered mutually with the IG. Initially, sessions were conducted to improve understanding of the concept of WLB. Then modifiable determinants of poor WLB were identified, activities were designed and implemented through group discussions to empower IG on improving their WLB. The progress of the intervention was monitored using process and outcome indicators. The changes after the intervention were evaluated in the post-intervention phase, using the same that was used in the pre-evaluation. The IG and CG were comprised of 60 and 58 nurses respectively. There were no differences in terms of socio-demographic characteristics between groups ($p < 0.05$). The mean value for the WLB of the IG was 67.63 before the intervention and after the intervention, it was 82.60. The improvement of the WLB in the IG was significant when compared to the CG ($p = 0.024$). Based on the pre-post comparison, the improvement of WLB in IG was statistically significant ($p = 0.001$) and there was no significant change ($p = 0.126$) in CG. Moreover, significant behavior changes were observed in receiving support from co-workers ($p = 0.001$, Chi square $= 18.8$), superior staff ($p = 0.007$, Chi square $= 14.2$), planning the daily activities ($p = 0.001$, Chi square $= 24.1$), recording income ($p = 0.001$, Chi square $= 21.1$), expenditure ($p = 0.001$, Chi square $= 18.9$), and having meals on time ($p = 0.001$, Chi square $= 38.2$) in the IG compared to the CG. An appropriately planned delivery of health promotion intervention was effective in achieving the expected outcomes of the study.

Keywords: *Work-life balance, Nurses, Health Promotion, Determinants*

EFFECTIVENESS OF A HEALTH PROMOTION INTERVENTION TO IMPROVE SOCIAL WELLBEING AMONG OLDER ADULTS IN "SAMAGI" ELDER SOCIETY, THARIYANKULAMA VILLAGE, ANURADHAPURA DISTRICT

Pathirana K.P M.D.[1]*, Wickramasinghe N.D.[2], Fernando W.M.S.[1]

[1]*Department of Health Promotion, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.*
[2]*Department of Community Medicine, Faculty of Medicine and Allied Sciences, Rajarata University of Sri Lanka, Saliyapura, Anuradhapura, Sri Lanka.*
*madhavipathirana96@gmail.com

Sri Lanka has the fastest growing ageing population in South Asia. As people age, social networks may shrink resulting older people at risk for social isolation and loneliness, leading to negative health outcomes. This study aimed to assess the effectiveness of a health promotion intervention to improve social wellbeing among older adults using health promotion approach in "Samagi" elder society in Thariyankulama village, Anuradhapura District. A pre-test post-test design with an intervention was conducted among 55 older adults to improve social wellbeing constructs such as social interactions, social support and family relationships. A process was initiated after engaging older adults as four sub groups to address determinants of social wellbeing identified by them. Helping each other, doing gardening together and share vegetables among group members, expressing gratitude for others, participating social works, spending story telling hours with grandchildren and carrying out five sense stimulation activities for brain development of grandchildren were implemented to address selected determinants. Data were collected using interviewer-administered questionnaire, focus group discussions and key informant interviews. Paired *t*-test, McNemar chi-square test and marginal homogeneity test was performed by SPSS to determine the effectiveness of intervention. According to the study findings, the mean (SD) age of the sample was 66.5 (4.4) years and the majority were females (76.4%, n = 42), 47.3% (n = 26) educated up to grade 5 and living with their families (90.9%, n = 50)). There was a statistically significant increase in overall wellbeing of older adults (df = 54, p < 0.001) and statistically significant increase in the social support of older adults (df = 54, p < 0.001) following the intervention. Seven out of nine components of healthy family relationships were significantly improved (p < 0.001) and six out of seven components of social interactions were significantly improved (p < 0.001). There were significant improvements in satisfaction about relationship with family and satisfaction about the level of support from the family (p < 0.001) following the intervention. A health promotion intervention is effective in improving social wellbeing constructs such as social interactions, social support and healthy family relationships among older adults.

Keywords: *Older adults, Social wellbeing, Social support,Social interactions, Family relationships*

EFFECTIVENESS OF A SCHOOL-BASED HEALTH PROMOTION INTERVENTION TO PROMOTE HOUSEHOLD MONEY MANAGEMENT BY TARGETING GRADE 09 STUDENTS OF THALDENA NATIONAL SCHOOL, BADULLA

R. M. C. D. Rathnayake[1]*, P. H. G. J. Pushpakumara[2] and G. N. D. Guruge[1]

[1]*Department of Health Promotion, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Anuradhapura, Sri Lanka.*
[2]*Faculty of Medicine & Allied Sciences, Rajarata University of Sri Lanka, Saliyapura, Anuradhapura, Sri Lanka.*
*rmc.dineshika@gmail.com

Economic fluctuations of the country directly affected the families as it is the primary functioning unit of society. Everyone has a responsibility to improve the management of household assets including money. The quasi-experimental study design was used for the research. The target group was grade-9 students from a mixed school. Both the intervention group (IG) and control group (CG) comprised 46 students. The self-administered questionnaire was used for students of both groups who were given ascent and consent from gradient to assess knowledge, attitude, and practices related to household money management before the intervention. The health promotion intervention was designed to promote knowledge, attitude, and practices and to identify opportunities and barriers related to household money management. The concept of Strong house versus Weak house concept, ("*Honda gedara*" *vs* "*Leda gedara*", "*Sepa wiyadam vs Moda wiyadam*"*)* and the constructed imaginary story were used for discussions with students and features of mentioned concept were entry points to discuss and plan activities for promoting household money management with student's capacity for identified determinants. Planned activities were creating money management books, gardening, reducing food ingredient leftovers, and using a list of items when shopping. Students were divided into ten task groups for monitoring activities and assessing indicators were created with students. The self-administered questionnaire was given to assess changes after the intervention and there was no significant difference between the sociodemographic data of IG and CG. After the intervention (Post data) mean values were compared in both IG and CG and values for Knowledge (IG: 50.0, CG: 37.1) and attitudes (IG: 16.0, CG: 13.0) were improved significantly ($p < 0.05$). Activities of creating money management books (15.2%), gardening (13.0%), reducing food ingredient leftovers and making additional food items (36.9%), and using a list of items when shopping (28.3%) were improved in the intervention group. During the entire process, the intervention group received 13 opportunities to meet and each meeting took 25 minutes on average. The study was flowed aligned with the principles of the health promotion approach and it was effective in promoting household money management by targeting grade-9 students.

Keywords: *Household money management, School, Health promotion, Grade 09*

POSTERS

PROMOTING HOME-BASED ECCD PRACTICES AMONG MOTHERS HAVING CHILDREN OF 1–5 YEARS, A HEALTH PROMOTION INTERVENTION
<u>M. D. T. Mendis</u>, D. S. P. Liyanapathirana, M. Karthiga, A. S. M. Azhar, K. A. D. M. G. Kuruppu, N. G. T. Indika, K. M. L. B. Abeyrathna, N. Rathnayaka and N. D. Guruge

ADDRESSING THE SELECTED DETERMINANTS LEADING TO POOR SOCIAL RELATIONSHIPS AMONG FAMILIES IN FOUR SELECTED AREAS IN SRI LANKA: A HEALTH PROMOTION INTERVENTION
<u>A. H. F. S. Harlik</u>, B. H. Fonseka, M. B. R. H. P. Rajakaruna, A. H. M. Malshani, H. M. L. Ashoka, M. G. B. H. M. Bandara, N. Rathnayake, G. N. D. Guruge and W. M. S. Fernando

IDENTIFYING AND ADDRESSING OBSTACLES FOR PROGRESS OF A HEALTH PROMOTION INTERVENTION IN PARTNERSHIP WITH COMMUNITIES IN SELECTED AREAS OF SRI LANKA
<u>B. H. Fonseka</u>, A. H. F. S. Harlik, M. B. R. H. P. Rajakaruna, A. H. M. Malshani, A. S. Niroshan, H. M. L. Ashoka, M. G. B. H. M. G. Bandara, N. Rathnayake, G. N. D. Guruge and W. M. S. Fernando

IDENTIFYING AND ADDRESSING THE DETERMINANTS OF EARLY CHILDHOOD DEVELOPMENT BY IMPLEMENTATING A HEALTH PROMOTION INTERVENTION WITH MOTHERS IN TWO DISTRICTS OF SRI LANKA
<u>K. Kavishalinie</u>, E. K. P. I. M. Jayasekara, W. M. I. D. Dissanayaka, W. A. D. L. U. Ranaweera, V. Nithushan, J. M. A. P. K. Ranasinghe, W. M. D. A. K. Wanigasekara, H. D. N. Soysa, G. N. D. Guruge and W. M. S. Fernando

MATHEMATICS

AN IMPROVEMENT TO THE INITIALLY BASIC FEASIBLE APPROACH TO THE TRANSPORTATION PROBLEM

E. M. D. B. Ekanayake[1]*and E. M. U. S. B. Ekanayake[2]

[1,2]Department of Physical Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
*dananjayaekanayake96@gmail.com

The optimization processes in mathematics, computer science, and economics are effectively solved by choosing the best component from a group of workable alternative components. One of the most important and effective applications of optimization in operations research is the transportation problem (TP), a subclass of linear programming. The TP is also one of the most highly regarded problems in the field of optimization, in which the objective is to minimize the total transportation cost or time of distribution of goods or services from various supply hubs to various demand hubs. The literature attests that numerous research projects have been developed in the past to solve the TP. Some techniques focus on finding an initial basic feasible solution (IBFS), while others focus on finding the optimal solution (OS) to the TPs. Vogel's Approximation Method, Northwest Corner Method, and Least Cost Method are the mathematical models related to providing an IBFS for a TP and are the most commonly used methods. In addition, many researchers have studied TPs and presented mathematical models that provide IBFS. Thus, after getting the IBFS, obtaining the OS is the general step in solving these problems. There, the stepping stone method or the modified distribution method (MODI) is used to get the OS value. Through this research study, a new method has been proposed to obtain IBFS values for TPs. Transportation problems is usually done in the form of a transportation table. Accordingly, the proposed method is presented based on obtaining the mean value of each column and row of the transportation table. The proposed method has proven to provide near-optimal solutions for balanced and unbalanced transportation problems to a reasonable degree of satisfaction, even for large-scale TPs. For that reason, using proposed method has solved TPs. There, those solution values are compared with existing methods used to obtain IBFS. It can be concluded that the efficiency of the proposed method has been achieved. According to that, the proposed method is straightforward to use and comprehend. The algorithmic approach proposed in this work is less complicated than well-known meta-heuristic algorithms in the literature.

Keywords: *Balance and unbalance transportation problem, Existing methods, Initial basic feasible solution, Optimal solution*

A NEW FOURTH ORDER APPROXIMATION FOR ONE DIMENSIONAL DIFFUSION EQUATION

S. S. Nawaratne[1]*, W. A. Gunarathna[1] and M. A. M. Mohamed[1]

[1]Department of Physical Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
*subodha1996sn@gmail.com

The one-dimensional diffusion equation (DE) models the distribution of heat in a uniform rod with respect to time. The diffusion equation is a linear parabolic partial differential equation in the form $\frac{\partial U}{\partial t} = \alpha^2 \frac{\partial^2 U}{\partial x^2}$. The DE is applied in physics, chemistry, finance, geology, etc. Analytical solution forms of the DE are often cumbersome. Therefore, computational or numerical methods have been more favourable in the literature. Finite difference method is a computational technique which is widely being used to solve the DE. There are three standard finite difference approximations; namely, explicit, implicit and Crank-Nicolson (CN) method depending on the discretization of the time derivative of the DE. Compared to explicit and implicit schemes, the standard CN (CN2) scheme is unconditionally stable and second order accuracy in both time and space. Therefore, this study aims to develop higher order (>2) approximations for the DE using CN concept. To attain this, the spatial (second) derivative (SD2) of the DE is formed to have a convex combination of two shifted second order accuracy central difference approximations of the SD2. The convex coefficients are determined to have fourth order approximation for SD2. Using the CN technique with the preceding order four approximation, a new fourth order CN (NCN4) approximation with two shift parameters, r_1 and r_2 is derived. The NCN4 approximation is spatially fourth order accuracy and temporally second order accuracy. Each pair of unequal integer shifts yields a unique fourth order CN scheme. Incidentally, a new second order accuracy Crank-Nicolson (NCN2) scheme with a single fractional shift (R) is also obtained from the CN4 scheme. It is found that the NCN4 approximation displays lower accuracy than that of the CN2 approximation, for $r_1 = 1, r_2 = 2$ and $r_1 = 2, r_2 = 3$. However, the NCN2 demonstrates better accuracy than the CN2 scheme when $R = \pm 1/N$, where N denotes the spatial grid size (e. g.: the maximum errors of the CN2 and NCN2 schemes are 0.0000003 and 0.0000001, respectively, when $N = 1000$ and grid size $h = 0.001$). The stability and convergence analysis of the proposed CN schemes and criteria on the selection for shift parameters will be the future subject of the study.

Keywords: *Diffusion equation, Crank-Nicolson scheme, Fourth order approximation, shift parameters*

OFFLINE SIGNATURE VERIFICATION BY USING PROPER ORTHOGONAL DECOMPOSITION

H. D. A. W. Subawickrama[1]*, S. A. A. Nishantha[1] and M. A. M. Mohamed[1]

[1]*Department of Physical Science, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.*
amandisubawickrama586@gmail.com

A signature is known as non-vision-based identification used in document authentication and personal verification. Signature verification is crucial in the field of financial, commercial, and legal matters. This study presents a novel approach for offline human signature verification using Reduced Order Modelling (ROM) based on Proper Orthogonal Decomposition (POD). So, this POD helps us to convert the high-dimensional data into a lower-dimensional model, which extracts the most important features that represent the more characteristic features of the original data set. The main objective of this study is to test the performance of the ROM by reconstructing an input signature and verifying the signatures in the test data set as genuine or forgeries. We consider 30 different real signatures as our training data set to create the ROM and to test the model performances we have used 10 different signatures. The ROM's required basis functions are obtained using the proper orthogonal decomposition. The eigenvalue spectrum is used to obtain the required number of basic functions. To do the verification process, we have trained 180 signatures which include 18 genuine signatures from each 10 different signature types. The error in the training data set was found using the singular values. An index and confidence interval relevant to the training data was found by replacing 40 genuine signatures randomly. Based on the index and the confidence interval, 60 signatures were tested as genuine and forgery. True Positive Rate (TPR), and False Positive Rate (FPR) are used to measure the model accuracy at the significant levels of 90%, 95%, 99%, and 99.9%. The reduced order model can successfully reconstruct the signatures when we select the number of dominant eigenvalues as 30. The quality of the signature is tested by the Structural Similarity Index Measure (SSIM). It gives the 0.6494 similarity index value. As this value is greater than 0.5, we can conclude that ROM produces quality reconstructed signatures. At a 99.9% confidence interval, the proposed technique gives the results with 64% accuracy.

Keywords: *Accuracy, Dimension reduction, Proper orthogonal decomposition, Reduced order model, Singular value, Signature verification*

PORTFOLIO OPTIMIZATION AND REBALANCE INCORPORATING TRANSACTION COSTS

M. W. M. L. Vidumali[1]* and S. A. A. Nishantha[1]

[1]*Department of Physical Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.*
*lalithayavidumali@gmail.com

The concepts of portfolio optimization and diversification have considerably improved the processes of development, comprehension, and financial decision-making. By carefully selecting and rebalancing their portfolios, asset managers are able to create the best asset allocation and rebalancing strategies. One can predict the expected outcomes by raising or lowering the amount of a particular item in a portfolio. Here, we examine the experimental findings from the literature, which compared the performance of rebalancing and standard Markowitz portfolio optimization in terms of risk and return on investment. The results are then compared to those of the trials that considered transaction costs. This research uses historical close prices for 10 randomly selected equities from the Financial Times Stock Exchange 100 Index (FTSE100) over a five-year period via yahoo finance. The MATLAB software is then used to create a portfolio with a risk-free rate, asset return moments, and an estimation of the mean covariance of each return. After calculating the weights of the three efficient portfolios and determining that the parametric efficient portfolio was the most diversified, it was chosen to be rebalanced. Optimized weights and transacted quantities of each investment were used in the quadratic programming model to rebalance the portfolio while accounting for transaction costs. A rebalancing model was developed using the portfolio with the greatest degree of diversification, which proved out to be the parametric efficient portfolio. When the model's variables were examined, it was found that the portfolio's risk and return were lower after rebalancing than they had been beforehand. When one variable decreased while others stayed constant, the risk and return of the portfolio steadily declined.

Keywords: *Efficient portfolio, Portfolio optimization, Portfolio rebalancing, Parametric efficient, Transaction cost*

GRACEFUL LABELING OF FEW TYPES OF GRAPHS AND THEIR APPLICATIONS

W. K. M. Indunil[1]* and A. A. I. Perera[2]

[1]Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
[2]Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka.
*asp1617030@as.rjt.ac.lk

Graph labeling is one of the most conspicuous research areas in graph theory and the history of graph labeling can be traced back to 1967. As well as graph labeling techniques are widely used in almost every field such as in the medical field, engineering field, military field, astronomical field, and many more. There is a vast number of graph labeling techniques such as prime labeling, radio labeling, antimagic labeling, graceful labeling, etc. Graceful labeling is a bit more popular out of these graph labeling techniques since it has a wide range of applications in the real world. Some of them are in coding theory, X-ray crystallography, missile guiding codes, communication networks, cryptography, etc. In this study, we introduce graceful labeling of triangular-type grid graphs L vertex union of triangular-type grid graphs, L disconnected triangular-type grid graphs, chain graphs of dice and key graphs with pendants, and a stack of prism graphs. Odd and even graceful labeling of several graphs out of the above mentioned also discusses for the fulfillment. Finally, we introduce a cryptographic scheme using an algebraic function along with the XOR function and discuss thoroughly how graceful graphs can be used in this method, and illustrate by using an example of both encryption and decryption processes. Also, we prove that this novel cryptographic method can be applied to any graceful graph. Further, we model a computer network using the chain of dice graphs with pendants and demonstrate briefly how graceful labeling can be used in multi-protocol label switching networks (MPLS).

Keywords: *Chain graph, Cryptography, Graceful labeling, Stack of $p + 1$ prisms, Triangular type grid graph*

ANALYSIS OF THE DYNAMICS OF MACHINE LEARNING TECHNIQUES USED IN FOOTBALL MATCH RESULTS PREDICTIONS

K. N. Kaluarachchi[1]*, K. P. Premachandra[1] and R. B. N. Dissanayake[1]

[1]*Department of Physical Science, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.*
*knk.nisansala2012@gmail.com

Precisely predicting sports results is a widely known challenge in the sports industry. It has now become the trend to predict single sports as well as less predictable team games such as football, volleyball, basketball etc. Predicting the outcome of a football match is an expanded area of research simply for the commercial assets involved in the betting process. Conventionally, the outcome of a match was predicted by the experts in the field. However, today, this approach is empowered by the growing amount of diverse football-related information that can be processed. In this study, the variation of machine learning (ML) techniques used to study the predictions of football match results is analyzed. The data used by the previous studies have been extracted from European leagues such as English Premier League (EPL), French League 1 (FL), German Bundesliga (GBL), Italian Series A (ISA), and Spanish La Liga (SLL). This study mainly compares the performance of different machine learning models used in previous studies. The data set used in this study was collected from the season 2008/2009 to 2022/2023 with 13000 data points in each league. Logistic regression (LR), decision tree (DT), random forest (RF), support vector machine (SVM), k-nearest neighbor (KNN), gradient boosting (GB), and naïve Bayes (NB) are the ML techniques that are used to predict the results in this study by partitioning the dataset into training and testing. The training set includes data from season 2008/2009 to 2017/2018, and the testing set contains data from season 2018/2019 to 2022/2023. By using several evaluation metrics such as accuracy, precision, sensitivity, F-1 score, mean squared error (MSE), and area under the receiver operating and characteristic curve (AROC), the best-performing model is chosen to make the predictions. The best ML model that uses to predict results in EPL, FL, ISA, and SLL is GB with accuracies of 0.6105, 0.6401, 0.6381, and 0.6430, respectively, while SVM is the best model to predict results in GBL with an accuracy of 0.6146. Moreover, the results show that the ML model with the best accuracy differs with different European Leagues.

Keywords: *Leagues, Prediction, Soccer, Sports, Supervised*

SOLVING LARGE SCALE MINIMUM SPANNING TREE PROBLEMS AND TRANSPORTATION PROBLEMS USING A MODIFIED ANT COLONY ALGORITHM

K. P. O. Niluminda[1]* and E. M. U. S. B. Ekanayake[1]

[1]Department of Physical Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
*kponiluminda@gmail.com

A spanning tree of a graph is a subgraph obtained from a connected graph that contains all the vertices of a graph. For a connected having no cycles graph there may be many spanning trees. As implied by the name, the Minimum Spanning Tree (MST) is the one with the shortest potential length among all spanning trees. The literature witnesses that different techniques have been developed in the past to solve the MST problem. Prim's and Kruskal's prominent algorithms have been developed for MST problems. Also, the Transportation Problem (TP) is one of the highly regarded problems in the field of optimization in which the objective is to minimize the total transportation cost of distributing resources from several sources to several destinations. The literature witnesses that different techniques have been developed in the past to solve the transportation problem. Some techniques, concentrate on finding an initial basic feasible solution and the rest focuses on finding the optimal solution to the TP. The Ant Colony Optimization Algorithm is a probabilistic method for handling computing problems that may be simplified to determine the best path of the graphs. This study proposes a heuristic method known as the Modified Ant Colony Algorithm, which is based on Ant Colony Optimization Algorithm, and has proven to provide the best performance combined with MST problem and TP for solutions to a reasonable degree of satisfaction even for large-scale problems. In this novel approach, the degree of satisfaction with the optimal solution has been improved by modifying Ant Colony Optimization Algorithm with the incorporation of the Transition Rule and Pheromone Update Rule. These experiments show that the Modified Ant Colony Algorithm outperforms other well-known meta-heuristic algorithms in the literature in terms of computational efficiency and solution quality. Specifically, the results demonstrate that the Modified Ant Colony Algorithm can solve large-scale MST and TP problems with a high degree of satisfaction in terms of the quality of the optimal solution. Additionally, this algorithm is less complex than other meta-heuristic algorithms, making it more suitable for practical applications. These findings have important implications for researchers and practitioners in the field of optimization, as they provide a promising new approach for solving complex optimization problems.

Keywords: *Ant Colony Optimization Algorithm, Initial Basic Feasible Solution, Minimum Spanning Tree, Optimal Solution, Transportation Problem*

SOLVING THE VEHICLE ROUTING PROBLEM WITH SIMULTANEOUS PICK-UP AND DELIVERY USING A LOCAL SEARCH-BASED HYBRID GENETIC ALGORITHM

P. V. V. Viduranga[1]* and M. K. D. D. Sandaruwan[1]

[1]*Department of Physical Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.*
*wishwavidu97@gmail.com

The transportation industry today demands effective decision-making tools that can help to reduce costs and to optimize resource consumption. The Vehicle Routing Problem (VRP) and its various variants are the primary focus of research in logistics planning optimization. Solving the VRP can result in significant improvements in transportation logistics, leading to better efficiency, cost savings, and resource utilization. One such variant of the VRP is the Vehicle Routing Problem with Simultaneous Pick-Up and Delivery (VRPSPD), where clients require both pick-up and delivery services simultaneously. In this problem, the delivery loads are supplied from a single depot at the beginning of the vehicle's service, while the pick-up loads are taken to the same depot at the end of the service. The key feature of this problem is that a vehicle's load in any given route is a combination of both pick-up and delivery loads, making the VRPSPD a complex and challenging problem that requires specialized algorithms to solve. Since the VRPSPD's complexity is NP-hard metaheuristic algorithms are commonly used in the literature for solving the problem. This study proposes a hybrid metaheuristic algorithm that combines Genetic Algorithm (GA) with Local Search (LS) techniques to solve the VRPSPD efficiently. The hybrid metaheuristic algorithm has three versions, namely, PHGA-P1, PHGA-P2, and PHGA-P3, with varying degrees of LS integration into the GA. The performance of the proposed algorithms was evaluated using a set of standard benchmark instances against the GA and the modified GA introduced by Rahimi in 2016. The proposed three hybrid algorithms outperformed both GA and the modified GA in terms of total traveling distance, with PHGA-P1 providing the best results while consuming less CPU time. Based on the results, the PHGA-P1 algorithm can be recommended to solve the VRPSPDs and the proposed hybrid metaheuristic approach has significant potential for further research.

Keywords: *Vehicle Routing Problem with Simultaneous Pick-Up and Delivery,* Hybrid *Metaheuristic, Genetic Algorithm, Local Search*

CHROMATIC POLYNOMIAL OF LADDER GRAPH

E. H. W. Weerabaddana[1]* and A. A. I. Perera[2]

[1]*Department of Physical Science, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.*
[2]*Department of Mathematics, Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka.*
*erushah84@gmail.com

The study of the chromatic polynomial is a special part in algebraic graph theory. Chromatic polynomial counts the number of graph colourings as a function of the number of k distinct colours in such way that no two adjacent vertices are assigned the same colour. It was originally defined by George David Birkhoff to solve the four colour problem in 1912. The chromatic polynomial is often used in graph colouring problems, which are widely applicable in resource allocation, scheduling, and pattern matching. Most chromatic polynomials are obtained from the inspection and the Deletion-Contraction method. There are general formulas of chromatic polynomial for some type of graph. But most of them have not been proven. Our work focuses on the general formula of special types of ladder graph. Here we consider ladder graphs (closed ladder graph) (CL_n) and an open ladder graph (OL_n) obtained by eliminating the side edges of the ladder graph. Also, we introduce the Millipede graph (M_n) as another special type of ladder graph. In this study, general formulas of chromatic polynomials for open ladder graph, closed ladder graph and Millipede graph are obtained by dividing the ladder graph into two graphs G_1 and G_2 by the common edge. Let $P_G(k)$ denote the number of proper-vertex colourings of the graph G by k distinct colours. The general formula of chromatic polynomial of CL_n for $n > 1$ can be recognised as, $P_{CL_n}(k) = k(k-1)(k^2 - 3k + 3)^{n-1}$. The general formula of chromatic polynomial of Open ladder graph (OL_n) for $n \geq 3$ can be recognised as, $P_{OL_n}(k) = k(k-1)^5(k^2 - 3k + 3)^{n-3}$. Also, the general formula of chromatic polynomial of Millipede graph (M_n) for $n > 1$ can be recognised as, $P_{M_n}(k) = k(k-1)^{2n+1}(k^2 - 3k + 3)^{n-1}$. The correctness of the obtained general formulas can be proven using the mathematical induction method.

Keywords: *Chromatic polynomial, Closed ladder graph, Millipede graph, Open ladder graph*

HIGHER ORDER COMPUTATIONAL TECHNIQUES FOR DERIVATIVES WITH APPLICATIONS

J. A. M. P. Weerasinghe[1]*, W. A. Gunarathna[1] and M. A. M. Mohamed[1]

[1]*Department of Physical Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihinthale, Sri Lanka.*
*malkipiyumali@gmail.com

Derivative is an important concept in mathematics/calculus and there are many applications of derivatives spread across many areas such as engineering, economics, medicine, and optimization. In many cases, existing analytical methods have failed to solve many derivative-based problems. Therefore, developing computational techniques for derivatives has been an active research area. The finite difference method, among other approximate methods such as finite element and finite volume methods, is a simple computational technique used to solve differential equations, due to its simple discretization process. The Taylor series is often devised to obtain finite difference forms for derivatives. In this method, a linear combination of the Taylor series of a function at various grid points are used to derive finite difference forms for derivatives. For higher-order approximations, this method includes heavy hand computations and solving large linear systems and thus, this computational process is cumbersome. This study aims to develop higher order accurate computational techniques for first and second derivatives. For sufficiently smooth function $f(x)$ and grid size h, we define the weighted average operators: $A^1_{h,s_1,s_2,\ldots,s_p} f(x) = \sum_{i=1}^{p} \lambda_i Q^1_{h,s_i} f(x)$ and $A^2_{h,r_1,r_2,\ldots,r_p} f(x) = \sum_{i=1}^{p} \mu_i Q^2_{h,r_i} f(x)$ for the first and second derivatives, respectively, where $Q^2_{h,r_i} f(x) = (f(x + r_i h) - 2f(x) + f(x - r_i h))(r_i h^{-2})$, $Q^1_{h,s_i} f(x) = (f(x + s_i h) - f(x - s_i h))(s_i h)^{-2}$, r_i, and s_i, $i = 1, 2, \ldots, p$, are some real numbers. Then it is shown that the foregoing derivatives approximate the first and second derivatives with an accuracy of order $2p$. Furthermore, two explicit formulas are derived in the numerator-denominator forms to find the weights, λ_i and μ_i of these operators. The MATLAB codes are developed to implement the explicit formulas. To attain efficient computations, separate MATLAB implementations are presented for the numerator and denominator parts of the explicit formulas. Then, using the MATLAB codes, generic weight coefficients for accuracy order 4, 6, 8, and 10 are also obtained in symbolic form. These approximations are applied to the second-order boundary value problem. Numerical tests are also presented to show the effectiveness of the proposed difference approximations.

Keywords: *First and second derivatives, Finite difference approximations, Second order boundary value problem*

FORECASTING GLOBAL FINANCIAL DEVELOPMENT INDEX AND PREDICTING ECONOMIC STABILITY USING VAR AND AGNES-PCA ALGORITHMS

R. R. W. G. B. M. K. B. Hulangamuwa[1]*, P. K. Premachandra[1] and Dissanayake R. B. N.[1]

[1] Department of Physical Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
* mkb.hulangamuwa@gmail.com

Vector autoregressive (VAR) models predict, forecast, and investigate the dynamic behaviour of time series variables. This study explores the dynamic behaviour of financial indices published by the International Monetary Fund (IMF) for gauging the development of financial institutions and markets. The study used VAR models to forecast the Financial Development Index (FDI) for the next ten years at a 95% confidence interval. The endogenous variables considered were the financial development index and indices for the depth, accessibility, and efficiency of financial institutions and financial markets. The analysis found that the VAR (9) model with the endogenous variables of financial development and financial institutions' efficiency is the best model to forecast FDI. Cross-validations were carried out to validate the results. Forecasting accuracy was evaluated using the mean absolute scaled error (MASE). Granger causality test results proved the presence of higher adjusted R squared (91.07%) in the final model. FDI exhibited a positive response for up to two years to a one standard deviation impulse in the financial institutions' efficiency index before reaching a stable state. The results of the Granger Causality, Impulse Response Function (IRF), and VAR models suggest that the efficiency of financial institutions is crucial to global finance development. In addition, the study utilized hierarchical agglomerative clustering (AGNES) and principal component analysis (PCA) to predict the stability of an economy using FDIs. By identifying which cluster a country belongs to, the study effectively determines the economic stability of that country. If a country is clustered with other stable economies, then it is considered stable, and if clustered with other unstable countries, it is considered unstable. This method clusters world economies into 11 optimal clusters, with one cluster primarily consisting of economically unstable economies that have experienced financial and economic crises. It should be noted that this is the first time that the AGNES-PCA (AGNES with PCA) algorithm has been used to cluster FDI data. In conclusion, the findings of this study offer valuable insights for economists, financial specialists, investors, and decision-makers, allowing them to anticipate future economic stability and make informed decisions regarding investment strategies and economic policies.

Keywords: *Economic Stability, Hierarchical Agglomerative Clustering, Impulse Response Function, Granger Causality, Principal Component Analysis, Vector autoregressive*

NEW SECOND AND FOURTH ORDER DIFFERENCE APPROXIMATIONS FOR FISHER EQUATION

C. T. Fernandopulle[1]*, W. A. Gunarathna[1] and M. A. M. Mohamed[1]

[1]Department of Physical Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
*ctharushi97@gmail.com

Fisher Equation (FE): $u_t = \beta u_{xx} + \alpha u(1-u)$, where α and β are constants, a nonlinear partial differential equation which is used to model physical systems involving the effects of both linear diffusions and nonlinear reactions. The FE arises in numerous applications, including brain tumour dynamics, population dynamics, chemical reactions, etc. In the literature, computational techniques have been preferred to attain a solution to the FE due to the lack of closed-form analytical solutions. Among them, the finite difference approximation (FDA) has widely been used to obtain a discrete solution to the FE. Combined with Crank-Nicholson (CN) technique, some second and fourth-order accurate CNFDAs appear in the literature. In these methods, the nonlinear part of the FE is discretised to its corresponding linear form using the lagging technique (LT). Since the convergence order of the LT is one, it brings down the CN schemes to first-order accuracy in time. Therefore, the CN schemes do not give the expected accuracy. This study aims to develop new highly accurate CN schemes for the FE using a new linearization technique (NLT). In this method, our approach is two-fold. First, a pre-conditioned operator (PO): $P_h = 1 + \frac{h^2}{12}\Delta_h^2$ for the second derivative (D_2) is constructed, where Δ_h^2 is the central difference operator for D_2. It computes the pre-conditioned $P_h D_2$ with order 4 accuracy from Δ_h^2. Secondly, to derive the NLT, the nonlinear part of the FE is discretised at the middle point of two consecutive time steps with order 2 accuracy, using concepts of arithmetic and geometric means. Then, using the NLT, a new CN scheme of second-order accuracy in both space and time is obtained. Also, a new CN scheme of second-order accuracy in time and fourth-order accuracy in space is derived using the PO and the NLT. Furthermore, a new CN scheme of first-order accuracy in time and fourth-order accuracy in space is constructed using the PO and LT. Richardson extrapolation technique is used to further increase the accuracy of the space discretization of order 4 schemes to order 6. From numerical tests carried out to demonstrate the performances, it is found that the proposed schemes for the FE are more accurate than the existing second and fourth-order CN schemes.

Keywords: *Crank-Nicholson scheme, Geometric mean, Order 2 central difference approximation, Preconditioned operator, Richardson extrapolation*

PREDICTING THE SURVIVAL TIME OF POST KIDNEY TRANSPLANT PATIENTS IN SRI LANKA

T. M. P. S. K. Thennakoon[1]*, N. Nanayakkara[2,3], H. G. N. Erandika[3],
P.K. Premachandra[1] and R. B. N. Dissanayake[1]

[1]*Department of Physical Science, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.*
[2]*Nephrology and Kidney Transplant Unit, National Hospital, Kandy, Sri Lanka.*
[3]*Centre for Research, National Hospital, Kandy, Sri Lanka.*
*sandunkumara2525@gmail.com

The accurate prediction of survival times is critical for improving the post-care of kidney transplant patients. In this study, the performance of two different models - the proportional hazard (PH) model and the accelerated failure time (AFT) model are compared for predicting survival times. The PH model assesses the relative risks of various factors on survival while the AFT model estimates the time until an event occurs. The performance of these models is evaluated under two temporal scenarios and the factors that affect survival times for kidney transplant patients are identified. Our findings provide insights into the factors that influence survival times and help improve the accuracy of survival predictions in clinical practice. 74 kidney transplant patients diagnosed at the National Hospital, Kandy from February, 2020 to December, 2022 are analysed. The dataset of post-kidney transplant patients during the first six months subsequent to the transplant is considered as Scenario I and that of during the first year subsequent to the transplant is considered as Scenario II. This study is limited to four AFT models based on exponential, Weibull, lognormal and log-logistic distributions. Log cumulative hazard plots and goodness of fit test are used to test PH assumptions. AIC is used to compare survival models. Constant hazard assumption for scenario I is held. While PH model having the lowest AIC value (AIC = 35.38631) is the best model for the scenario I, PH model having the lowest AIC value (AIC = 122.4384) among AFT models is invalid due to violated PH assumption in scenario II. However, the exponential AFT model having the next lowest AIC value (AIC = 246.6439) is the best model out of all models in scenario II. Based on the violation of the PH assumption, the PH model is appropriate for short-term studies while the AFT model is appropriate for long-term studies in predicting the life expectancy of kidney transplant patients. The exponential AFT model shows that factors such as donor type, recipient age, recipient gender, employment status, alcohol consumption and betel chewing have affected the post-kidney transplant survival times.

Keywords: *Proportional hazard model, accelerated failure time models, Akaike Information Criterion, Goodness of fit*

RADIO MEAN LABELING OF CYCLES AND PENDANT GRAPHS

G. H. S. N. Weerasinghe[1]* and A. A. I. Perera[2]

[1]*Department of Physical Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.*
[2]*Department of Mathematics, Faculty of Science, University of Peradeniya, Peradeniya, Sri Lanka.*
*nethmini1026@gmail.com

A graph G is a pair of sets $\big(V(G), E(G)\big)$, where $V(G)$ and $E(G)$ are the set of vertices and the set of edges in G, connecting the pair of vertices, respectively. The diameter of a graph is the "longest shortest path" between any two graph vertices u and v, denoted by $max_{u,v} d(u, v)$, where $d(u, v)$ is the graph distance. Graph labeling is one of the most popular research areas in graph theory. Among all graph labeling methods, radio labeling is one of the most practical labeling methods. Radio labeling problem was first modeled by Hale in 1980. The concept of radio labeling of graph G was defined by G. Chartand and R. Ponraj introduced the notion of radio mean labeling of G and they found the radio mean number of graphs and subdivided graphs. Telecommunications, biology, and physics are some of the areas in which radio labeling can be applied. A radio labeling f of G is an assignment of positive integers to the vertices of G satisfying, $|f(u) - f(v)| \geq diam(G) + 1 - d(u, v)$, where $u, v \in V(G)$ and $d(u, v)$ is the distance between any two vertices in the graph. In this research, we have been generalized the above result by including arithmetic mean of labelings f instead of their difference, such that $\lceil [f(u) + f(v)]/2 \rceil \geq diam(G) + 1 - d(u, v)$. The radio mean number of f, $rmn(f)$ is the maximum number assigned to any vertex of G. The radio mean number of G, $rmn(G)$ is the minimum value of $rmn(f)$ taken over all radio mean labelings f of G. Alternative proof for radio mean number of cycles and pendant graphs are presented in this research work.

Keywords: *Cycle, Pendant Graph, Radio Mean Labeling, Radio Mean Number*

POSTERS

GENERALIZATION OF ODD PRIME LABELLING OF SNAKE GRAPHS
K. H. C. De Silva and A. A. I. Perera

PHYSICS

MODELLING OF GROUND MAGNETIC DATA TO UNDERSTAND GEOLOGICAL CONTROL OF GEOTHERMAL ACTIVITIES IN MADURU OYA GEOTHERMAL FIELD

G. M. T. Dilshan[1], S. A. Samaranayake [1]*, H. O. Wijewardane[1] and U. Dahanayake[1]

[1]Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.
*samaranayakerusl@gmail.com

Although Sri Lanka is not located with close proximity to active plate boundaries and active fault zones with thermal signatures, it contains number of hot springs such as Rangiriulpotha, Kanniya, Nelumwewa, Kapurulla, Mahaoya, Wahawa, Mahapelessa and Maduru Oya. The origin of geothermal fields in Sri Lanka is still arguable. In order to identify the subsurface characteristics, it is necessary to conduct geophysical surveys along with geological surveys. The potential field methods such as gravity and magnetic are the commonly used methods to identify deep subsurface structures. The present study was focused to model the magnetic anomalies over the Maduru Oya geothermal field to demarcate subsurface deep driven geological features. Total magnetic field intensity data collected by Geological Survey and Mines Bureau of Sri Lanka were used as raw data for the present study. Data were corrected to eliminate diurnal variation and the earth magnetic field effect. The resultant anomaly map obtained was used for further processing. Data enhancement techniques including 3D analytical signal and upward continuation were applied to anomaly data to map edges and estimate depths to the subsurface structures. Shape of the anomalous body was demarcated by 2D magnetic subsurface modeling along four profiles. NW-SE extending linear feature was evident from magnetic survey and 2D modeling concluded that it was a deep driven fracture passing through the study site. The background rock type of the Maduru Oya geothermal field area is granite gneiss and it consists with magnetic properties which can be studied by magnetic survey. However, the observed fracture does not have any magnetic properties and hence this contrast could be identified in magnetic survey. The present study concluded that the observed NW-SE driven fracture was about 140 m broad with further dipping in to the NW-SE direction. This could probably be a feeding fracture of the Maduru Oya geothermal system.

Keywords: *Maduru Oya Hotspring, 3D analytical signal, upward continuation, 2D magnetic modelling, fracture*

USE OF CINNAMON WOOD BIOCHAR AS A WATER PURIFYING AGENT

H. P. T. P. Gunarathna[1]*, C. A. Thotawatthage[1] and H. O. Wijewardane[1]

[1]*Department of Physical Sciences, Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale, Sri Lanka.*
*tpgunarathna@gmail.com

Cinnamon Wood Biochar (CWBC) possesses the ability to remove a diverse range of pollutants, including the heavy metals and, organic compounds from water. Therefore, to study the possibility of CWBC as an adsorbent for the removal of temporary hardness caused by Calcium Bicarbonate ($CaHCO_3$) in water was carried out due to its potential as a sustainable and cost-effective alternative to traditional water treatment methods. This study investigated the use of CWBC prepared at temperatures of $300°C$, $400°C$, and $500°C$ for the removal of Ca^{2+} to reduce temporary hardness in water. The physical and chemical properties of the biochar were characterized using Scanning Electron Microscope (SEM), and Atomic Absorption Spectroscopy (AAS) technique were conducted to evaluate its adsorption capacity for Ca^{2+} at different concentrations (50 ppm, 100 ppm, 150 ppm, 200 ppm, 250 ppm). The results showed that the $400°C$ CWBC had 10.32% adsorption capacity (from initial concentration) for Ca^{2+} and could effectively remove it from water containing $CaHCO_3$ at an optimum concentration of 250 ppm. Furthermore, as the application with the use of Electrospinning technique the preparation of nanofiber with 50000 Mw Cellulose Acetate (CA) and $400°C$ CWBC in 53 μm scale showed promising results for Ca^{2+} adsorption. The adsorption process was considered by varying the concentration, while the other parameters were keeping constant. The CWBC also exhibited good stability and could maintain its adsorption capacity over multiple cycles of use. Overall, this study demonstrates the potential of CWBC as an effective and sustainable adsorbent material for the removal of Ca^{2+} to reduce temporary hardness in water, which could contribute to improved water quality and reduce the negative impacts of $CaHCO_3$ in water systems.

Keywords**:** *Cinnamon Wood Biochar (CWBC), hardness, Calcium Bicarbonate ($CaHCO_3$), nanofiber, Water quality*

POSTERS

IDENTIFICATION OF GROUND WATER POTENTIAL IN THE PREMISES OF THE FACULTY OF APPLIED SCIENCES, RAJARATA UNIVERSITY OF SRI LANKA USING AN ELECTRICAL RESISTIVITY SURVEY
H. A. S. Thakshila, S. A. Samaranayake, H. O. Wijewardane and U. Dahanayake

EXTRACTION OF SILICA NANO-PARTICLES FROM PALMYRA SHELL AS AN AGRICULTURAL WASTE VIA SOL-GEL METHOD
U. D. D. S. Gamage, C. A. Thotawatthage and H. O. Wijewardane

LOW-COST QUADRIFILAR HELIX ANTENNA FOR SATELLITE DATA RECEIVING
K. G. M. S. Thilakarathne, J. M. K. W. Kumari, C. A. Thotawatthage, J. Weerasinghe and H. O. Wijewardane

Organization of ASURS 2023

Programme Chair:
Dr K. A. S. H. Kulathilake

Programme Secretary:
Mrs Ishantha Hewarathna

Organizing Committee:
Dr Uthpala Ekanayake
Dr Naleen Jayaratne
Mrs Prabuddhika Kandegedara
Mr Wiraj Wickramaarachchi
Dr Malaka Wijayasinghe

Editorial Board:
Mr P. S. Palliyaguruge
Dr Kaushlaya Premachandra
Dr Dinazarde Raheem (Chief Editor)
Dr Lalith Senarathna
Dr Suchithra Senevirathne

Cover & Booklet Design:
Mrs Ishantha Hewarathna
Mr Wiraj Wickramaarachchi