PROCEEDINGS

IRCUWU 2022

6TH INTERNATIONAL RESEARCH CONFERENCE

JULY 28TH & 29TH, 2022

"Elevating the quest for resilience to spring forward"

Uva Wellassa University of Sri Lanka

IRCUWU 2022

6th International Research Conference - 2022

"Elevating the Quest for Resilience to Spring Forward"

July 28-29, 2022

Uva Wellassa University
Badulla
Sri Lanka

ISBN: 978-624-5856-38-1

Published by:
Uva Wellassa University of Sri Lanka, Badulla, 90000
Sri Lanka

Acknowledgments

The 6th International Research Conference of Uva Wellassa University (IRCUWU2022), themed "Elevating the quest for resilience to spring forward" is a two-day virtual conference where the inauguration session preceded two technical sessions. The conference would not have materialized without the help, contribution, dedication, and well wishes of a number of personalities.

The Chairman of the Research Committee and Organizing Committee of IRCUWU2022 express their heartfelt gratitude to the Chief Guest, Professor J.L. Ratnasekera, Vice Chancellor of Uva Wellassa University of Sri Lanka, keynote speakers; Professor Jung Min Heo, Division of Animal and Dairy Science, Chungnam National University, Republic of Korea and Professor Dr. Amiya Bhaumik, President, Lincoln University College, Malaysia, for sharing their invaluable experiences and thoughts with us.

All track coordinators, panel members, and track conveners deserve a special thanks for their valuable contributions for this event. Furthermore, the authors and presenters are deserving of endless praise for their contributions and for sharing their important research findings in a variety of methods.

This work would not have been witnessed by the audience without the ready assistance and co-operation extended by the Editor-in-Chief, the members of the Editorial Board, and Reviewers in finalizing the Proceedings while maintaining the accepted standards in scientific publications.

Special thanks and appreciation are also extended to IT and Audio-Visual Units of Uva Wellassa University for their untiring effort to stream the event live allowing uninterrupted online conferencing.

A heartfelt appreciation must be extended to the Bank of Ceylon, Badulla Branch as the main sponsor, who consistently supported this event during tough times. We are highly grateful towards the Sinharaja Forest Dynamic Plot "ForestGEO" funded by Smithsonian Tropical Research Institute, USA for the financial contribution. Further, financial support of the AHEAD World Bank Project and the Seylan Bank, Badulla Branch is recalled with gratitude.

Finally, sincere appreciation goes to all the committed academic, administrative, and non-academic staff members of Uva Wellassa University and all those who actively engaged in IRCUWU2022's success.

IRCUWU2022

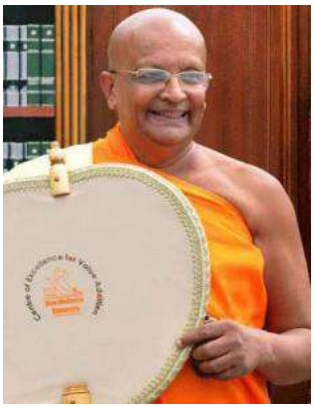
Uva Wellassa University was established as the first entrepreneurial university of Sri Lanka with the aim of producing graduates with exceptional entrepreneurial and technical skills specialized towards adding value to Sri Lanka's resource base. IRCUWU 2022 is yet another important milestone which marks the university's journey towards research excellence. IRCUWU 2022, once again brought forward as an online conference, intends the dissemination of research findings of Uva Wellassa University as well as those of other local and foreign participants.

Under the theme of "*Elevating the quest for resilience to spring forward*", the conference explores the potential for overcoming adversities and reaching socio-economic progress through information and innovation. IRCUWU 2022 invites all researchers, scientists, scholars, industrialists, professionals and students to come together to share and review their novel findings and innovations under ten thematic areas;

1. Agriculture & Animal Husbandry
2. Aquaculture & Fisheries
3. Business Management
4. Computing & Informatics
5. Engineering & Technology
6. Environmental Sciences
7. Food Sciences & Bioprocesses
8. Hospitality & Tourism
9. Humanities, Social & Library Sciences
10. Material & Mineral Sciences

Following a comprehensive peer-review process, researchers will present 221 selected research findings under the ten theme areas, all as oral presentations. The abstracts presented at the IRCUWU2022 are archived in the university web system as an electronic archive.

Chancellor's Message



I am very pleased to convey this message and my well wishes for the 6th International Research Conference of Uva Wellassa University. Organized as an online conference for the third consecutive time due to the prevailing adverse conditions, the theme "*Elevating the Quest for Resilience to Spring Forward"* is most timely. During all hardships, the resilience to remain undefeated and always strive forward with fresh determination is much required.

As a university, it is our foremost responsibility to bring forth innovative solutions for contemporary issues, by combining theoretical concepts with practical scenarios in the form of research. IRCUWU2022, being an international conference, will present distinctive studies, researchers and scholars from Sri Lanka and all over the world. Therefore, I believe that this research conference will present a wonderful opportunity for researchers of different fields to discuss, debate and exchange views on their novel research findings. Ultimately, in due course, I hope their knowledge and ideas will contribute to the improvement of the socio-economic situation of Sri Lanka.

I will take the opportunity to appreciate the Vice Chancellor, Academic Staff, and Non-academic Staff of Uva Wellassa University for their great commitment towards successfully hosting this international event. My blessings go to all the organizers and participants of IRCUWU 2022 to have the strength and courage to strive forward surpassing all adversities.
May the triple gem bless you!

Most Venerable Bengamuwe Sri Dammadinna Nayaka Thero
Chancellor
Uva Wellassa University of Sri Lanka

Chief Guest's Message

It is with great pleasure, I am sending this message on the occasion of the IRCUWU2022, organized by the Uva Wellassa University (UWU), under the theme “Elevating the quest for resilience to spring forward”.

IRCUWU2022, conducted as an online conference due to the prevailing situation in the country, would provide space for researchers to present their novel findings to a diverse audience having different perspectives and interesting insights. The participants gain the opportunity to view novel advanced research in their fields of interest and interact with leading personnel in the respective fields. Also, this conference brings forward research of multiple disciplines onto an individual platform allowing participants including researchers, scholars and policy makers identify the available potential as well as the gaps in development with ideas as to how to bridge them.

I wish to express my sincere gratitude to the Organizing Committee and all the members of UWU Family for their untiring efforts to make the IRCUWU2022 a success. Finally, I wish all the participants, presenters and evaluation panelists to have a pleasant and productive experience in attending the IRCUWU2022.

Professor Jayantha Lal Ratnasekera
Vice Chancellor
Uva Wellassa University of Sri Lanka

Research Committee Chairman's Message

It is indeed a great pleasure and pride for me to disclose this message on the occasion of the 6th International Research Conference of Uva Wellassa University (IRCUWU), held under the theme "Elevating the quest for resilience to spring forward". Uva Wellassa University has made remarkable contributions in the field of research and development over the past years and the Annual Research Conference conducted by the University is evidence to such outstanding contributions.

Producing well-rounded graduates who could make significant contribution to the nation is one of the main targets of the University and Uva Wellassa University takes the responsibility in creating the path for the same. Hence, IRCUWU2022 has been organized in addressing the need of the nation. This time the International Research Conference strives to impart frontiers of knowledge in 10 major fields.

IRCUWU has been offering the attendees a platform to learn, to share, and to disclose their knowledge at both national and international levels. With every passing year IRCUWU has advanced into a bigger and better event, and it is the aim of the association and the organizers to take it to even greater heights.

I appreciate the organizing committee for showing a keen interest in organizing a successful conference and contributing new ideas and research findings. We as an organization are overwhelmingly enthusiastic to share valuable know-how, improving skills, and stimulating ideas together.

Professor H.M.J.C. Pitawala
Chairman
Research Committee
Uva Wellassa University of Sri Lanka

IRCUWU2022 Coordinator's Message

It is a privilege to be writing this message for the 6th International Research Conference of Uva Wellassa University as the Conference Coordinator. The consecutive Research Conferences held by our university have continued to grow in magnitude and esteem. We hope that this 6th International Conference themed "*Elevating the quest for resilience to spring forward*" held via an online platform due to restrictions imposed by the current situation of the country, will be proof of resilience as well as another important step in reaching new horizons.

International Research Conferences provide a common platform for researchers, scholars and experts from different countries for disseminating their range of findings, knowledge and views. They create stimulating environments for further analysis and innovation through novel approaches and the establishment of collaborations. We expect IRCUWU2022 will be such a platform that advocates for the advancement of all fields touched by it, be it Science, Technology, Agriculture or Management.

It is no simple task to plan and execute a scientific research and, concluding it with a presentation on an international platform. Therefore we would like to congratulate all undergraduates who have achieved this remarkable milestone of their careers for the very first time as well as all other authors and presenters taking part in this conference. We hope that this conference will be an insightful and productive experience for all attendees.

Dr. K.M.M.C.B. Kulathunga
Coordinator/IRCUWU2022
Uva Wellassa University of Sri Lanka

IRCUWU2022 Secretary's Message

I am honoured to be sending this message for the 6th International Research Conference of Uva Wellassa University 2022, as the Secretary of this prestigious event. Since its inception, IRCUWU has contributed annually to the dissemination of novel research findings and ideas, while always reaching out to wider audiences both locally and internationally.

In a changing world, the need for generating new ideas and knowledge has become indispensable. IRCUWU, over the years has contributed to the advancement of the scientific community by publishing novel studies in key areas of research. I aspire that IRCUWU2022 brought to light under the theme of "*Elevating the quest for resilience to spring forward*" will be resourceful in providing timely solutions for the society at large.

The IRCUWU2022 was organized successfully as an online conference, while facing many challenges, owing to the commitment of many. My heartfelt gratitude goes to the Vice Chancellor, the Research Committee as well all the academic and non-academic staff of the university, for their contribution towards different aspects of this event. I must also thank the members of the organizing committee for the immense support they have rendered in making this event a success. Finally, I would like to thank all presenters and participants for the interest they have showed towards this conference. I hope it will be a productive and enjoyable experience for all.

Dr. N.M.N. Nambapana
Secretary/IRCUWU2022
Uva Wellassa University of Sri Lanka

Keynote Speech

A review of strategies to reduce feed cost in monogastrics

Increasing world population gradually makes an increasing demand for food based on agricultural commodities. Nevertheless, the limited availability of land and production make huge competition between humans and animals for crops, and also adverse effects could be made perhaps because of dramatic changes in climate. In this light, conventional feed ingredients for livestock increased demand along with the higher price. Particularly, corn and soybean meal are widely used as conventional feed ingredients in commercial poultry diets around the globe. Beyond the aforementioned challenges, some countries that used corn as biofuel feedstock made a huge impact (i.e., a price advance) on monogastric feed production. However, existing anti-nutritional factors in those alternative feed ingredients would be unlikely for its full replacement to corn and soybean in poultry diets. Overcoming these limitations, feeding exogenous enzymes to monogastric animals is the one major nutritional advancement during the last few decades. Nowadays, the feed industry accepts enzymes as a standard diet constituent for monogastric animals. Moreover, understanding the basic mechanisms of enzymes and the structure of substrates leads to increased utilization in the feed industry. A basic understanding of the feed enzymes that benefit nutrient digestibility and growth performance may result from reducing digesta viscosity, releasing the bound phosphorus from phytate hydrolysis, and increasing the nutrient availability by opening the encapsulated nutrients by disrupting the cell wall. Nonetheless, the questions are yet partially answered in enzyme technology. Collectively, the effectiveness of exogenous enzymes on broiler production and undergoing mechanisms are still a mystery and little is known. With this in mind, we are going to review a couple of recent studies and address if the enzymes are meaningful to monogastric animals.

Despite the demonstrated superiority of the net energy (NE) system over the digestible energy (DE) and metabolizable energy (ME) systems, its utility in monogastric (i.e., swine) diet formulation has not gained widespread application in some regions including North America, Asia, and Australasia. In this regard, we are going to review if the NE system along with standardized ileal digestibility (SID) is reliable and applicable for monogastrics.

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Keynote Speech

Opening avenues and broadening horizons in crisis situation

"*Opening Avenues and Broadening Horizons in Crisis Situation*" is the topic which has been chosen in a timely and perfect manner when Russia – Ukrain war, Sri Lanka and other countries are facing surmounting economic challenges.

In today's volatile business environment we just try not to be only to bounce back but also should go beyond the status quo. To have such a mindset the entire society must work together collectively in a team approach. It cannot be just simply in a solo manner. Resilience is commonly thought of as "bouncing back," like a spring, to our pre-crisis norm. However, when events of this magnitude occur, we cannot return to "normal" life as we knew it before the crisis. Our world has changed and we must change with it. There is no going back. A more apt metaphor for resilience might be "bouncing forward" to face an uncertain future. This involves constructing a new sense of normality as we recalibrate our lives to face unanticipated challenges ahead. The abilities of the human bounce back from stress and predict health-related measures when controlling for other positive characteristics and resources. We assessed resilience, optimism, social support, mood clarity, spirituality, purpose in life and health-related measures.

To reinforce the theme of "*Opening Avenues and Broadening Horizons in Crisis Situation*" we need to work on creating positive entrepreneurship culture from the primary education system through to the university level. Entrepreneurship culture starts with a problem and moves with no restrictions to gather all resources to achieve the goal, thus developing the specialties, which are the core of any academic institution. In the meantime to get rid of the (tent thinking), which limits the establishment of new inter-specialties. In the view of this approach, Entrepreneurship culture should have a place, through believing in the mentality that sees the change as an opportunity, to deal with difficult challenges, in the absence of enough resources for the same. Then the education institution culture shall begin to change, leaving enough space for the Entrepreneurship culture spirit, which is an optimistic spirit in nature and adopt the ideas that are never afraid of failure. Positive entrepreneurship can only be injected into society when we train our entire educational ecosystem with value and ethics-based business education. The educational ecosystem includes not only students but also teachers, lecturers, professors, educational administrators and family members. Entrepreneurship education is a motivation for the economic growth of any country. Integrating entrepreneurship culture in education may result in the substantial formation of entrepreneurs and the building of their skills. The most important of all, changing the mentality and the spread of change spirit. Most likely the students shall see joining Entrepreneurship, as an effective factor in their upcoming life. The Keynote speech will explore the various aspects of value and ethics-based business education along with the importance of human life in the quest for resilience to spring forward.

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AGRICULTURE & ANIMAL HUSBANDRY

Paper ID: IRCUWU2022-32

Nitrogen, phosphorus and potassium concentrations in rice grains produced under organic and inorganic nutrient management systems

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Rice (*Oryza sativa* L.) serves as an important source of essential mineral elements to humans. Until recently, paddy cultivation in Sri Lanka mainly relied on chemical-based conventional farming practices. Although it has substantially increased crop yields, they have adversely affected the environment due to misuse. Issues arised due to environment pollution and human health led the government to take policy decisions to promote organic paddy cultivation in the country. However, it is not clear whether grain nitrogen (N), phosphorus (P) and potassium (K) concentrations of rice would vary under organic and inorganic nutrient managed conditions. Moreover, there is no evidence on nutrient accumulation in grains under organic and inorganic farming conditions in Sri Lanka. Therefore, the objective of the current study was to compare the N, P, and K status of paddy grains cultivated under inorganic or organic fertilizer applied conditions. A total of 48 paddy grain samples (i.e., 32 organically managed fields for at least three years and 16 inorganically managed fields) were collected representing paddy lands in Anuradhapura, Polonnaruwa, and Gampaha districts. Nitrogen concentration in grain samples were measured using Kjeldahl method while P and K concentrations were measured using colorimetric method. There was a significant interaction between districts and the type of fertilizer applied for grain K concentration ($p<0.05$), i.e., grains produced in Polonnaruwa (3.3 mg/g) and Gampaha (2.8 mg/g) districts recorded higher K concentration under inorganic and organic fertilizer applied conditions, respectively. N and P concentrations of grain were similar among the three districts and type of fertilizer applied ($p>0.05$). Average N and P concentrations of the paddy grains were 11.5 and 2.6 mg/g, respectively. Understanding this spatial variability of grain nutrition as affected by the type of nutrient management system is important when making agronomic decisions for sustainable paddy cultivation in Sri Lanka.

Keywords: Inorganic; Organic; Paddy; Seeds

Financial assistance from the World Bank, under the Accelerating Higher Education Expansion and Development (AHEAD) (*Grant No AHEAD/RA3/DOR/AGRI/PERA-No16)*

Paper ID: IRCUWU2022-62

Spirulina platensis: Growth and meat quality enhancer in broilers

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Spirulina (*Spirulina platensis*) is a nutrient-rich blue-green alga and is naturally present in the photic surface layer of the reservoirs in dry and wet zones in Sri Lanka. Dietary Spirulina supplementation in broiler diets as a growth promoter and meat quality enhancer, especially with locally produced broiler diets, has not been evaluated in Sri Lanka according to our knowledge. The present study was conducted to evaluate the effect of supplementation of dried Spirulina with a local commercial broiler chicken diet on growth performance and meat quality. One day-old, male, Cobb 500 broilers (n=120) were allocated into three groups and fed with one of the three experimental diets for 35 days; control diet, 4% Spirulina supplemented diet and 8% Spirulina supplemented diet. The diets were in mash form and prepared by adding the Spirulina to the commercial broiler diet (corn and soyabean meal basal diet with 24 and 17% crude protein in broiler starter and broiler finisher, respectively) as a top dressing. The Spirulina supplementation (4 and 8%) significantly improved the live weight at slaughtering and weight gain of broilers while decreasing (p<0.05) the feed conversion ratio. Diets supplemented with Spirulina increased relative organ weights in the digestive system in broilers. At 4% supplementation, Spirulina increased (p<0.05) ileal protein digestibility coefficients, whereas it was not significantly different at 8% supplementation level compared to the control group. Furthermore, birds fed Spirulina had higher (p<0.05) water holding capacity and yellowness with lower (p<0.05) cooking loss in breast meat. In conclusion, the present study showed that dietary Spirulina supplementation (4% and 8%) improved the growth performance and meat quality of broiler chickens. Therefore, Spirulina as a feedstuff would support sustainable chicken meat production in Sri Lanka because it will reduce our reliance on imported raw materials. Moreover, Spirulina has approximately improved protein digestibility by 6.4% which supports environment-friendly chicken meat production due to reducing nitrogen excretion.

Keywords: Broiler chicken; Growth performance; Meat quality; *Spirulina platensis*

Paper ID: IRCUWU2022-73

Organic selenized yeast influenced growth, oxidative stress, and selenium accumulation in young chickens with mixed *Eimeria* infection

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The effect of dietary inorganic and organic selenium (Se) supplementation on growth performance, gut health, oxidative makers, and selenium accumulation in coccidiosis infected broiler chickens was studied. A total of 168 one-day-old Ross broilers (Ross 708) were randomly allocated into 24 cages with seven birds per cage and six replicates for each treatment. Four treatments were; (1) Se un-supplemented and un-challenged (CON), (2) inorganic Se supplemented and un-challenged (SSU, 0.3 mg/kg as sodium selenite), (3) inorganic Se supplemented and challenged (SSC), and (4) organic Se supplemented and challenged (SYC, 0.3 mg/kg Selenized yeast, Sel-Plex®). Chickens in respective challenge treatments were infected with *Eimeria acervulina*, *Eimeria tenella*, and *Eimeria maxima* oocysts mixture (15,000 sporulated oocysts/chicken) on day 16. Growth performance was measured for 16-, 22-, and 24-days post-hatch periods. On day 22, intestinal and liver samples were collected to analyze the lesion scores and the antioxidant makers. Feces were collected to enumerate the *Eimeria* oocyst shedding from day 22 to 24. At the end of the experiment, serum, liver, and breast muscle samples were collected to analyze the Se concentrations. Up to day 16, before the infection, no body weight difference ($p>0.05$) was observed between treatment groups. On day 22, SSC chickens showed lower body weight ($p<0.05$) compared to its unchallenged counterpart (SSU). Dietary organic Se (SYC) favorably improved body weight compared to its inorganic counterpart (SSC) under the *Eimeria* challenge on day 22. *Eimeria* challenge elevated ($p<0.05$) the fecal oocyst counts regardless of the dietary selenium source. Similarly, higher ($p<0.05$) lesion scores were observed in the *Eimeria* challenged chickens independent of dietary selenium. In liver, HMOX-1 expression tends to elevate in the SYC chickens compared to other treatments ($p=0.036$). Among treatments, broiler chickens fed SYC had higher ($p<0.05$) Se accumulation in breast muscle. Contrary, broiler chickens in SYC had lower ($p<0.05$) Se accumulation in liver compared to inorganic SSU and SSC. These results confirmed the efficacy of organic Se compared to inorganic Se for muscle Se enrichment, stress reduction and growth improvement in mixed *Eimeria* infected broiler chickens.

Keywords: Broiler; Chicken; Coccidiosis; Selenium; Selenium accumulation

Paper ID: IRCUWU2022-90

Seasonal and genotypic variations of total monomeric anthocyanins and total catechins in selected purple genotypes of tea (*Camellia sinensis* (L.) O. Kuntze) and the relationship between anthocyanins and blister blight disease severity

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Anthocyanin-rich *Camellia sinensis* (L.) O. Kuntze genotypes are the basis to produce specialty tea type "Purple tea". Anthocyanins and catechins are two important metabolites in "purple tea". However, information on variability in the above biochemical compounds among Sri Lankan genotypes is limited. Antifungal activity of anthocyanins against *Exobasidium vexans*, the causal organism of blister blight (BB) disease in tea has been reported. The relationship between anthocyanins and BB disease resistance remains elusive. Hence, this study investigated the genotypic and seasonal effects on anthocyanin and catechin biosynthesis in purple tea genotypes and the relationship between anthocyanins and BB disease resistance. Fourteen genotypes having green, moderately purple, and intensely purple color leaves were selected. Total monomeric anthocyanin (TMA) and total catechin (TC) contents during wet and dry seasons were quantified following AOAC and ISO protocols, respectively. Expression levels of genes *ANS* and *ANR* were assessed using semi-quantitative PCR. Blister blight disease severity was assessed using Area Under Disease Progress Curve (AUDPC). During both seasons, TMA content was high and TC content was low in purplish genotypes. In contrast, green genotypes had high TC content and low TMA content irrespective of the seasons. All the genotype categories had lower TMA content during the dry season compared to the wet season. A significant reduction of TMA content was observed only in intensely purple genotypes. The seasonal effect on TC biosynthesis was insignificant. Irrespective of leaf pigmentation, a common decreasing trend in TC biosynthesis was observed during the dry season. During both seasons, TC and TMA showed a significant negative correlation (wet=-0.536; dry=-0.697). In parallel with the biochemical variations, comparatively higher *ANS* and *ANR* transcripts were found in purple and green genotypes respectively. Results showed an up-regulation of anthocyanin biosynthesis while down-regulation of catechin biosynthesis in purple genotypes, and vice versa were true for green genotypes. The negative correlation (-0.261) between TMA and BB disease severity suggested the role of TMA in tea plant resistance against BB and needs further confirmation. This was the first attempt where biochemical and molecular approaches were applied to understand the biochemical variations in purple tea genotypes in Sri Lanka.

Keywords: Anthocyanin; Blister blight; Catechins; Gene expression; Purple tea

We acknowledge the financial assistance given under the Indo-Sri Lanka Joint Research Programme Ministry of Science, Technology, and Research, Sri Lanka.

Paper ID: IRCUWU2022-100

Phylogenetic characterization of the non-descriptive indigenous cattle population in the northern province of Sri Lanka using mitochondrial cytochrome *b* region

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The indigenous cattle population in Sri Lanka is declining owing to the indiscriminate crossbreeding with high producing exotic breeds. If no immediate conservation strategy is employed valuable adaptive characters possessed by indigenous cattle may get disappear. Genetic characterization and phylogenetic analysis are the initial steps in development of proper management strategies for conservation of genetic resources and preventing the loss of desirable genes. This study mainly investigated the phylogenetic relationship of local non-descriptive inherently small (Northern Local Cattle, NLC) cattle population in Northern Province of Sri Lanka with other tropical and temperate species of genus *Bos*, using mitochondrial cytochrome *b* gene. DNA extraction was carried out using the blood samples collected from NLC population; Mannar (3) and Jaffna (2) districts and some other Sri Lankan indigenous cattle populations; Lankan cattle (3) and Thawalam (3). Mitochondrial cytochrome *b* (mtDNA cyt *b*) region was PCR amplified and sequenced to assess phylogenetic relationship. The analysis was performed with 34 cattle mtDNA cyt *b* sequences including 11 sequences from collected samples and 23 sequences from species of genus *Bos* downloaded from National Center for Biotechnology Information database. No significant differences in nucleotide composition were found between NLC population and the Indian *Bos indicus* breeds. Five polymorphic sites consist of one parsimony-informative site and four singleton variable sites were identified among the five sequences of NLC population. Phylogenetic analysis assigned NLC population forming distinct lineages of *Bos indicus* ancestry. A close genetic distance was observed between NLC population and the other indigenous cattle populations studied. With the closest relationship to Indian *Bos indicus* breeds, it could be assumed that subsequent introgression of Indian indicine may have influenced the matrilineal origin of NLC population. The population might have then been evolved over generations under low level of selections featured in the traditional animal husbandry system in Northern Province. Small body confirmation of NLC compared to the other Sri Lankan indigenous cattle populations may be due to development of phenocopies owing to hot and semi-arid climatic conditions in the area to which they have been continuously exposing for generations together with isolated breeding.

Keywords: Genus *Bos*; mtDNA Cyt *b* gene; Northern local cattle; Phylogenetic analysis

Paper ID: IRCUWU2022-120

Dietary crude protein and apparent metabolisable energy interactively influence growth performance and carcass traits in broiler chickens from 14 to 35 days post-hatch

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Sustainable chicken-meat production is imperative to meet increasing global demands for protein sources coupled with food security. Reducing nutrient densities of diets would enhance sustainability but may negatively impact broiler growth performance. However, reduced-crude protein (CP) maize-based diets typically improve energy utilisation. Therefore, the objective of the present study was to test the hypothesis that reduced-CP diets will permit reductions in dietary energy densities; thereby, promoting sustainability. A total of 420 male Ross 308 chickens were allocated into four dietary treatments (15 birds/replicate) with a 2×2 factorial array. The wheat-based dietary treatments consisted with standard (13 MJ/kg) or reduced (12.5 MJ/kg) metabolizable energy (ME) concentrations with two CP concentrations (210 and 170 g/kg). The study determined growth performance and carcass traits in broiler chickens from 14 to 35 days post-hatch. Data were subjected to two-way ANOVA and probability level of less than 5% with LSD Student *t*-test was considered statistically significant. A treatment interaction (p=0.002) was observed for weight gain where low-ME diets reduced weight gains by 8.70% (1848 versus 2024 g/bird) in birds offered 170 g/kg CP diets, but ME had no significant effect with 210 g/kg CP diets. A similar treatment interaction was observed for FCR where broilers offered a standard-ME diet outperformed those fed a low-ME diet by 6.67% (1.511 versus 1.619) with 170 g/kg CP diets, but again no significant difference was observed with 210 g/kg CP diets. Dietary CP reductions decreased feed intakes by 3.78% (3025 versus 3144 g/kg, p=0.012), regardless of dietary ME. As a main effect, standard-ME diets supported heavier relative fat pads weight than low-ME diets by 13.0% (8.34 versus 7.38, p=0.040). The CP diets with 210 g/kg generated heavier (p<0.05) *Pectoralis* major, and *Pectoralis* minor than those with 170 g/kg by 12.9% (203 versus 180 g/kg), and 9.97% (34.2 versus 31.1 g/kg), respectively. The hypothesis was rejected as 0.5 MJ/kg reduction in energy density of the 170 g/kg CP diets compromised weight gain and FCR and the reduction in dietary CP did not generate an energy-sparing effect, which was anticipated in wheat-based broiler diets.

Keywords: Broiler chickens; Crude protein; Metabolisable energy; Sustainability

Paper ID: IRCUWU2022-130

The risk of spreading African swine fever in Sri Lanka

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African swine fever (ASF) is a deadly transboundary infectious disease of domestic and wild pigs with 100% mortality rates. ASF is caused by the ASF virus (ASFV), a large double-stranded DNA virus of the *Asfarviridae* family. ASF was first discovered in East Africa in the early 1900s, and the transcontinental spread of this disease first appeared in Portugal in 1957. By 1960, ASF broadened its infection among other European countries, and the introduction of ASF to Georgia in 2007 started a new transmission chapter. In 2018, China, the largest pork producer globally, reported the occurrence of ASF that immediately caused tremendous losses to the worldwide pig meat production. By May 2022, ASF has been ubiquitous in most parts of Asia, for example, Mongolia, North Korea, the Philippines, South Korea, Malaysia, Indonesia, Timor-Leste, Papua New Guinea, Viet Nam, Laos, Cambodia, Thailand, Myanmar, Bhutan, and India. Sri Lanka has not documented any cases of ASF as of 20th May 2022, but the ASF growth trend in recent years strongly signifies the risk of virus entry into the country. The pork industry has been growing in Sri Lanka, overwhelming the traditional religious and cultural biases. Outbreaks of ASF in neighboring countries like India raise concerns over the potential for transboundary movement of ASFV into the country through trade and tourism. Once ASFV is found in a region, it is challenging to eradicate the virus as it can persist in meat, meat products, animal feeds, etc. There is no available vaccine or drug against ASFV; killing infected pigs to prevent the disease spread has been successful. However, it causes many environmental, ethical, and financial losses. Therefore, our research strongly suggests the importance of introducing contingency plans that ensure no possible future invasion of ASF; the government should focus on preventing entry of the virus through strict quarantine measures at the borders, controls on illegal trade, and effective management practices, including biosecurity measures to safeguard the local pork industry.

Keywords: African swine fever (ASF); African swine fever virus (ASFV); Biosecurity

Paper ID: IRCUWU2022-134

Avocado seed powder as a partial replacement of maize in quail diet

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Generally, commercial broiler diets are used to feed quails in Sri Lanka, but those diets certainly do not accomplish the nutritional requirement of quails. Consequently, it usually reduces the productivity in quails along with high production cost. In Sri Lanka, avocado (*Persea americana)* seeds are freely available source of essential nutrients and also rich in phytochemical compounds. Therefore, the objective of this study was to determine the possibility of partial replacement of maize with avocado seed powder (ASP) as an alternative energy source in quail diets. A total of 48, four weeks old, male "Japanese quails" (*Cortunix cortunix japonica*) (115.8±29.97 g) were randomly allocated into three dietary treatments to have four replicate cages (four birds per cage) per each treatment. Dietary treatments were followed as; (1) maize based diet with no ASP, (2) maize substituted diet with 5% ASP, (3) maize substituted diet with 10% ASP. Body weights and feed intakes were recorded weekly for four weeks. At the end of the experiment, one bird from each cage was sacrificed to measure meat quality parameters. Data were analysed using Minitab 17 software package. Tukey's multiple range test was performed to determine the significant differences between treatments at $p<0.05$. Treatment effect was not observed ($p>0.05$) for body weight, average daily gain and average daily feed intake. There was no significant difference among treatments ($p>0.05$) in pH, cooking loss, water holding capacity and texture (hardness, cohesiveness, springiness and chewiness) of meat. In conclusion, ASP can be used as a partial replacement for maize in quail diets up to 10% without compromising growth performance and meat quality parameters.

Keywords: Avocado; Growth performance; Meat quality; Quail

Paper ID: IRCUWU2022-180

Value chain analysis for disregarded economically potential plants in Sri Lanka: With reference to *Moringa oleifera*

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Even though *Moringa oleifera* is a nutrient-dense, superfood with increasing demand in the international market, and we have a vast potential to tap in-to it while improving the rural income, we still regard this as an underutilized plant in Sri Lanka. Another factor is that, research in-to its utilization and commercialization opportunities in Sri Lanka is limited. Therefore, the primary objective of this study was to identify the existing potential of the plant, to act as an income generator while improving the rural community. Value chain analysis was done qualitatively, in order to map the existing value chain for *M. oleifera* leaf and pod-based products and to identify main actors and constraints along both value chains. Additionally, value addition and gross profit margin were calculated in order to identify the average profit gain by each actor along the value chain. North Central, Central, North, Uva and Western Provinces were selected where, the cultivations are taken place. A total of 47 participants were drawn purposively, and interviewed through face-to-face interviews using open ended semi structured questionnaires in order to gather primary data needed. It was concluded that *M. oleifera* is an advantageous cultivation with higher gross profit margins. Exporters add the highest average value addition in both chains. Even though *M. oleifera* has a massive potential of income generation, the communication gap among actors in the value chain and lack of awareness among local consumers hinder the possible income generation. Further, lack of support from enabling actors, rapid price fluctuations in Moringa pod-based value chain due to seasonality of the crop and arbitrary higher profits gain by leaf collectors in the local market have reduced the effectiveness and efficiency along the value chains. Due to that, most of the farmers have already abandoned the cultivation and move towards other crops. Thus, implementation of proper price mechanisms, collaborative engagement of all the stakeholders along the chain and increase the perception and awareness of local consumers regarding the nutritional and medicinal value of Moringa is a must in order to enhance the value chain activities.

Keywords: Mapping; *Moringa oleifera*; Value addition; Value chain

Paper ID: IRCUWU2022-186

Effectiveness of beneficial *Bacillus* species to control bovine mastitis

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Bovine mastitis is responsible for considerable economic losses in dairy cattle industry due to lower milk production, veterinary expenses, high maintenance costs and early culling of infected animals. The major therapeutic approach is antibiotic usage in bovine mastitis control. However, antibiotic resistance is the risk associated with this practice. Resulting treatment failures, presence of antibiotic residues in milk and spread of resistant bacteria across the environment are serious threats to animal and public health. Therefore, it is essential to produce biological formulations to reduce mastitis. This study aimed to develop bacterial preparations effective against mastitis pathogens, using three *Bacillus* strains namely CD-D1, CD-D3 and CD-D5, originated from local cattle and to determine the most effective *Bacillus* combination. Three combinations comprised of 10^8 cfu/mL of CD-D1+CD-D3 (BaciBIO1), CD-D1+CD-D5 (BaciBIO2) and CD-D3+CD-D5 (BaciBIO3) in 1:1 proportion, were examined for growth inhibitory activity on 21 bovine mastitis pathogens by Radial Streak Line method. BaciBIO1 clearly inhibited 15 pathogens (71.43%) out of 21 pathogens. Out of 14 Gram positive bacteria, 13 Gram positive bacteria (92.86%) and out of 7 Gram negative bacteria, 2 Gram negative bacteria (28.57%) were inhibited by BaciBIO1 combination. BaciBIO2 showed clear inhibition on 13 (61.91%) of the tested pathogens all of which were Gram positive bacteria. The corresponding values for BaciBIO3 were similar to BaciBIO2. Notably, BaciBIO1 only made clear inhibition zones against Gram negative pathogens which included BMP 5 strain of Coliform group and BMP 20 (*Escherichia coli*). In contrast other two combinations did not exhibit clear inhibition against any Gram-negative bacteria. However, growth of latter mentioned two Gram negative bacterial strains were affected partially. The differences between the mean growth inhibitory activity of three *Bacillus* combinations were not statistically significant ($p \geq 0.05$). In conclusion, three tested preparations displayed strong antagonism against common mastitis causative bacteria while CD-D1+CD-D3 *Bacillus* combination had higher inhibitory activity concerning the Gram staining category and the number of clearly inhibited pathogens. BaciBIO formulations would be potential candidates for biological control of bovine mastitis in Sri Lanka.

Key words: Antibiotic resistance; BaciBIO; *Bacillus* strain; Bovine mastitis; Inhibitory activity

Paper ID: IRCUWU2022-214

Effects of thermal stress on physiological and blood parameter changes on selective cattle breeds in dry zone

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Dairy cattle are an important element of Sri Lankan livestock industry. Dairy cows reared in dry zones are exposed to high ambient temperatures, relative humidity, and wind. The temperature-humidity index (THI) is a commonly used metric for monitoring the level of stress. This study was carried out to assess the effect of heat stress on the physiological and hematological profiles of Jersey and crossbred (Jersey × Friesian) cattle in the dry zone. Twenty dairy cows with similar physiological conditions at Ridiyagama NLDB dairy farm were selected for the study. Physiological parameters [heart rate (HR), respiration rate (RR), rectal temperature (RT), pulse rate (PR), and peripheral skin temperature (PST)], and hematological parameters were measured during five weeks. Blood samples of 20 cows from both control (Jersey) and treatment (Jersey × Frisian crossbred) groups were collected from the caudal vein into anti-coagulated (EDTA) coated tubes and analyzed for a complete evaluation of packed cell volume (PCV), red blood cell (RBC) count, and total white blood cells (WBCs). The data were statistically analyzed using SAS (version No.9.0-2000). All the physiological parameters were significantly different ($p<0.05$) and the hematological components of cows in the control and treatment groups were not significantly different. There is an association between the THI and pulse rate, heart rate, respiration rate, peripheral skin temperature, and the rectal temperature of Jersey and the Crossbreds in both groups ($p<0.05$). Furthermore, there is an association between white blood cells (WBCs) concentration and THI of crossbred ($p=0.0001$) and jersey ($p=0.0001$) animals in both the treatment and control groups. This study was focused on dairy cattle's physiological reactions to elevated temperatures. WBC content in the blood and physiological parameters like respiration rate, heart rate, pulse rate, rectal temperature, and peripheral skin temperature can be effectively used as clinical diagnostic tools to identify the stress condition of animals in the low country dry zone. Further studies are required to reconfirm the research findings.

Keywords: Heat stress; Hematological parameters; Physiological parameters; Temperature humidity index

Paper ID: IRCUWU2022-215

Isolation of *Escherichia coli, Proteus* and *Salmonella* spp. from beef and pork and their sensitivity to commonly used antibiotics

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Due to increased morbidity and mortality, foodborne diseases are leading to greater public health significance. Food can be contaminated from the point of raw materials, during the production process and in the consumer channel. Further, these microorganisms have led to the development of resistance against commonly used antibiotics due to the imprudent use of antibiotics. Antibiotic resistance development has become a leading public health concern globally due to its impact on the health of humans and animals, food security and on the global economy as well. Hence this study focused on isolating *Escherichia coli, Proteus* and *Salmonella* spp. from beef and pork and investigating their sensitivity to commonly used antibiotics. Pork (n=14) and beef (n=18) samples were collected from six suppliers during one-month period and *E. coli, Proteus* and *Salmonella* spp. were isolated. Further the isolates (8 *E. coli*, 7 *Proteus* spp. and 7 *Salmonella* spp.) were checked for antibiotic sensitivity to commonly used antibiotics [Ampicillin (10 µg), Ceftriaxone (30 µg), Ciprofloxacin (30 µg), Gentamycin (30 µg), Tetracycline (30 µg), and Trimethoprim (25 µg)]. This study revealed the presence of four *E. coli*, six *Salmonella*, and five *Proteus* species in beef samples and four, two and three isolates of *E. coli, Salmonella* and *Proteus* from pork samples, respectively. All the *E. coli* isolates (8/8), two isolates of *Proteus* (2/7) and two *Salmonella* isolates (2/7) showed resistance to Ampicillin. All *E. coli* and *Salmonella* isolates were resistant to Gentamycin whereas all the *Proteus* isolates also showed resistance except one. Ceftriaxone was the only sensitive antibiotic for all the isolates tested. Ciprofloxacin is ineffective against four isolates of *E. coli* (4/8), all the *Proteus* isolates were susceptible except one (1/7) and three *Salmonella* isolates were resistant (3/7). All *Proteus* isolates except one were resistant to tetracycline (1/8) and a similar pattern was observed with Gentamycin. Two *E. coli* (2/8), four *Proteus* (4/7) and one *Salmonella* (1/7) isolates were resistant to Trimethoprim. Some *E. coli, Proteus* and *Salmonella* showed multidrug resistance having resistance to more than two antibiotic groups. This study concluded that there are *E. coli, Proteus* and *Salmonella* isolate present in beef and pork samples and these isolates have different sensitivities to antibiotics, even they have multidrug resistance.

Keywords: Antibiotic resistance; *E. coli*; Isolation; *Proteus*; *Salmonella*

Paper ID: IRCUWU2022-249

Effect of 1-methylcyclopropene on shelf-life and postharvest qualities of two yardlong bean (*Vigna unguiculata*) varieties

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The yardlong bean (*Vigna unguiculata*) is a popular and healthy horticultural product with high nutritional value. It is commercially grown for its green pods in tropical and subtropical regions covering Asia, South America, Africa and Southern Europe. However, the shelf-life of yardlong beans is short. In addition, skin discolouration, dehydration and softening deteriorate its postharvest quality and lose its commercial value. 1-Methylcyclopropene (1-MCP) is an ethylene inhibitor widely used in postharvest technology to extend the shelf-life of many fruits and vegetables. The objectives of this study were to investigate the effect of 1-MCP on shelf-life and postharvest qualities of two yardlong bean varieties: "*Hawari mae*" and "*Mas mae*" and to investigate the best concentration of 1-MCP which enhances the shelf-life and postharvest qualities of selected yardlong bean varieties. Freshly harvested yardlong beans were treated with three different concentrations of 1-MCP (0, 1, 3 and 5 µL/L) for 15 h period and they were stored under ambient temperature (27±1°C). Fresh weight loss, hardness, pod colour, total soluble solids, chlorophyll content and ion leakage were evaluated every other day. The results showed that 1-MCP treatments significantly inhibited chlorophyll degradation and fresh weight loss while delaying pod colour discoloration in both varieties. The total soluble solids content significantly declined in treated "*Hawari mae*" variety. From the different concentrations of 1-MCP, 1 µL/L had the most favourable effects, extending shelf-life, and maintaining postharvest qualities of both yardlong bean varieties and it increased the shelf-life of both varieties by two days (66%). Results indicated the potential commercial use of 1-MCP in postharvest management of yardlong beans.

Keywords: 1-Methylcyclopropene; Postharvest quality; Shelf-life; Yardlong beans

Paper ID: IRCUWU2022-282

Home gardening in Sri Lanka in response to the Covid-19 pandemic

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Household food insecurity is one of the most commonly reported social and economic hardships during the Covid-19 Pandemic. Many households struggle with access to fresh fruits and vegetables during lock down periods. In this context, growing perishables in home gardens has become a popular outdoor activity. Therefore, the current study was conducted to determine the recent trends in home gardening and to identify socio-economic drivers that influence home gardening during the Covid-19 pandemic in Sri Lanka. A pre-tested questionnaire was used to collect socio-demographic information and home gardening related knowledge, attitudes and practices from 1030 households covering nine provinces. Excluding incomplete questionnaires, 829 households were used in the analysis. Descriptive statistics and Binary Logistic Regression (BLR) analysis were used for data analysis. The majority of the participants (79.4%) were practising home gardening prior to Covid-19. A higher knowledge level (71.9%) and attitudes (86.2%) were recorded on home gardening. Provision of safe food (Mean Rank, R=4.7), fresh food (R=4.7) and importance as a physical exercise (R=4.4), were recognized as the major perceived benefits. Gender, residing locality, knowledge and attitudes on home gardening, degree of mental relaxation received from home gardening, land extent under home gardening and the contribution of home gardening products to the overall vegetable demand of the house indicated significant associations ($p<0.05$) with the adoption of home gardening due to the Covid-19. According to the findings of BLR, males, semi-urban dwellers (Odds Ratio, OR=2.41) and urban dwellers (OR=1.30) indicated significantly ($p<0.05$) higher probabilities of engaging in home gardening during the pandemic. Furthermore, respondents with relatively higher knowledge and attitude levels also showed a similar trend. With respect to the home gardening extent, respondents with a limited land availability (<1 Perch) had the highest affinity to start practising home gardening during the pandemic. Engaging in home gardening activities has positively contributed to overcoming food security concerns and physical well-being during the Covid-19 Pandemic in Sri Lanka. The provision of more knowledge and training on home gardening would play a critical role in enhancing home gardening in Sri Lanka, to ensure food security.

Keywords: Covid-19 pandemic; Food security; Home gardening; Socio-economic drivers

Paper ID: IRCUWU2022-332

Morphological and molecular screening of fifteen finger millet (*Eleusine coracana*) genotypes in Sri Lanka for salt tolerance at seedling stage

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Finger millet (*Eleusine coracana*) is a self-pollinating allotetraploid highly nutritious cereal crop that is considered as the second staple crop in Sri Lanka. Finger millet has wide adaptability to survive under harsh conditions with minimal inputs and therefore can be introduced to marginal lands for cultivation ensuring food security. However, due to the lack of attention on this crop, genetic studies and genomic information are limited on this crop. Furthermore, the salinity response of Sri Lankan finger millet germplasm has not been revealed yet. Thus, the present study aimed to evaluate the variation of morpho-physiological performances of 15 genotypes of finger millet under salinity stress and to reveal the genetic diversity of the selected finger millet genotypes. Thirteen accessions and two cultivated varieties (Rawana and Oshada) of Finger millet were obtained from the Field Crop Research Institute, Mahailluppallama. The salinity response of the selected subset was assessed at the germination stage and seedling stage at high salinity stress levels; 200 mM (21 dSm^{-1}) and 150 mM (17 dSm^{-1}) respectively. Salinity responsive parameters were measured seven days after imposing salinity at the germination stage and 21 days after imposing salinity at the seedling stage under hydroponic condition. Genetic diversity assessment was done using eight finger millet genomic SSR markers and two EST-SSR markers specific to salinity stress-responsive genes. Statistical analysis of relative morpho-physiological parameters and evaluation of genetic variation were done by using Minitab 20 and Powermarker V3.23 software respectively. Acc. No 7088, 12225, 11369, 8630 and 11332 depicted a moderate level of survival potential compared to others while maintaining a substantial level of growth at high saline stress indicating the feasibility of introducing to marginal lands. Based on genetic relatedness, acc. No. 12225, 11369, 8630 and 11332 except 7088 clustered into one group proving their close relationship. The salinity response characteristics of the selected subset of finger millet germplasm together with the genetic relatedness identified in this study can be used in future crop improvement studies toward salt tolerance. Furthermore, genomic SSR markers, UGEP24, UGEP78, UGEP1, UGEP10, UGEP65, and EST-SSR marker C15674 were identified as potential markers for future genetic studies on finger millet.

Keywords: Finger millet; Germination stage; Salt tolerance; Seedling stage; Simple Sequence Repeat markers

Paper ID: IRCUWU2022-333

A study on the status of adoption of standards by tea export firms in Sri Lanka to comply with international market requirements

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Tea is an important agricultural commodity in Sri Lanka making a significant contribution to export earnings. However, due to the emergence of stringent food quality and safety, environmental and social standards and regulations in various international markets, Sri Lankan tea exporters have encountered enormous challenges when complying with these standards. Several rejections of consignments of tea have been recently reported due to the failure to comply with their governing standards. This study was aimed to identify various food quality and safety standards adopted by tea export firms in Sri Lanka catering to different international market destinations. This study adopted both qualitative and quantitative approaches covering 39 tea export firms in the country selected by simple random sampling technique. Both an online survey and case studies were conducted to collect the primary data. The online survey was based on a questionnaire which was pre-tested to clarify any misunderstandings and ambiguities. Identified issues in the pre-test were formulated to increase the reliability of the questionnaire. The case studies involved interviews with eight tea export firms comprising four large-scale and four SME tea exporting firms selected by purposive sampling technique. Descriptive and correlation analysis were used to analyse the data. Results revealed standards for tea are complex consisting of various public and private standards. Adoption of public voluntary standards and private voluntary standards by tea export firms accounts for 65.7% and 34.3%, respectively. Thus, the adoption of public voluntary standards by tea export firms is more important in international tea trading. Public voluntary standards such as ISO 22000, HACCP and GMP certifications were the most predominant while Organic, FSSC 22000 and BRC were the common private voluntary standards in international tea trading. Implementing food quality and safety standards (77%) are important compared to the environment (20.5%) and social (2.5%) standards in tea exporting. Adopting to a certification like organic, fair trade or rain forest alliance is a competitive advantage for tea export firms since they can target niche markets. Improved awareness and building capacity and infrastructure of export firms to comply with international market requirements are essential conditions to enhance the competitiveness of Ceylon tea in the international market.

Keywords: Compliance; International market destinations; Private voluntary standards; Public voluntary standards

Paper ID: IRCUWU2022-335

Study on implementation and continuation of good agricultural practices among fruit and vegetable farmers in Kegalle District

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Consumer interest in safe food while maintaining the environment and worker well-being has popularized at present. The Sri Lankan government has introduced Good Agricultural Practices (GAP) certification system to ensure food safety and quality since 2015. It has been identified that farmers' adaption to the GAP program has been slow, and there is a low rate of farmers' recertification to this program. Thus, the goal of this study was to investigate the determinants that influenced the successful implementation of the SL-GAP program in the Kegalle district, as well as to identify the challenges that GAP-adapted fruit and vegetable farmers have in maintaining the GAP. Purposive sampling technique was used and a field survey was conducted for 100 fruit and vegetable farmers (50 GAP adapters and 50 GAP non-adapters) using a pre-tested questionnaire and structured interviews from March to April 2022. Data were analyzed using descriptive statistics and Binary Logistic Regression analysis by SPSS version 25. Results revealed that contact with extension officers, years of farming, government funding, training about GAP, and having internet access were significant factors for GAP adaptation. Years of farming showed a negative effect while others were positive. Lack of premium prices in the local market, unavailability of marketing channels, high cost of production, and lack of fertilizers were the key constraints faced by the adopted fruit and vegetable farmers in continuing good agricultural practices. According to the findings it can be suggested that government should focus on conducting GAP training including more farmer awareness programs, making available premium prices, and suitable marketing channels for items produced through the GAP. The authorities should be more involved in providing material support to GAP farmers, especially at starting which enables more farmers engaging in GAP. Government should also focus on conducting consumer awareness programs, promotions, and advertising to increase the visibility of GAP certification resulting in a higher price for GAP products due to increasing demand for them in the local market.

Keywords: Adapters; Good agricultural practices (GAP); Non-adapters

Paper ID: IRCUWU2022-362

Evaluation of agronomic, yield and yield related characteristics of selected exotic rice germplasms under Sri Lankan field condition

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Being the staple food, yield improvement is a high priority in rice breeding programs. One standard practise is to introduce exotic rice cultivars. Prior to introduction, they should be tested under local field conditions to evaluate their performance. This study reports the results of germplasm evaluation of selected exotic rice accessions which were obtained from the International Network for Genetic Evaluation of Rice. Fifteen exotic rice germplasms were evaluated, in comparison to three local check varieties, at the research fields of Regional Rice Research and Development Centre, Bombuwala during 2020/21 Yala and Maha seasons for their agronomic, yield and yield-related characteristics. Seeds from pure breeding exotic rice lines and 3 local check varieties were germinated to obtain seedlings. Seedlings were transplanted into the field after 21 days from emergence. Rice lines were evaluated in Randomized Complete Block Design with 3 replicates. Related data were recorded at 5-leaf, vegetative, late vegetative, heading, flowering, and maturity stages of the rice plant. Seedling height, leaf length and width, days to 50% heading, culm length, culm diameter, 100-grain weight and yield per plant were considered as the main agronomic and yield-related traits that determine the growth rate and yield of the exotic accessions to select the best germpalsms. Data were analyzed using one-way ANOVA while the means were compared using Tukey's pairwise comparison at 5% significance level. Data from two consecutive cultivation seasons revealed that the agronomic and yield-related characteristics of accession number 1, 3, 6, 8, 9, 10, 12, 13, 14, and 15 exotic rice lines were not significantly different from the local check varieties while accession number 11 exhibited lower performance. Evaluated primary data revealed that selected exotic accessions had the capability of growing under local conditions. Consequently, selected lines could be utilized in rice breeding programs as parents for hybridization or as co-development lines to improve new rice varieties which in turn help to increase the local rice production.

Keywords: Agronomic traits; Exotic accessions; Germplasm evaluation; Rice

Paper ID: IRCUWU2022-446

Azolla pinnata as a feed substitute for improved performance in laying hens during the peak-production period

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Successful application of locally available feed raw materials supports sustainable poultry production in Sri Lanka whilst reducing the dependency on soybean meal like imported feed ingredients. Accordingly, Azolla (*Azolla pinnata*) obtains special consideration due to its high protein content, high availability, fast growth rate, and low cost of production. Therefore, this study was designed to determine the effect of partial substitution of layer feed with fresh Azolla as a dietary protein source on laying performance and egg quality parameters in Shaver Brown® laying hens at the peak-production period. Ninety, 24-wk old hens were allocated to each of three dietary treatments; (1) CON: 100% commercial layer feed, (2) T1: 95% commercial feed + 5% fresh Azolla, (3) T2: 90% commercial feed + 10% fresh Azolla, and obtained three replicate pens per each treatment (10 hens/pen). Feed intake, number of eggs, and egg weights were recorded daily basis to calculate weekly feed conversion ratio (FCR) and egg mass. Body weights were recorded weekly from 25 to 31 wk post-hatch. Egg quality parameters (egg weight, shape index, shell thickness, yolk index, yolk colour, and Haugh unit) were evaluated at the end of the 31 wk post-hatch. Data were analysed using one-way ANOVA in JMP® Pro 16.0 software package (SAS Institute Inc. JMP Software. Cary, NC), and the Least Significant Difference (LSD) Student's t-test was used to determine the significant differences between experimental groups ($p<0.05$). Proximate analysis revealed the crude protein content of Azolla as 16.32%. Significant treatment effects were observed ($p<0.05$) for laying performance from 25 to 31 wk post-hatch, where T2 improved egg production rate, egg weights, egg mass, and FCR than the CON group by 16.7, 5.3, 23.2, and 18.2%, respectively. Moreover, external and internal quality parameters of eggs were influenced by the dietary treatments where T2 increased ($p<0.05$) yolk index, Haugh unit and egg yolk colour than the CON by 8.8, 6.2, and 74.7%, respectively. In conclusion, the 10% substitution of commercial feed with fresh Azolla can effectively be used to improve the performance of Shaver Brown® laying hens in their peak production period.

Keywords: Azolla; Egg quality; Laying hens; Laying performance

Paper ID: IRCUWU2022-448

Development of low caffeine genotypes by backcross breeding of tea (*Camellia sinensis* (L) O. Kuntze)

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Tea is the most popular non-alcoholic beverage in the world. Caffeine is the most abundant alkaloid, giving briskness and creaming properties to black tea. It has several health benefits but when consumed in excess amount it causes negative health effects. Globally, there is an increasing demand for low caffeine tea cultivars. Therefore, in the current study, a high caffeine containing cultivar TRI 3055 (25.913 mg/g) was crossed with low caffeine containing cultivars; PBGT 41 (15.093 mg/g), PBGT 48 (12.836 mg/g) and PBGT 49 (18.915 mg/g) to develop three F1 progenies with the objective of developing low caffeine cultivars. Furthermore, nine accessions from three F1 progenies were backcrossed with PBGT 41, PBGT 48, and PBGT 49 to develop nine Back Cross (BC1) progenies of 41 genotypes. Caffeine of all individuals in three F1 and nine BC1 progenies along with their parents were profiled using High Performance Liquid Chromatography (HPLC) following the ISO protocol. According to the result, three F1 progenies reported intermediate caffeine ranges (18.86 to 27.07 mg/g). Interestingly, four BC1 progenies of PBGT 41 reported the lowest caffeine ranges (9.06 to 19.08 mg/g, 9.71 to 20.22 mg/g, 13.83 to 20.62 mg/g, and 13.46 to 27.26 mg/g). Similarly, low caffeine range of 12.45 to 21.78 mg/g, 11.77 to 23.08 mg/g, and 12.44 to 15.50 mg/g were recorded from three BC1 crosses of PBGT 48. However, a comparatively a higher caffeine range was recorded for two BC1 progenies of PBGT 49 (16.04 to 23.63 mg/g and 18.34 to 21.09 mg/g). None of the genotypes in three F1 progenies recorded lower caffeine values than the lowest parents. Nevertheless, 29 to 57% genotypes in nine BC1 progenies had lower caffeine contents than the lowest parent indicating the potential of developing low caffeine genotypes through backcross breeding. Seventeen genotypes identified with low caffeine contents from BC1 progenies could be utilized in future for the development of low caffeine cultivars.

Keywords: Backcross; *Camellia sinensis*; HPLC; Law caffeine genotypes; Progeny; Tea breeding

Paper ID: IRCUWU2022-469

The impact of transportation distance on PSE and DFD occurrences in chicken meat at a commercial broiler processing plant and their effect on quality attributes of breast meat

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Pale, soft, exudative (PSE) and dark, firm, dry (DFD) conditions are growing problems in the broiler processing industry. PSE meat has pale colour, soft texture, and low water holding capacity whereas DFD meat shows a dark colour and firm and dry texture. These defects diminish the meat quality and cause financial losses. Short- and long-term stressors, genetics, way of transportation of chicken, and environmental temperature are the main causes of these defects. Hence, the objective of this study was to identify the effect of transportation distance on the prevalence of PSE and DFD conditions in chicken breast meat obtained from a commercial broiler processing plant and their impact on the quality traits of raw breast meat. A total of 50 broilers each from three different farms (short distance-<50 km; medium distance-50–100 km; long distance >100 km) were randomly selected and slaughtered. Breast fillets (n=150) were then tested for the PSE and DFD conditions based on the lightness (L*) value (PSE: L*>58, Normal: L*≤58, and DFD: L*<48). A total of 10 breast fillets from each farm (5 PSE and 5 normal) were analyzed for colour, pH, and water holding capacity (WHC). The effects of transportation distance and meat type (PSE and normal) were estimated using a two-way analysis of variance (ANOVA). Interestingly, DFD meat was not found among the samples. A significant association was found between the transportation distance and the prevalence of PSE condition in chicken breast. The occurrences of PSE meat after long-, medium-, and short-distance transportation were 32%, 16%, and 10%, respectively. In this study, PSE meat showed a higher L* value (59.2) and lower a*(8.4), pH (5.79), and WHC (71.43%) values as opposed to normal meat (54.8, 9.0, 5.98, and 76.70%), respectively (p<0.05). However, the results further indicated that the transportation distance had no significant impact on the majority of meat quality traits, except WHC. In this regard, long-distance transportation resulted in a lower WHC (p<0.05) compared to medium- and short-distance transportation. In conclusion, the transportation distance had a noteworthy impact on the prevalence of PSE meat and WHC of raw chicken breast meat.

Keywords: Breast meat; DFD; Lightness; pH; PSE; Water holding capacity

Paper ID: IRCUWU2022-471

Study on the degree of satisfaction of supply chain stakeholders on the transformation of conventional tea auction into an e-auction

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Sri Lankan tea has reputation for producing quality, finest and cleanest teas. Colombo tea auction is the main marketing channel to dispose of bulk tea in Sri Lanka. Fearing the loss of the physical auction, the concept of E-auction was shelved in Sri Lanka for a long time. Though Covid-19 pandemic situation arose, still this industry progressed as an integral part of other industrial environments. Meantime, the conventional auction was shifted to an e-auction platform, as productivity and technological enhancement to facilitate especially the buyers with other stakeholders. Although E-auction has been continued over the year since April 2020, no depth study has been undertaken to identify the pros and cons of E-auction. Hence, this study was aimed to determine the degree of satisfaction in transforming into E-Auction among 75 stakeholders representing each category using a questionnaire-based survey with a stratified sampling method. A questionnaire was developed to collect primary data on the socio-economic status, usability, perceived usefulness, and ease of use of the E-Auction process. The questionnaire was pretested, and Cronbach values exhibited was 0.955. A scoring system and 5-point Likert scales were developed to measure the above criteria and indexes. Descriptive analysis and Ordered Logistic Regression were applied to measure variables and explain the relationship between the degree of satisfaction of stakeholders with the transformation into E-Auction and other explanatory variables. The results revealed that 45.33, 49.33 and 5.33% of stakeholders are satisfied highly, moderately, and low with the transformation into E-auction, respectively. The overall model was significant at 5% significant level (prob>chi^2=0.0000) and pseudo R^2=0.6704. The degree of satisfaction was positively correlated with stakeholder's experience, age, and perceived usefulness while that of positively correlated with perceived ease of use at 5% significant level. Meanwhile, education level, stakeholder type, and usability were negatively correlated with stakeholders' satisfaction. Considering the above facts of stakeholders' satisfaction with the transformation of the conventional auction into a novel E-Auction, it could be concluded that E-Auction process is more effective in all dimensions and needs appropriate, user-friendly improvements with the technological advancement of the ICT sector.

Keywords: Covid-19; E-auction; Satisfaction; Stakeholders

Paper ID: IRCUWU202-489

Impact of export diversification on economic growth in Sri Lanka: An application of auto regressive distributed lag model

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Export diversification is identified as a growth-enhancing mechanism for developing countries in both theoretical and empirical literature. According to the descriptive analysis related to both market diversification and product diversification, Sri Lanka was less capable of doing product diversification and exports of goods remained concentrated in garments, tea, other agricultural products, and gems between 1995 and 2015, growing by a factor of 3.2 and running constant for about 25 years. The prime objective of this study was to empirically examine the long-run and short-run relationships between export diversification and economic growth in Sri Lanka using annual time series data from 1995 to 2019. The study used gross domestic product at a constant price as the dependent variable while export diversification (Herfindahl-Hirschman index), gross capital formation, and population were taken as explanatory variables. The study employed Augmented Dicky-Fuller test and Kwiatkowski-Philips-Schmidt-Shin test to find the stationary properties and Autoregressive Distributed Lag model to examine the long-run and short-run relationship. The result of the econometric model revealed that there was a long-run relationship between gross domestic product, export diversification, gross capital formation, and population. Export diversification and gross capital formation showed a positive and significant relationship while the population gave a positive and insignificant relationship with economic growth in the long run. Among the variables, export diversification showed the highest contribution to economic growth where one percent increase will grow the economy by 0.59 percent. Furthermore, the short-run relationship showed a mixed result in that all the variables become statistically significant. Hence, the study suggested that the government should diversify its export portfolio that includes more value-added commodities in its export basket rather than primary goods to foster a thriving manufacturing sector and use of sophisticated technology and establishing an effective trade finance to promote exports.

Keywords: Autoregressive distributed lag model; Economic growth; Export diversification; Long run; Sri Lanka

Paper ID: IRCUWU2022-496

Factors determining the demand for food diversity in urban sector of Sri Lanka

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Eating a large variety of food is an internationally accepted recommendation for a healthy diet because it is associated with positive health outcomes. Nutritionists believe that the key to an optimal diet is to eat a variety of foods. The extent to which citizens of a country consume a diversity of goods has been linked to the economic well-being of a country. However, dietary diversity is particularly problematic among poor populations in developing countries, whose diets are primarily comprised of starchy staples. Given that food variety influences nutritional quality, studying the demand for food consumption diversity is important for health policies. This study, therefore, examined the demand for diversity in food consumption in the urban sector of Sri Lanka. Data were extracted from the household income and expenditure survey (HIES) 2016, conducted by the Department of Census and Statistics (DCS) in Sri Lanka. Data of 3,349 households were extracted from the survey data for urban sector analysis. The theoretical model of this study was derived from the traditional consumer utility maximization model. The diversity in food consumption was measured using the well-known Entropy index. Factors determining the demand for food diversity were analyzed using Ordinary Least Square (OLS) model. Findings of the study revealed that the female headed households, working wives and larger households had a greater preference for food diversity in the urban sector of Sri Lanka. However, the parameter predictions for the household-size-squared variable showed economies of scale related to food consumption diversification. Further, age and the education level of the household head had a positive impact on diet diversity. Interestingly, our results confirmed a non-linear relationship between household income and food consumption diversity as suggested by the non-linear Engel curves. This study contributes to the scarce empirical evidence related to demand for food diversity in Sri Lanka.

Keywords: Consumer demand; Entropy index; Food diversity; Urban sector of Sri Lanka; Utility maximization

AQUACULTURE & FISHERIES

Paper ID: IRCUWU2022-155

Livelihood status of fishing community in Deduru Oya reservoir, Sri Lanka

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Deduru Oya reservoir was built in 2014 inundating more than thousand hectares for irrigation purposes. Fisheries is one of the major occupations of the villagers. Nearly 120 fishermen were engaged in fisheries. The availability of scientific data about fishers' livelihood and hydrological parameters in the Deduru Oya reservoir were scanty. The research objectives were to estimate the fishers' current livelihood status in Deduru Oya reservoir in Sri Lanka, assess the effect of water fluctuation level and rainfall on fish yield, investigate the success level of the co-management system, and conduct a market chain analysis for most common fish species in the reservoir. The study was carried out from February 2022 to May 2022. A pre-test questionnaire survey applying stratified sampling was carried out for fishermen (n=72) with consent. Primary data were collected using a semi-structured questionnaire, interviews, and focus group discussions. The current study examined fishermen's livelihood capitals *i.e.* natural, financial, physical, social and human capitals. Hydrological data were collected from the Irrigation Department. Fish harvest data were collected from National Aquaculture Development Authority. Data were analyzed as descriptive statistics using SPSS and MS Excel. Capture per unit effort for gillnet was 0.036 kg/m^2/day. Fishermen livelihood capital access was greater than 50% out of whole sample, indicating potential amelioration. Fish yield was highly correlated with annual rainfall (r=0.926, p<0.01) besides less correlation with water level (r=0.656). Three fisheries societies had functioned separately. A cooperative co-management system was functioning in the Deduru Oya reservoir. Fishermen, the fishing community, retailers, wholesalers, and consumers were the roles in the market chain for the main fish species. The market chain mainly reached the final consumer through mobile vendors and wholesalers as a secondary pathway. *Macrobrachium rosenbergii* reached to export market through a major private company. The current study attempted to disclose livelihood capitals of fishermen and existing management strategy which may contribute sustainable management of Deduru Oya fishery in the long run. However, further research work is recommended.

Keywords: Deduru Oya fishery; Hydrological parameters; Livelihood capitals; Management strategy

Paper ID: IRCUWU2022-156

Livelihood status of fishing community of Mahakanadarawa reservoir in Anuradhapura, Sri Lanka

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Mahakanadarawa reservoir is the major, perennial reservoir in Anuradhapura District Sri Lanka, which consists of a 1457 ha land area. Status of the existing fishery and livelihood capitals of Mahakanadarawa reservoir were scanty in literature. Hence, the current study mainly investigated on fishery and livelihood capitals of fishermen in Mahakanadarawa reservoir. Primary data were collected from eight landing sites of the Mahakanadarawa reservoir during the period from February to May 2022. A pre-tested questionnaire was used and 72 fishermen were interviewed, and three focus group discussions were conducted. Information on livelihood status under social, human, physical, natural, and financial capitals, current fishery profile, fish post-harvesting techniques, market chain analysis, and fisheries management practices were collected. Capture per unit effort (CPUE) for the gillnet fishery was calculated. Secondary data including stocking of fish fingerlings and species-wise harvesting data for the past 10 years were collected from the district aquaculture extension office (Anuradhapura) of the National Aquaculture Development Authority of Sri Lanka. Secondary study on length-weight relationship of *Oreochromis niloticus* along with its condition factor value was also performed. It was revealed that *O. niloticus* had negative allometric fish growth (b=2.6667) with condition factor value of 1.9092. The female fish had a higher mean total length compared to the male fish. In the fishing community, 95.83% males and 4.17% females had engaged in fishery activities. Mainly gill nets and non-mechanized fiberglass canon were used. Average CPUE was 0.000339 kg/m^2/day. Strong positive (r=0.841) correlation was reported for fish stocking and fish production. Smoking and sun drying were the most common post-harvest methods observed. The fish supply chain targeted the regional market and it was conducted by secondary networks of two-wheeler vendors (motorcycles). A cooperative level co-management system was identified among the reservoir fishing community. The current study discloses livelihood capitals of fishing community along with existing supply chain which can be utilized for sustainable management strategy of the Mahakanadarawa reservoir in the long run.

Keywords: Fisher livelihood; Mahakanadarawa reservoir; Market chain

Paper ID: IRCUWU2022-244

How women contribution to improve fisheries sector in Sri Lanka

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Sustainable development goals in United National Development Program specified the gender equity in Goal 5 relevant to the blue economy. Hence, the issue of gender and development in the blue economy seeks to link Goal 5 to Goal 14, which would then speak to empowering women to participate in all aspects of conserving and sustainably using our oceans, seas and marine resources. Central Bank of Sri Lanka has mentioned that the fishing industry contributes 3% to the Gross National Production (GNP) of the country. The current study was conducted to investigate how the women employers related to fisheries and marine sectors contribute to GNP at different levels. The study was conducted through a questionnaire from fisherwomen and executive-level officers in government and non-government institutes. The percentage of women present in each institute was calculated. National Aquatic Resources Research and Development Agency (NARA), National Aquaculture Development Authority (NAQDA), Department of Fisheries and Aquatic Resources (DFAR) and Marine Environment Protection Authority (MEPA) from the government sector alongside processing establishments and entrepreneurs from the private sector were selected for the study. According to the Borgen report, girls' education in Sri Lanka has significantly improved over the last two decades. The girls percentage in education related to this sector was calculated from the Faculty of Fisheries and Marine Sciences, University of Ruhuna (FMST) and the Ocean University of Sri Lanka (OCU). The percentage of women in NARA represented 44.90% while MEPA, DFAR, and NAQDA represented 40.00, 33.30, and 13.20%, respectively. As female lecturers, FMST and OCU represented 43.75 and 45.45%, respectively. In the private sector, women's representation is less than 15.00% at the executive level. Female percentage is gradually increasing in education institutes yearly. The executive level women officers' enrolment is slowly improving but the contribution of entrepreneurs and the private sector needs more contribution. Women education related to this sector is increasing currently because of the total female percentage of our country is higher than male. Government should involve and provide training programs for fisherwomen and select more female executive officers to fisheries and marine science related institutes.

Keywords: Education; Empowerment; Executive level; Fisheries; Sustainable development goals (SDG); Women

Paper ID: IRCUWU2022-288

A preliminary study on status of fishing gear types in the shrimp fishery in Jaffna lagoon, Sri Lanka

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Jaffna lagoon, the largest brackish water body in Sri Lanka, has a well-established shrimp fishery. The status of shrimp fishery in the lagoon is poorly understood due to the lack of monitoring and scientific studies. This study investigated different fishing methods used in shrimp fishery in Jaffna lagoon and their catch rates. Data on shrimp fishing methods were collected from all thirty-nine landings sites along the Jaffna lagoon from October 2021 to June 2022. The results showed that a total of 6,174 fishers involve in shrimp fishing activities in the lagoon throughout the year by using five different fishing methods: fyke nets, lagoon seine nets, kandi method, trammel net, and manual picking. Of these, fyke nets (90%) were widely used, followed by lagoon seine nets (9.6%). All these fishing methods except for manual picking are operated using Mechanized (Mechanized traditional boat [MTRB]-35%; outboard fiberglass reinforced plastic boat [OFRP]-26%) and non-mechanized (non-mechanized traditional boat [NTRB]-39%) fishing crafts. The composition of shrimp in fyke nets was 58% of total catch, while the lagoon seine nets reported 62%. The catch rate of lagoon seine nets (4.32 kg/fisher/day) was higher than the fyke nets (2.75 kg/fisher/day; $p<0.05$). *Penaeus semisulcatus* and *Metapenaeus monoceros* were the dominant shrimp species in the harvest. Nine different types of fyke nets were recorded in the Jaffna lagoon according to the number of concentration chambers, number of leaders and the wings, and depth of operation. Among the fyke nets 47% of Double-side chambered fyke nets (type II) were mainly practiced in the lagoon, followed by 21% of single-side chambered fyke nets with a single wing (type III) and 9% of single-side chambered fyke nets (type I). Other types of fyke nets are rare in operation and are limited to particular fishing locations. The catch rate for type II fyke nets (1.39 kg/fyke-net/day) was higher than that of type III (1.18 kg/fyke-net/day) and type I (0.19 kg/fyke-net/day). However, discard percentage was higher in type III (27%) than in type 1 (20%) and type II (19%). Further studies will be important to understand the importance and impact of each fishing gear and to propose suitable management strategies.

Keywords: Fishing gears; Fyke nets; Jaffna lagoon; Seine net; Shrimp fishery

Paper ID: IRCUWU2022-347

Impact of Covid-19 pandemic on ornamental fish industry in Gampaha District, Sri Lanka

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Covid-19 is a viral infectious disease caused by SARs-COV-2. It was reported first in China in December 2019 and spread to most countries in the world creating health, economic and social issues. Ornamental fish farming industry is one of the main aquaculture industries and the present study was focused to investigate the impact of Covid-19 on the ornamental fish farming industry in Sri Lanka. Gampaha District was selected for the study as it is one of the main districts operating considerable number of ornamental fish farms in the country. Data were collected from 09 divisional secretariat divisions from 14th February 2021 to 16th May 2021. Out of 123 ornamental fish farmers in the district randomly selected 93 respondents were used to collect the data. Due to the prevailed Covid-19 pandemic situation and travel restrictions in the country a telephone-based survey was conducted. Data were analyzed under two categories to illustrate the status of ornamental fish farming industry before and during the Covid-19 pandemic. Twenty-three species of ornamental fish are cultured in the district. A significant difference was recorded in fish sales between before and during the Covid-19 pandemic period indicating 92.47% sales before pandemic and it was decreased up to 62.37%. During the pandemic period, 36.56% of the farmers reported zero income. Among the issues faced by the fish farmers, it was recorded that 75.27% of the farmers were affected by the transport restrictions. Inability to maintain a fixed price for the farmed fishes, fluctuations in the market price of ornamental fish varieties, shortage in fish feed supply, and limited availability of medications for disease control were reported as the other main issues faced by the ornamental fish farmers in the Gampaha district.

Keywords: Covid-19; Fish farming; Gampaha district; Ornamental fish

Paper ID: IRCUWU2022-371

An island-wide survey on household fish and seafood consumption in Sri Lanka

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Being an island nation, seafood plays a vital role in the people's diet in Sri Lanka. Seafood is one of the best dietary sources of protein and other nutrients but also a major pathway of human exposure to contaminants. Thus, risk-benefit assessments are required to limit the exposure to toxicants while increasing the benefits of seafood consumption. Currently, the lack of data on household fish and seafood consumption rates in Sri Lanka challenges the risk-benefit assessments. The main objectives of the present study were to quantify the household fish and seafood consumption rates for widely consumed seafood species and identify the determinants of seafood consumption in Sri Lanka. The data were collected using a random web-based online questionnaire survey. Ninety-seven percent (n=2,078) of the total survey respondents (n=2,149) reported consuming fish and seafood, with an average daily consumption of 119.07 g/day. The majority of survey respondents (99%) reported consuming sardinella species, whereas the least consuming seafood was seaweed (1%). The most consumed freshwater fish included tilapia (52%), snakehead fish (13%), giant freshwater prawn (12%), and carp (10%). A total of 99% of the survey respondents indicated that "freshness" was their primary concern when purchasing fish and seafood. The consumption rates of seafood species (kg/ individual/year) followed the order tuna species (10.85)>sailfish (3.91)>prawns (3.78)>trevallies (3.01)>cuttlefish (2.34)>seer (2.21)>rockfish (1.83)>sharks and skates (1.81)>crabs (1.16)>marlins (0.89)>bivalves (0.18)>lobsters (0.14). The most preferred cooking method of fish was fish curry (45%), followed by fried fish (30%) and *Ambul Thiyal*/sour black fish curry (21%). Seafood contributes 42% (0.34 g/kg/day) and 48% (0.39 g/kg/day) of the daily protein requirements for adult males and adult females, respectively. The present study concludes that seafood contributes around 46% of the daily protein requirement of Sri Lankans. The seafood consumption parameters quantified by the present study will be of great importance for the future risk-benefit assessment of Sri Lankan seafood consumers.

Keywords: Consumption rates; Fish; Seafood; Sri Lanka; Survey

Paper ID: IRCUWU2022-376

A review of the present status of culture-based system of *Macrobrachium rosenbergii* (giant freshwater prawn) in Udawalawa and Samanala reservoirs, Sri Lanka

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Macrobrachium rosenbergii (giant freshwater prawn) is one of the most economically important species in the Sri Lankan inland fishery sector. In aquaculture, giant freshwater prawn (GFP) brood stocks are collected from the wild and some farmers are inclined to capture fishery rather than culture-based freshwater prawn fishery. The present status of the culture-based approach for *M. rosenbergii* was reviewed in the current study to find out the potential improvement. Two major reservoirs in Sabaragamuwa Province, Samanala and Udawalawa reservoirs were selected as the study sites. Majority of samples (75%) were taken from fishing populations of each reservoir using a simple random sampling technique. Primary data were collected using a pre-tested questionnaire, and key person interviews while secondary data were collected from reliable secondary sources. Data were analyzed descriptively by using IBM SPSS statistics 26 software. Out of the total catch, 45% of the GFP catch was harvested from the Udawalawa reservoir while it was 20% from the Samanala reservoir. Average monthly freshwater prawn catch was 10–20 kg in each reservoir. The monthly total income generated by GFP was 55.93% in Udawalawa reservoir and 46.67% in Samanala reservoir out of total fishery income, respectively. Fifty percent of the fishermen have experience of 20–30 years in the industry and 91.53% of them occupy fishing as their major income source. Gill net was the major fishing gear of the GFP fishery in the two reservoirs. Key person interview with the freshwater prawn exporters revealed that in two reservoirs exporter competitions, company buyers, and exporting destinations fluctuated seasonally and government awareness programs will be crucial to uplift the industry. The supply chain comprised both local and foreign market interventions, with a higher number of fishermen selling their catch to intermediate merchants and the final buyer. The study revealed that the freshwater prawn culture needs to be developed properly and government involvement with knowledge transfer programs will be essential for enhancing the industry.

Keywords: Culture-based system; Giant freshwater prawn; Samanala reservoir; Udawalawa reservoir

Paper ID: IRCUWU2022-379

A preliminary survey on socio-economic status of Navanthurai and Karainagar lagoon fishing villages, Northern Sri Lanka

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Navanthurai and Karainagar are considered as two main fishing villages situated in different Fisheries inspector divisions in Jaffna lagoon in northern, Sri Lanka. The socio-economic and fishery status of Karainagar and Navanthurai lagoon fishing villages were meagre and comparative studies are limited in the literature. This study was conducted from February 2022 to May 2022 with an aim of evaluating socioeconomics which may aid in improving the management system of the lagoon fishing villages. Primary data were gathered using a semi-structured questionnaire from selected 100 fishermen out of 500 through snowball sampling method at both sites. The secondary data were gathered from the Department of Fisheries and Aquatic Resources (DFAR). Analysis of the socio-economic characteristics and fisheries status were performed by using IBM SPSS 26 and Excel 2013. The outcome of the study revealed that the majority of fishermen in Navanthurai were aged 20–30 years with ordinary level education (44%) and fishermen in Karainagar were middle aged group of men and women (31–40 years) with the primary education (57%). The monthly income of fishermen was estimated as 77% in Navanthurai and 71% in Karainagar; which came under 20,000 LKR to 50,000 LKR income category. There were 5 types of fishing crafts i.e., stake net, fyke net, gill net, crab net and cast net, and 3 types of fishing gears i.e., non-mechanized traditional boat (NTRB), mechanized traditional boat (MTRB), and outboard fiberglass reinforced plastic boat (OFRP) in both fishing villages. During the study period, shellfishes which belong to family Penaidae (3%) and family Portunidae (10%), finfishes which belongs to families Mugilidae (17%), Gerreidae (13%), Siganidae (16%), Aridae (11%), and Scardae (9%) were identified in both villages. The higher catches per unit of major fishing gears were recorded as 8–14 kg for the stake net in Navanthurai, 5–10 kg for the fyke net in Karainagar during April 1st to May 1st, 2022. The market structure was strong in Navanthurai due to the availability of more stakeholders who involved in marketing of fishes than those of Karainagar. The awareness on fisheries sustainability was at moderate level (2.34<mean value<3.66) in both sites. This study provides baseline information on socio-economic status of the two fishing villages which would facilitate development of an optimum long-term management strategies.

Keywords: Catch per unit; Fishing gears; Fisheries sustainability; Lagoon; Socio-economic

Paper ID: IRCUWU2022-382

Indigenous fishing knowledge of fishing practices in Kokkilai lagoon, Sri Lanka

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Coastal lagoons provide a variety of valuable natural services, including the productivity of fisheries. The Kokkilai lagoon is one of the most prominent fishing estuarine lagoons in Sri Lanka's northeast, with a high production rate when compared to other fishing areas in the Mullaitivu and Trincomalee districts. Indigenous fishing knowledge of a specific lagoon is critical for long-term resource sustainability, fishing activity regulation, the introduction of modern techniques and gear, as well as to understand the lives of fishing communities. Indigenous fishing knowledge is traditional knowledge passed down through the centuries concerning fishing gear, boats, techniques, seasons, and activities in a specific community. The goal of this study was to gather information on fishing techniques, fishing boats, fishing gear, species composition, catch per unit effort, and the level of awareness of indigenous knowledge in Kokkilai fishing community. The current study was conducted at Kokkilai fishing community from February 2022 to May 2022. Primary data was gathered through a questionnaire survey of 100 people, personal interviews, group discussion with fishing cooperative community leaders and direct field observation. Secondary data was gathered from the Mullaitivu Fisheries Department and from relevant journal articles. The data was statistically analyzed by using the SPSS 26, Microsoft Excel, and Minitab 17 software packages. According to the study, three different types of fishing boats such as outboard fiberglass reinforced plastic boat [OFRP], mechanized traditional boat [MTRB], and non-mechanized traditional boat [NTRB], and twelve types of fishing gears, including gill nets, cast nets, and scoop nets were employed in Kokkilai. The majority of fishermen at the Kokkilai lagoon landing locations in Mullaitivu had 1–10 kg of catch per day. More than 40 food fish and shellfish species were identified in the Kokkilai lagoon during the study period. In 2020 and 2021, the average annual fresh fish production rate was 147.35 and 228.96 mt, respectively. There were no distinct marketing systems. The harvest was directly sold to fish collectors and exported. *Litopenaeus setiferus*, *Penaeus monodon*, *Scylla serrata*, and *Menippe mercenaria* had the highest demand in the Kokkilai area. To some extent, the Kokkilai fishing community understands the importance of fishing sustainability at a moderate level ($2.34 \leq$ Mean value ≤ 3.66). The findings of this study may substantiate the indigenous knowledge-based fishing management in the Kokkilai lagoon.

Keywords: Fishing management; Fishing methods; Indigenous knowledge; Kokkilai lagoon; Sustainability

Paper ID: IRCUWU2022-393

A study on livelihood aspects of *Kappaphycus alvarezii* seaweed farmers in Valaipadu, Sri Lanka

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Despite the fact that seaweed farming has been practiced in Valaipadu in the Kilinochchi District in Sri Lanka nearly for a decade with a comparatively higher production rate than the other farming areas in northern province, no detailed study has looked into the impact of seaweed farming on the livelihoods of seaweed farmers. This study aimed to investigate the living standards of seaweed farmers while identifying the constraints affecting their seaweed farming. Primary data was gathered from all seaweed farmers (n=88) in Valaipadu from February to May 2022 using a pretested structured questionnaire, key-personnel interviews, and direct field observations. Secondary data was collected from the National Aquaculture Development Authority of Sri Lanka, Poonagary and relevant journal articles. The data was statistically analyzed using simple descriptive methods. The sole macroalgae grown in Valaipadu village was the red seaweed *Kappaphycus alvarezii*. Among the respondents, 58% solely depend on seaweed farming as their prime livelihood, while others practice this as an extra-income earning source apart from conventional economic activities such as fishing. A total of 54.5% people who were previously unemployed, are now employed in seaweed farming. Many farmers had an average annual income range of 106,990–200,000 LKR from seaweed farming. Results showed that majority of the seaweed farmers in Valaipadu are females (62.5%), indicating the potential for women empowerment using seaweed farming. Findings also discovered several constraints such as unpredictable weather, water quality changes, diseases, price fluctuations, poor quality of planting materials, and lack of regular training confronted by the seaweed farmers. The economic benefits arising from seaweed farming had improved the living standards of the seaweed farmers in Valaipadu by allowing them to enjoy a quality life. However, their livelihood can be improved further by solving the main constraints in seaweed farming. Providing proper training and extension programs under the public-private partnership to promote seaweed cultivation as a commercial enterprise is recommended.

Keywords: Constraints; *Kappaphycus alvarezii*; Northern; Seaweed farming; Socio-economic status

Paper ID: IRCUWU2022-399

Current status of seaweed farming in Northern Province of Sri Lanka and development of seaweed Database

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Seaweed farming in Sri Lanka has made a positive contribution to the national economy of the country. The current state of seaweed cultivation in the country has not been assessed properly. Therefore, the present study focused on an investigation of the current status of seaweed farming in Northern Province of Sri Lanka. The primary data collection was done using a pre-tested structured questionnaire, key informant interviews, discussions with seaweed farmers and secondary data sources such as the data derived by Sri Lankan customs and NAQDA (Northern Province) was also used. The total number of 101 farmers were selected for the survey from three districts including Kilinochchi, Mannar and Jaffna in the Northern Province. In Northern Province 56.4% of respondents earn an additional income from seaweed farming. The greatest number of female seaweed farmers are doing seaweed culture (61.5%) in Kilinochchi District. Ladder (PVC) and monoline were the major culture methods practicing in the Northern Province. All farmers followed monoline culture method, while 24.7% of farmers practiced both ladder and monoline culture methods for their farming. However, 44.9% of respondents do seaweed farming as their full-time occupation. According to the data derived by Sri Lanka Customs, India, Japan, China, and South Korea are the major seaweed export destinations. Several private companies are involved in the seaweed farming industry and they directly buy from the farmers. Due to the current economic crisis, most of the farmers were severely affected by the cost of fuel for their boats and other necessities. Further, there were new farmers who recently registered and received around 100,000 LKR of government subsidies to begin farming. Furthermore, disease and pest outbreaks caused by climate changes as well as low prices paid to farmers were identified as the major constraints to seaweed farming in the Northern Province. The database includes the seaweed species found in Sri Lanka, their morphological characteristics, and applications, and will serve as a source of information for seaweeds. The findings of the present study revealed that seaweed farming is a viable source of income for the Northern coastal community.

Keywords: Constraints; Culture method; Economic crisis; Seaweed database; Seaweed farming

Paper ID: IRCUWU2022-415

Zebrafish as a model for aging

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The global population has tended to develop models for human aging which cause the functional decline of the organs. The understanding aging process promotes the development of advanced treatments for age-related diseases. Zebrafish poses a novel model for vertebrate aging with a gradual aging phenotype and experimental manipulation advantages over the other vertebrate models. As a model for human aging, zebrafish has given insights into the disease studies of cancers, cardiovascular, neurodegenerative, and hematopoietic with their remarkable genetic and biological arrangement. Therefore, zebrafish can be identified as a promising model for human genetics, particularly in neurogenetics and toxicity testing. The whole genome of zebrafish is available and the transparent embryonic stages, high fecundity, high regeneration ability, easy maintenance and development of transgenic strains, and the existence of many mutant strains are added values to this tropical ornamental fish. In Sri Lanka zebrafish are mainly used for toxicity testing and in the ornamental fish industry, colored variants are becoming popular. However, the scientific potential of zebrafish on aging plays an important role in developing anti-aging therapies. Therefore, the aging process of zebrafish also needed to be studied with the purpose of using as a model for human aging studies in Sri Lanka. This effort will be based on reviewing the aging process of zebrafish and its application as a model for aging in humans.

Keywords: Aging; Laboratory animals; Model organism; Zebrafish

Paper ID: IRCUWU2022-422

Effects of stocking density and feeding frequency on growth performances of guppy fish (*Poecilia reticulata*)

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The guppy (*Poecilia reticulata*) is one of the world's most widely reared and traded tropical fish species. Managing stocking densities is important in guppy farming. Changing water quality, estimating quantity of feeds and frequency of feedings are leading problems to feed wasting and water pollution. Therefore, this research mainly targeted defining a protocol for guppies in high stocking densities in suitable water quality parameters and feeding frequency. The study was conducted for four months using four different stocking densities of 15 (D1), 45 (D2), 60 (D3), and 75 fish/ft^3 (D4) with 30 fish/ft^3 as the control with three replicates. Two experiments (E1 and E2) were conducted maintaining equally constant water quality parameters and fish were fed commercialized fish feed at 10% of fish body weight. E1 consisted of five feeding frequencies whereas E2 had six feeding frequencies per day. Total length and weight of fish were measured, and all the parameters were compared with the control. The survival rate of guppy fish in both experiments showed significantly low value in D4 and the highest value in D1 (p<0.05). There were significantly high specific growth rates in D1 (p=0.002), D3 (p=0.018) and D4 (p=0.002). E1 and E2 experiments showed significantly high specific growth rate in D1 than in controller (p<0.05). Weight gain (%) in both experiments were highest in D1 (1057.19±90.94, 1001.43±60.94) and D2 (918.62±90.94, 884.69±60.94). There was no significant difference in length gain in E1 whereas it was significantly different in D1 with the control (p=0.032) in E2. Further, there was a negative allometric fish growth rate (b=1.7) in E1 and positive allometric growth rate (b=3.24) in E2 with feeding frequencies. The present results are very promising in terms of providing the maximum performance of guppy fish in D2 (45 fish/ft^3) density level which can be used without having problems in both experiments which is higher than current industrial performance level.

Keywords: Feeding frequency; Guppy; Growth rate; Stocking density; Survival rate; Weight gain

Paper ID: IRCUWU2022-427

Defining a protocol for breeding and rearing crystal shrimp *(Caridina cantonensis)* using treated municipal water and mineralized reverse osmosis (MRO) water

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Ornamental shrimps have become increasingly popular in the aquarium sector in recent years and it can be considered as an upcoming hobby in the world. Among the freshwater ornamental shrimps, crystal shrimp (*Caridina cantonensis*) have a high demand due to their color patterns and attractive behaviors. *C. cantonensis* is highly sensitive species for water quality changes, hence there are low number of breeders available all over the world. Therefore, this study aimed to develop a breeding and rearing protocol using treated municipal water (T1) and mineralized reverse osmosis (MRO) water (T2) with the aim of high production. MRO water was prepared using commercially available special mineral mixture (3 g/L) mix with RO water. Matured, 90 (2 females: 1 males) healthy red crystal shrimps (4-4.5 months old) were selected as brooders and 10 females, and 5 males stocked in each tank. Number of offspring and their survival rate were measured in both T1 and T2. Temperature, pH, total dissolved solids (TDS) were measured on daily basis and general hardness (GH), potassium hardness (KH), total ammonia (NH_3), nitrate (NO^{3-}), nitrite (NO^{2-}) were measured on a weekly basis in both treatments. Results were analyzed using an independent sample t-test with 95% confidence interval. According to the result, there was a significant difference ($p<0.05$) in number of offspring in T2 when compared with T1. Also, there was a significant difference ($p<0.05$) in the survival rate of the crystal shrimp larvae in T2 compared with T1. There was no significant difference in water quality parameters in both treatments during the study period. Both treated municipal water and MRO were able to use for breeding the crystal shrimp. MRO water showed a higher number of offspring and a better survival rate for the crystal shrimp. Therefore, MRO water is the best treatment compared with municipal treated water for breeding and rearing of crystal shrimps and there should be more research focused on other affecting factors to enhance the breeding and rearing of them.

Keywords: Crystal shrimp; Mineralized reverse osmosis water; Total dissolved solids; Treated municipal water

Paper ID: IRCUWU2022-430

Study of food sources and feeding habits of selected freshwater fish in five reservoirs of Monaragala District

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The food sources and feeding habits of freshwater fish are important factors to be considered for the high fish production in local reservoirs in Sri Lanka. Identification of major food items in different fish species with higher commercial demand will provide wide knowledge for further studies on their niche overlapping. This study focused on the diet composition of commercially important four freshwater fish species: *Oreochromis niloticus*, *Catla catla*, *Labeo rohita*, and *Cirrhinus mrigala* in five selected reservoirs (Handapanagala, Hambegamuwa, Yudaganawa, Kiriibbanwewa, and Saddhathissa reservoir) in Monaragala District. The study was conducted from March to June 2022. A total of 60 fish samples were purchased from fish landing sites of each reservoir and the total length, standard length, body weight, and length of the gastrointestinal tract were measured and relative gut length (RGL) was calculated to determine their feeding habits. The diet was determined qualitatively and quantitatively using frequency occurrence and numeric methods. Phytoplankton was the most prominent food item in *O. niloticus* (76.05%), and *L. rohita* (52.44%) whereas, macrophytes were high in *C. mrigala* (45.59%) and *C. catla* (38.56%) collected from Handapanagala reservoir. Macrophytes were the most prominent food item in all four fish species collected from Hambegamuwa reservoir and in *L. rohita* and *C. mrigala* collected from Kiriibbanwewa. Macrophytes and phytoplankton were dominant in all four fish species collected from Saddhathissa and Yudaganawa reservoirs. There was a significant difference among phytoplankton, detritus, and unidentified matter in the stomach of all four species in five reservoirs. Other than *O. niloticus*, there were significant differences among the macrophytes in stomach of the three species in all reservoirs. There were no significant differences among the animal parts in stomach of four species collected from five reservoirs. Other than *L. rohita*, there were no significant differences among the zooplankton in stomach of the other three species. The mean relative gut length of all four fish species (RGL>3.0) showed herbivorous feeding habits. Hence, it can be concluded that four of the analyzed species in each reservoir were herbivores in feeding habits, and the relative gut length further verified the findings which could lead to higher fish production by enhancing phytoplankton production.

Keywords: Feeding habit; Freshwater fish; Gut content; Relative gut length

Paper ID: IRCUWU2022-479

Optimization of stocking density of red balloon platy (*Xiphophorus maculatus*) in aquaponics system with *Echinodorus uruguayensis*

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Xiphophorus maculatus and *Echinodorus uruguayensis* are prominent fish and aquatic plant species in the ornamental aquatic industry in Sri Lanka. High stocking density maintained in a limited area in ornamental fish farming leads to deteriorate the water quality. Objective of this study was to increase the stocking density at the rearing stage of *X. maculatus* fry using an aquaponic system with *E. uruguayensis* plant. Juvenile fish with mean average weight of 0.03±0.02 g was stocked in glass tanks (1.5×1×1 ft) with three different stocking densities 40 (T1), 35 (T2), and 30 fish/30 L (T3) respectively and final density was selected based on the standard practice of rearing farms. Six plants of the same age and size were introduced into separate set of tanks with pieces of roofing tiles as substrate and maintained for 69 days until platy fry reach marketable size. Total height, wet and dry weight, number of leaves, leaf and root lengths, plant height and stem length were measured in plants. Growth parameters were analyzed using one-way ANOVA. Dissolved oxygen, pH, temperature, nitrate, ammonia, nitrite, and phosphate were measured during the study. Tanks were refilled with freshwater to compensate the evaporated volume. Results revealed that there was no significant difference (p>0.05) between stocking density of *X. maculatus* for the specific growth rate, fish survival rate, fish weight, and length gain. The highest weight gain (0.88±0.14 g) and length gain (21.48±2.53 mm) of fish were obtained from T3. Furthermore, T3 showed the highest fish survival rate (98.89±1.92). The highest specific growth rate was observed from T2 as 2.12±0.24%. T1 showed the highest total height gain in *E. uruguayensis* (26.85±3.99 cm) and the highest root length gain (16.83±0.14 cm; p<0.05). Further, the highest mean wet biomass gains and the highest mean height gains (p>0.05) were recorded as 13.52±1.92 g and 17.54±6.25 cm, respectively. These results revealed that aquaponic system support plant growth and growth performances are increasing with enhanced fry densities. It was observed that water quality parameters were at the optimum levels throughout the study period. Stocking density of red balloon platy fry can be increased up to 40 fish/30 L using aquaponic system with *E. uruguayensis* during fry rearing and well grown plants can be harvested as additional benefit.

Keywords: Aquaculture; Fish growth parameters; Fry rearing; Ornamental fish; Ornamental plant

Paper ID: IRCUWU2022-483

Molecular detection of Megalocytivirus isolates in sea caged Asian seabass (*Lates calcarifer*) in Sri Lanka

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The family Iridoviridae (Genus Megalocytivirus) is associated with serious systemic infections resulting in significant mortality (up to 100%) in both marine and freshwater fish throughout the world. Thus, the mass mortality associated with the loss of scales has been a significant impact on the Asian seabass (*Lates calcarifer*) aquaculture industry in Sri Lanka. The Infectious spleen and kidney necrosis viruses (ISKNV), classified under the genus Megalocytivirus, are found in Asian seabass culture in Sri Lanka. However, knowledge of the genetic profile of ISKNV is limited. Thus, a rapid and accurate detection method must be developed for the effective management of this viral disease. Therefore, the present study was aimed at determining the molecular characterization of ISKNV using the IRB6 gene in Asian seabass in Sri Lanka. Twenty moribund fish samples of Asian seabass were collected from sea cages in the Trincomalee District in Sri Lanka. Fish were selected based on the clinical signs suspected of ISKNV, such as pale gills and petechial hemorrhages in the operculum, fin base, and abdomen. Viral DNA was extracted from the kidney and spleen tissues and the complete sequence of the IRB6 gene (570 bp) was amplified. Amplified DNA samples were sequenced, and a phylogenetic tree was constructed using the maximum likelihood (ML) method. The best-fit evolutionary model for the data was selected using the Model Test (GTR+I+G4 model) as implemented in MEGA X. Nine samples were PCR positive for ISKNV and phylogenetic analysis showed that the positive samples were 76% homology with a phylogenetic cluster of megalocytiviruses containing ISKNV with identical IRB6 gene regions. Because of megalocytivirus phylogenetic clustering, the ISKNV strains found in the present study are similar to the ISKNV strains found in Australia, the United States, China, the Philippines, Singapore, and Thailand. The genome sequence provides useful information concerning the evolution and divergence of iridoviruses in cultured fish in Sri Lanka.

Keywords: Asian seabass (*Lates calcarifer*); Infectious spleen and kidney necrosis virus (ISKNV); Megalocytiviruses; Sri Lanka

Paper ID: IRCUWU2022-510

Identification of general conditions to form Biofloc using fisheries sector by-products

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The fisheries and aquaculture sector has been identified as an organic waste-producing sector in Sri Lanka. This waste includes fish and shellfish offal; the head, gut, bones, and blood which contain a heavy load of nutrients that can be used in fish feed. The biofloc technology generates the nitrogen cycle by maintaining a higher C/N ratio by stimulating heterotrophic microbial growth. It assimilates nitrogenous waste into microbial proteins that can be exploited by cultured species as a live feed. The complications of this technology have created the concept of a separate bioconversion process instead of directly applying it to the culture pond/tank. The purpose of this research was to identify the general conditions for the bioconversion of the fish waste into microbial protein in a separate bioreactor using the principle of biofloc technology. The fish offal, mainly the heads, fins, and blood were blended, and 10 g of the slurry was used in the experiment. According to the nitrogen content of the slurry, dextrose was used as the carbon source (C:N of 20:1) and commercially available product "NB-25" (1 g/L) was used as bacteria culture. The trial was carried out in triplicate using this mixture and distilled water (500 mL), under aerobic conditions in a conical flask with the help of a hot plate magnetic stirrer (40^{o}C, 300 rpm) for 12 h. The levels of nitrate-N, nitrite-N, ammonia-N, pH, dissolved oxygen, and total solids were determined 4 hourly, and data were analyzed by using the Kruskal-Wallis test at $p<0.05$. A significant reduction in ammonia-N level and nitrite-N level from 4–8 hours (Ammonia-N from 0.66±0.16 to 0.12±0.01 mg/L, nitrite-N from 0.53±0.07 to 0.38±0.04 mg/L) were observed followed by a slight decrease from 8 to 12 h. The nitrate-N level gradually increased from 174.52±16.29 to 238.00±39.30 mg/L. The biomass had increased by 4.51% after 12 h of the bioconversion. Based on the results, after 8 h of the bioconversion process, the liquid product could be a good live feed for fish. Further, this model can be used as an efficient and value-added approach to supply supplementary feed for aquaculture systems.

Keywords: Bioconversion; Biofloc; Fish by-products; Fish feed; Microbial protein

Paper ID: IRCUWU2021-571

Growth performance of genetically improved farmed tilapia (GIFT) fry fed with fish waste-based Biofloc

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Biofloc technology is a symbiotic process which provides nutritional value to culture species. In intensive fish farming, highest cost recorded for feeding. Therefore, biofloc technology is used to minimize the feeding cost. However, vigorous aeration requirement, mixing and need start-up time to form biofloc are drawbacks of biofloc technology. As a solution, biofloc can be formed in separate bio-reactor under control conditions and then it can be fed as a supplementary feed to the culture ponds. Aim of this research was to investigate the growth performance of Genetically Improved Farmed Tilapia (GIFT) fry and water quality changes when utilizing the fish waste-based biofloc. When developing biofloc, grinded fish waste (nitrogen source), distilled water, dextrose (carbon source) and 'NB 25' (microbial culture) were mixed for 6 h until the biofloc was formed under aerate condition in a conical flask kept on hotplate magnetic stir at 40°C. The experiment was laid out in a completely randomized design with two treatments and three replicates, totaling six experimental units. Each experimental unit consisted of a fiberglass tank containing 40 GIFT fries. Commercial feed (10% of biomass) and biofloc (10 g/m^3) mixture was used as treatment A and only the commercial feed was used as control (treatment B). A volume of 100 mL of biofloc was added directly to the treatment A tank daily. The experimental period was 15 days and water quality changes were measured. Nitrate, nitrite, and ammonia levels were measured three times during this experiment. Results revealed that in treatment A, dissolved oxygen level was significantly low and other water quality parameters including temperature, pH were at optimum level. Higher levels of nitrate and nitrite were recorded in control. Final weight, weight gain and the specific growth rate were significantly higher (p<0.05) in the treatment A (0.72±0.09 g; 0.47±0.09 g; 3.09±0.44%) than in the control (0.40±0.05 g; 0.17±0.03 g; 1.47±0.36%), respectively. As results indicated, fish waste-based biofloc improved the growth performance of the GIFT fry without causing significant water quality changes.

Keywords: Biofloc technology; Intensive fish farming; Supplementary feed; Water quality

BUSINESS MANAGEMENT

Paper ID: IRCUWU2022-138

Assessing the impact of E-Word of Mouth (E-WOM) on consumers' purchase intention for cosmetic products with the mediation role of brand image: Special reference to Facebook users

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Social media marketing (SMM) is one of the emergent trends and a different marketing strategy that advertisers worldwide use today with the competition. In day to day life, cosmetics plays a significant part as cosmetics are used as a regular ritual by almost everyone. The Electronic Word of Mouth (E-WOM) generated by the comments on social networking sites can influence the consumers' purchasing decision due to the vital role played by the SMM. However, the adoption of E-WOM information by consumers is influenced by different factors. This study aimed to investigate the factors that affect E-WOM adoption on consumer purchase intention with the mediation effect on the brand image. Furthermore, this research assessed the effect on the purchasing intent of cosmetic products of the E-WOM information. The lack of research attention has been given on the impact of E-WOM on purchase intention with the mediating effect of brand image. Hence, this research addressed the knowledge and empirical gap. The researcher used the quantitative method in conducting this study. The data was collected from a sample of 384 respondents from Facebook users from generation Z residing in Western Province based on random sampling techniques. The collected data were analyzed by the Smart PLS software by adopting SEM. According to the findings, the researcher drew a conclusion that there is a significant impact of E-WOM on purchase intention. Further, results revealed that there is a partially mediating effect of brand image on the relationship between E-WOM and purchase intention. The findings provide insights for the cosmetics marketers to successfully manage the E-WOM activities that can create consumer attention towards cosmetics products. Moreover, the spread of accurate information through Facebook can foster a strong brand image, which will finally result for an actual purchase behavior by consumers.

Key words: Brand image; Electronic word of mouth; Facebook; Purchase intention; Social media marketing

Paper ID: IRCUWU2022-139

The impact of social media marketing activities on brand equity with the mediation through brand trust (reference to the banking sector in Sri Lanka)

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Social media marketing activities are regarded as a tool for creating trustworthy value within consumers and similarly, social media platforms help organizations to do promotional and relational activities successfully. The creation of trust would be helped to enhance brand equity. The banking sector has been growing speedily over time, and it can be identified as a vital and competitive sector due to its homogeneous features. As a result, it is critical to establish a long-term emotional and trusting brand relationship with consumers. According to the gap explored, this study aimed to investigate how social media marketing activities influence brand equity in relation to the banking sector with the mediator of brand trust related to the Sri Lankan context. The main objective of this research study was to investigate the impact of social media marketing activities on brand equity in the banking service sector and to identify the mediating effect of brand trust related to the banking service sector**.** The data were collected from a sample of 331 social media users selected purposively who follow and engage with social media pages owned by the banks. Smart PLS statistical package was used to analyze survey data using Partial Least Squares–Structural Equation Modeling. By using the PLS path modeling, it was identified that social media marketing activities have a significant positive impact on brand equity and brand trust in the banking sector in Sri Lanka. Further, the current study identified that there is a partially mediating effect of brand trust on the relationship between social media marketing activities and brand equity. The findings provide insights for bank marketers to successfully manage social media marketing activities that can create consumer interest in a bank's brand. Moreover, the spread of accurate brand-related information across a company's social media pages can foster strong brand trust, which makes brand equity for banks.

Keywords: Banking service sector; Brand equity; Brand trust; Social media marketing activities

Paper ID: IRCUWU2022-140

The impact of Facebook marketing on the purchase intention of generation Z customers (with special reference to fashion brands)

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In the 21st century, social media marketing has become more popular in Sri Lanka as well as in the global context. Among them, Facebook marketing plays a major role due to being the largest social media platform. As a result, Facebook marketing may help to make an impact on purchase intention. In particular, this research focused on how Facebook marketing impacts the purchase intention in fashion brands related to generation Z by filling both the empirical and knowledge gap since there has been little quantitative analysis on these studies. Hence, one of the primary data collection methods, a self-administered questionnaire was developed while covering three Facebook marketing elements; credibility, informativeness and entertainment factors. Similarly, purchase intention has been measured by electronic word of mouth marketing. In particular, data were collected by 384 respondents using the purposive sampling technique while distributing the questionnaire through social media. Data analysis was conducted by SPSS software 21 using descriptive, correlation and regression analysis. The evidence presented in this research study proved a strong positive correlation and significant positive impact from all the independent indicators on Ppurchase intention. Accordingly, the study results imply that the strongest to weakest influential factors are informativeness, credibility, and entertainment, respectively. The study results are much important mainly for the consumers, fashion businesses, and future researchers to make decisions.

Keywords: Credibility; Entertainment; Facebook marketing; Informativeness; Purchase intention

Paper ID: IRCUWU2022-142

The impact of social media on business transformation of SMEs in Sri Lanka: The role of organizational agility as the mediator

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Technology has created considerable interest among people all over the world. Therefore, the growth of social media is important as it allows people to communicate and share information online. It is clear that the ease with which people can share information and communicate through social media has led to an increase in many online activities, including business activities. As the importance of social media has grown, businesses have focused on using these technologies as an effective way and business plan to reach a large customer base while improving their online business strategies. A problem related to the use of social media is that, unlike SMEs in developed countries, SMEs in developing countries still lack awareness of and understanding of the benefits of business innovation achieved through the use of social media. Therefore, the current study sought to propose a framework for investigating the impact of social media: Identity, groups, presence, reputation, conversation, relationship, and sharing on business transformation of SMEs in Sri Lanka by identifying the role of organizational agility as a mediator. The research was quantitative, and primary data was collected through a self-structured questionnaire. 156 SMEs were selected as the sample for the study, and the sample was selected using a random sampling technique. The SmartPLS statistical package was used to analyze survey data using Partial Least Squares-Structural Equation Modeling. The results of this study showed that social media has a positive and significant impact on the business transformation of SMEs. Further, organizational agility partially mediated the relationship between social media and business transformation in SMEs. Moreover, these findings form the basis for theories of social media and business transformation, as well as current management implications for promoting social media use due to the lack of awareness among SMEs in Sri Lanka.

Keywords: Business transformation; Organizational agility; Small and medium enterprises (SMEs); Social media

Paper ID: IRCUWU2022-143

The impact of online visual merchandising on buying behavior of Facebook users in Sri Lanka (with special reference to mobile phone industry)

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In today's society, online channels such as websites and social media sites have a significant impact on customer behavior. Visual merchandising is one of important marketing strategies for online businesses. The purpose of this study was to explore the impact of online visual merchandising on buying behavior with special reference with Facebook users in Sri Lanka. This study focused on how online visual merchandising impacts the mobile phone buying behavior of customers. This research focused on main factors under online visual merchandising which are manner of presentation, Facebook page environment and aesthetic of presentation with buying behavior of mobile phones. A self-administered questionnaire was distributed among 200 respondents through simple random sampling techniques. Regression analysis, Pearson's correlation coefficient and descriptive statistics have been used for the analysis of data. According to the research findings there was a significant impact of the manner of presentation, environment of Facebook page and aesthetic of presentation on Facebook users' mobile phone buying behavior. Finally, there was a significant impact of online visual merchandising on Facebook users' mobile phone buying behavior in Sri Lanka.

Keywords: Aesthetic presentation; Facebook page environment; Manner of presentation; Online buying behavior; Online visual merchandising

Paper ID: IRCUWU2022-152

The impact of narrative transportation in video storytelling advertising on brand loyalty: The mediating role of brand experience and brand love (special reference to food and beverage sector in Sri Lanka)

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The concept of narrative transportation in video storytelling advertising and branding outcomes is thought to be at an introductory stage of the narrative advertising research arena. Long-form video storytelling advertisements deliver an authentic and engaging brand story while constructing favourable branding outcomes through narrative transportation. Prior scholars have investigated the area of narrative advertising in print, radio and television advertising rather digital media landscape. In addition, scholars have mentioned that narrative transportation in video storytelling advertising varies due to product type, branded content, sample, country and culture. The paper aimed to investigate the impact of narrative transportation in video storytelling advertising on brand loyalty with the mediating role of the brand experience and brand love in the food and beverage sector in Sri Lanka. This study connects and explores the concept with the brand resonance model and customer-brand relationship theory. The study adopted the quantitative approach and the sample consisted of 352 respondents from Western Province, Sri Lanka. The multi-stage sampling technique has been used. The survey was conducted and data was analyzed using Partial Least Squares-Structural Equations Modeling (PSL-SEM) and Statistical Package for the Social Sciences (SPSS). The results demonstrated brand love fully mediates the relationship between narrative transportation in video storytelling advertising and brand loyalty. Theoretically, the study fills the gaps in traditionally separate research areas of narrative transportation and branding outcome variables. Under managerial implications, video storytelling advertisements in the digital marketing strategy of the firm to create brand loyalty via brand love and long-duration ad formats will be appropriate for social media platforms.

Keywords: Brand experience; Brand love; Brand loyalty; Narrative transportation; Video storytelling advertising

Paper ID: IRCUWU2022-160

Accessing the impact of luxury handicraft brand experience on customer engagement: With mediating effect of website quality

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The handicraft industry has been a rising in the past few years in the global market. Digitalization has become a major reason for the growth of the industry. Sri Lanka is one of the major producers of handicrafts with an affluence culture with prideful history and heritage. The industry is rich in traditional values that can attract tourists and locals. Before industrial development, the handicrafts industry in Sri Lanka has deemed a potential economic advantage for the country. Yet, this industry is still playing a major contributor to the development of the national economy. Despite the significance, there are a limited number of scholarly works in the context which leads to identifying the search gap. Hence, the objective of the study was to investigate the impact of the brand experience of luxury handicraft brands on customer engagement with the mediating role through the quality of the website. The research sample consisted of 384 customers and 05 managers of the luxury handicrafts brands in the Colombo district selected via purposive sampling method and survey was conducted. Data was analyzed through PLS-SEM by using SmartPLS software. The researcher used descriptive statistics to analyze the demographic details of luxury handicrafts customers through IBM SPSS software. By using PLS, path modeling measured four hypotheses and identified the significant positive impact of the brand experience on the customer engagement with the mediating role through website quality. Partial mediation was observed between the variables. As future research directions, the researcher highlights the qualitative study to identify deep perceptions on the context. Furthermore, testing this framework over time and across industry for future research can provide additional meaningful insights. Since satisfaction and emotion can be updated frequently with small changes in the actions of companies, it will be interesting to use data across different time periods to understand the time-variable effects of satisfaction and emotions on customer behavior and consistent performance.

Keywords: Brand experience; Customer engagement; Luxury brands; Website quality

Paper ID: IRCUWU2022-179

The impact of organizational commitment on job satisfaction with virtual work during Covid-19 pandemic (special reference to government school teachers in Kandy area)

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Virtual work was not a primary possibility for all organizations before Covid -19 pandemic, but with the pandemic situation it has become a new and unprecedented standard. Even in the education sector, it made all the educational institutions going on line with virtual classes and the online education system from the physical environment. The purpose of this study was to examine the relationship between organizational commitment and job satisfaction of government school teachers with virtual work during Covid-19 pandemic times and to determine if there is an empirically provable relationship between variables, and the direction and the intensity of this relationship. Quantitative research was conducted on a research sample of 384 government school teachers working in Kandy area. Primary data was collected through a self-administered questionnaire. The sample was selected using a convenience sampling technique. Descriptive statistics, coefficient correlation and simple linear regression analysis were conducted to achieve the research objectives. The data was analyzed using SPSS Statistics 26 package. The findings manifested that organizational commitment of teachers significantly influence on job satisfaction. The study provided teachers with precious implication to enhance the organizational commitment and satisfaction. The study contributes to the literature of organizational commitment and job satisfaction theory. However, this study suggests some further research in the future to validate the findings.

Keywords: Covid-19, Job satisfaction; Organizational commitment; School teachers, Virtual work

Paper ID: IRCUWU2022-181

The impact of occupational safety and health on job performance in maritime industry in Sri Lanka: Evidence from operational level dock workers in port of Colombo

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A healthy employee is a wealthy employee; occupational safety and health refer to all the activities involved in protecting and promoting the physical, mental and emotional well-being of the employees. Therefore, they can perform their job efficiently and effectively. Based on the researcher's observations the researcher observed that the operational level dockworker's performance is very low even though they have occupational health and safety practices in the workplace. The objective of this study was to identify the impact of occupational safety and health on operational level dock workers' performance in the port of Colombo, Sri Lanka. A sample of 106 operational level dockworkers was selected using convenience sampling for the study and a structured interview with three safety officers. Therefore, this research is conducted with a mixed approach. A convenience sampling technique was applied for the study. Primary data was collected through a questionnaire. Descriptive analysis, regression, correlation techniques, and statistical package for social sciences version 25.0 software were used to analyze the data. While the qualitative components were analyzed using a thematic approach. The results revealed that occupational safety and health significantly impact job performance. Moreover, lack of performance appraisal, lack of disciplinary actions, and low management commitment are the main issues that the industry faces when implementing occupational safety and health. Moreover, the existing research studies are concerned with the quantitative approach, but this study is concerned with the qualitative approach as well. The study provides employers and safety practitioners with the valuable implications to enhance occupational safety and health practices, and effective evaluation procedures for employers, introducing employee recognition events for every employee. Therefore, it will enhance the employee's job performance efficiently.

Keywords: Job performance; Maritime industry; Occupational safety and health; Port of Colombo Sri Lanka

Paper ID: IRCUWU2022-208

Relationship between organizational stressors and organizational performance of senior level managers in multipurpose co-operative societies: Limited to Central Province in Sri Lanka

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Stress is a universal issue which every working person is facing when achieving organizational goals or individual goals. Present research was designed to investigate how organizational stressors affect the performance of senior level managers in co-operative societies which became the main objective. Identifing the relationship between related stressors and organizational performance, identifying the relationship between roles related stressors and organizational performance and identifing the relationship between interpersonal related stressors and organizational performance were the sub objectives of the study. Findings will be beneficial to both government and co-operative policy makers to evidently identify the reasons behind the stressors of senior level managers. There is no scientific study conducted in the local context to ascertain the organizational stressors and organizational performance in multipurpose co-operative societies yet. This became the leading gap of the study. Formerly there were no theories formed to explicate the organizational stressors and organizational performance in Co-operative societies. Researcher conceptualized a deductive type quantitative study to test the hypothesis by following the survey method. There were 102 senior level managers in the Central Province. For this study it selected 80 senior level managers using the stratified sampling method. A standard questionnaire was used to collect the primary data. Task demand related stressors, role demand related stressors, and interpersonal demand related stressors were the independent variables to the organizational performance. Accordingly, the results proved that there was a negative correlation between organizational stressors and organizational performances. Task demand related stressors, role demand related stressors, and interpersonal demand related stressors had a negative association to the organizational performance. Interpersonal demand related stressors had the highest negative correlation with the organizational performances. Role demand related stressors had the lowest correlation with the organizational performances. Clearly defining the job roles of senior managers, establishing a grievance and conflict management mechanism were the recommendations of the study. This study was carried out in one province of Sri Lanka which is another the major limitation of the study and researcher recommend to expand the study into other provinces in future.

Keywords: Multipurpose cooperatives societies (MPCS); Performance; Stress

Paper ID: IRCUWU2022-227

Investigating the adoption of digital banking practices in the age of Covid-19 (insights from MSMEs in Western Province, Sri Lanka)

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Digitalization in the banking industry has been accelerated with the Covid-19 pandemic situation because of the social distancing guidelines and curfew. When considering the business sector, not all businesses can adopt digital banking practices quickly. Micro, Small and Medium Enterprises (MSMEs) have many obstacles to adopting technological improvements due to a lack of knowledge and capital. However, many MSME owners struggle to continue their businesses with the prevailing Covid-19 situation and search for ways to keep current operations going. Therefore, the primary purpose of this study was to identify the impact of different factors having on the attitude toward digital banking practices of Sri Lankan MSMEs, which leads to their adoption of digital banking practices in the age of Covid-19. The researcher used the extended Technology Acceptance Model as a theoretical framework. Data was gathered from 275 MSME owners and managers in the Western Province of Sri Lanka using survey questionnaires. The analysis was conducted using both IBM SPSS 23 and Smart-PLS software. Structural Equation Modelling with Partial Least Square was employed to assess the hypotheses. The findings indicate that the attitude toward digital banking practices in the Covid-19 era was positively influenced by perceived ease of use, perceived usefulness, and e-trust, while perceived risk and resistance to change were influenced negatively. Moreover, the findings demonstrate that MSMEs' attitudes toward digital banking practices have a direct positive impact on the adoption of digital banking practices in the Covid-19 era. Accordingly, this research approved the applicability of the Technology Acceptance Model with the inclusion of additional variables, to investigate the adoption of digital banking practices by MSMEs in the Covid-19 era with reference to developing countries like Sri Lanka. Further, the results suggest that implementing the required strategies from both the banks and the government to enhance their digital literacy will improve MSMEs' productivity in their operations. Furthermore, the research presents managerial implications to enhance performance and customer service to boost the adoption of digital banking practices**.**

Keywords: Adoption of digital banking practices; Attitude towards digital banking practices; Covid-19; Micro, Small and medium enterprises (MSMEs)

Paper ID: IRCUWU2022-228

The impact of social media marketing on brand equity creation (with special reference of fashion wears retail industry in Northern Province)

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The fashion wear retail industry has potential to contribute considerably to the economic development of Sri Lanka. After thirty years of war as a country, Northern Province has a great opportunity to develop the fashion wear retail industry and there are many people who spend their time on social media platforms in Northern Province. Social media marketing is an important tool between service providers and the customers in building up a good relationship among them. It's a collection of online tools that facilitate interaction and communication between users. This study sought to analyze the impact of social media marketing on brand equity creation with special reference to the fashion wear retail industry in Northern Province, Sri Lanka. The objective of this study was to find the relationship between social media marketing in brand equity creation in the fashion wear retail industry in Northern Province. The present study empirically evaluated social media marketing dimensions (identity, conversation, reputation and relationship) and their impact on brand equity creation in the fashion wear retail industry in Northern Province. The sample consisted of 150 social media users of five districts in Northern Province (Mullaitivu, Vavuniya, Kilinochchi, Mannar and Jaffna) and primary data were gathered through a structured questionnaire among the respondents. The results of this study were analyzed using descriptive statistics, correlation analysis, and regression analysis approaches. All the social media marketing dimensions have positive value with existing social media marketing. Possible managerial implications are considered in light of the finding, and further study topics are suggested. This research contributes to the growing literature on the Northern Province fashion wear industry.

Keywords: Brand equity; Fashion wear industry; Northern Province; Social media marketing

Paper ID: IRCUWU2022-254

The impact of emotional intelligence, work-life balance and self-efficacy on workplace behavior: Among working women in public banking sector (reference to the Central Province)

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Psychological empowerment plays a significant role in most of the organizations to maintain their workforce and employee relation scenario. Therefore most of the human resource managers shifting through the concepts like emotional intelligence, self–efficacy and work-life balance. The Sri Lankan female employees in the public banking sector play a vital role in the development of the country's economy. They have to face a lot of problems because of the extra workload and stressful professional career attitudes. Even though the study revealed the women employees of the public banking sector and their emotional intelligence level and how it affects their workplace behavior. This study identified the emotional intelligence and its impact on workplace behavior with self – efficacy and work life balance as the mediators with special reference to working women in the public banking sector in Central Province. A sample of 300 women employees of the top three public banks in the Central Province was selected in terms of cluster sampling method and simple random sampling method. Survey data were analyzed using Partial Least Square–Structural Equation Modeling by using Smart PLS statistical package. The outcome of the study highlights that emotional intelligence was a significant determinant of three constructs namely, workplace behavior, work-life balance and self-efficacy. Furthermore, work-life balance and self –efficacy of women employees in the public banking sector were also positively affected to the workplace behavior. Moreover, work-life balance and self-efficacy of female banking employees were observed to have a partial mediation on the relationship between emotional intelligence and workplace behavior. Findings of this study provided an insight for the policy makers of the banking sector to enhance their awareness level relevant to the gender difference with psychological factors to gain the advantage in employee relation process and academics to the novel direction of this area.

Keywords: Emotional intelligence; Self- efficacy; Work- life balance; Workplace behavior; Working women

Paper ID: IRCUWU2022-257

The impact of celebgram endorsement on consumer purchasing behavior of women clothing brands in Sri Lanka

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Social media marketing has become one of the most trending marketing strategies in the world. Among the several kinds of social media platforms, Instagram is a popular social media among the people. Celebgram endorsement is one of popular social media marketing strategies that most of the businesses are using to promote their products and services. Celebgram endorsement plays an important role in influencing the consumer purchasing behavior with credibility. This study clarified attractiveness, trustworthiness, expertise, popularity and product celebgram matchup as key attributes of the celebgram endorsers to represent the celebgram endorsement and identify how those characteristics have impacted towards consumer purchasing behavior of women clothing brands in Sri Lanka. The ultimate objective of this study was to identify how celebgram endorsement impacted on consumer purchasing behavior of women clothing brands in Sri Lankan context. This research was implemented and designed using a quantitative approach. Both primary and secondary data was used for the observation. Researcher selected 384 of Instagram users in Sri Lanka as a sample of this to collect primary data. Researcher conducted data collection by using self-administered questionnaire five point likert method. Snowball sampling technique was used by the researcher as the sampling technique of this study. The result of this observation was analysed by using descriptive analysis, correlation analysis and multiple regression analysis. According to data analysis results have shown that demographic information, relationship between the independent variables and dependent variables of this study. All the predicted hypotheses were accepted according to the results of the analysis. Findings have shown that there is a significant impact of the celebgram endorsement on consumer purchasing behavior of women clothing brands in Sri Lanka. Further tested key attributes of celebgram endorsers have significantly and positively impacted the consumer purchasing behavior.

Key words: Celebgram endorsement; Consumer purchasing Behavior; Instagram; Social media marketing

Paper ID: IRCUWU2022-262

The impact of green human resource management practices on employee retention in apparel industry: The role of work engagement as a mediator

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The apparel industry is the backbone of the Sri Lankan economy which means it provides a higher contribution to the Gross Domestic Production and employment in Sri Lanka. Thus, most of the people are involved in the Apparel sector and on the other hand, it is one of the highest sources of foreign exchange earners to the country. With this background, Sri Lanka is famous for its' apparel in the global market which is second only to the agricultural production of the country. With the competitive green market transformation in the global market, environmentally friendly employee practices are crucial for the sustainability of Sri Lanka apparel. Further, with the pandemic and the economic conditions of the country, employee retention has become one of the major issues faced by apparel companies today. Therefore, companies are seeking solutions to resolve this matter. Green Human Resource Management (GHRM) is one of the best methods used in Western countries to retain and manage employees in an environmentally friendly manner. However, GHRM and its related concepts are novel concepts to the Sri Lankan context. This study aimed to investigate the impact of GHRM practices on employee retention in the apparel industry with the mediating role of work engagement. For this study, 100 respondents were randomly selected from the apparel companies in Galle District. Data collection was conducted through a questionnaire and analysed data using SPSS software. Correlation, multiple linear regression, Baron and Kenny mediator analysis and Sobel test method were used for data analysis in this study. Findings revealed that green recruitment, green training and development and green rewards and compensation significantly impact employee retention. Further results suggested that the impact of GHRM practices on employee retention mediates by work engagement. Considering all findings related to this study, GHRM significantly affects employee retention in the apparel industry and work engagement can add value to this relationship.

Keywords: Employee retention; Green human resource management, Green recruitment; Green reward and compensation; Green training and development; Work engagement

Paper ID: IRCUWU2022-275

Impact of customer lifetime value, emotional confidence, and brand loyalty on customer retention; Special reference to milk powder industry in Colombo district

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In the rapidly dynamic world, most companies seek higher profitability while differentiating from their competitors. For that, they are more concerned with retaining profitable customers rather than attracting new ones. As the problem identified, understanding the extent of the total worth over the whole period of customers' relationship and behavior of emotional confidence as an independent variable. Therefore, this study aimed to investigate the impact of customer lifetime value, emotional confidence, and brand loyalty on customer retention. When concerned about the milk powder industry, it is identified as an industry with complex competition and huge promotional campaigns. Therefore, this study was conducted with special reference to the milk powder industry, and 250 milk powder consumers were selected from the Colombo district in Sri Lanka as the sample. The study has developed a single-mediator structural model to explore the impact of customer lifetime value, emotional confidence, and brand loyalty on customer retention. Brand loyalty plays the mediator role to identify the indirect impact of independent variables. A self-administered structured questionnaire was used to collect primary data under the simple random sampling technique method. Analysis has been conducted with IBM SPSS 23 and Smart-PLS software. The results of the study highlight that customer lifetime value and emotional confidence are significant determinants of two variables of customer retention and brand loyalty. And customer lifetime value and emotional confidence have a direct and indirect significant positive impact on brand loyalty and customer retention. Also, the brand loyalty of milk powder companies positively impacts customer retention. Moreover, brand loyalty positively mediates the relationship between customer lifetime value and customer retention and emotional confidence, and customer retention in the milk powder industry in the Colombo district. Also revealed that higher customer lifetime value and emotional confidence drive incur a higher impact on brand loyalty and customer retention. The finding of the study suggests that having a very clear understanding of customers and their purchasing behavior can improve customer retention. As well as interpret managerial implications to enhance customer retention. With this study, future research is directed to focus on adding multiple mediators and moderator variables to the existing model to get more understanding of the industry.

Keywords: Brand loyalty; Customer lifetime value; Customer retention; Emotional confidence; Milk powder industry

Paper ID: IRCUWU2022-280

Import substitution industrialisation and economic growth: Evidence from South Asian region

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The developing countries initiate various macroeconomic policies to achieve sustainable economic growth. Import substitution industrialisation (ISI) is one of the key policies adopted by developing countries, since World War II, in order to promote domestic production and reduce economic dependence on foreign countries. In this case, import substitution industrialisation, as a trade policy has provided countries with different outcomes. Therefore, empirical literature is inconclusive on the effectiveness of ISI policy for economic development. The aim of this study was to examine the impact of Import Substitution Industrialisation on economic growth, with special reference to selected South Asian countries; Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka. This study employed panel data analysis including panel unit root test, cointegration test, fixed effect model, granger causality test and impulse response technique for the period from 1990 to 2019. The findings of this study indicated that, manufacturing value added and total subsidies have a significant positive impact, while the trade balance, tariff on imports and inflation do not have a significant impact on the economic growth in South Asian countries. Moreover, impulse response reveals that, in the long run, the economic growth in South Asian region has a slight response to ISI indicators. This paper concludes that ISI policy can significantly influence the economic growth in South Asian region, in the short run, but not in the long run. Therefore, it is recommended for South Asian countries to adopt ISI policy in the short run to protect domestic industries, becoming more export-oriented in the long run.

Keywords: Economic growth; Fixed effect model; Import substitution industrialisation; Macroeconomic policy; South Asian region

Paper ID: IRCUWU2022-300

A study on the impact of cash flow management on financial sustainability of SMEs (with special reference to manufacturing sector SMEs in Western Province, Sri Lanka)

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SMEs are the backbone of the most developed and developing countries because they play an important role in the economic growth of a country. But most of the SMEs fail in different stages in their lifetime because of not having the financial sustainability in the business. The concept of cash flow management has become a significant concern in the finance sector to maintain the short-term liquidity within the businesses. Therefore, this study focused on the impact of cash flow management on financial sustainability of SMEs. There were three independent variables concerning cash flow management, they are cash flow planning, ash flow monitoring and cash flow controlling. Dependent variable financial sustainability measuring using profitability and solvency. A quantitative study conducted by involving 275 SMEs selected from manufacturing sector Western Province Sri Lanka using simple random sampling technique. Data was collected using a structured questionnaire and analyzed using descriptive and multiple linear regression analytical methods. The findings manifested that there is a significant relationship between Cash flow Management and Financial Sustainability. Further, cash flow planning and controlling has a positive impact on financial sustainability of SMEs while cash flow monitoring has a low impact on financial sustainability of SMEs. According to the results, cash flow management is important to ensure Financial Sustainability of SMEs. This study suggested that maintaining cash flow management practices in SMEs gives a good financial sustainability to the SMEs.

Keywords: Cash flow controlling; Cash flow management; Cash flow monitoring; Cash flow planning; Profitability; Solvency

Paper ID: IRCUWU2022-323

Analyzing the impact of energy prices on economic growth (evidence from OECD countries)

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Energy has been recognized as the key driver of the manufacturing sector from the first industrial revolution to the current era of the fourth industrial revolution. Consequently, the countries that abundantly have energy resources account for higher standard of living compared to the countries who lack energy resources. Crude oil has been widely used as a source of energy across the globe and therefore there is a higher demand for crude oil despite the price of crude oil has been fluctuating over time due to various reasons. OECD countries have been maintaining higher economic growth while accounting for a large proportion of world's energy consumption for decades. Thus, many scholars have addressed the nexus between economic growth and crude oil price in OECD countries and other countries applying different empirical models. However, most of such studies have focused only on the direct relationship between oil prices and economic growth, ignoring the transmission mechanism which indicates the indirect impact of oil prices on economic growth which can occur through different channels. Hence, the main purpose of this study was to quantify the impact of oil prices on economic growth of OECD countries through analyzing the impact of oil prices on channel variables such as interest rate, exchange rate, government expenditure and investment. The study was based on annual data collected from 38 OECD countries during the period 2001-2020 and panel data analysis based on generalized method of moments (GMM) estimation was carried out to accomplish the objectives of the study. The study revealed that the overall net impact of increasing the oil price on economic growth is negative. The negative impact on economic growth is mainly through government expenditure and investment. Despite the interest rate, it positively affects economic growth, the negative impact of both government expenditure and investment outnumbers the positive impact of interest rate and hence the overall net impact is negative. Apart from that, oil price negatively affects channel variables such as interest rate and investment while positively affects both exchange rate and investment. According to the findings, the study strongly recommends swift from crude oil to alternative energy sources. Specifically, renewable energy sources such as solar power and wind power can be easily produced domestically and therefore study recommends using such energy sources as the driving forces of economic growth in the long run.

Keywords: Economic growth; Energy prices; Exchange rate; OECD countries

Paper ID: IRCUWU2022- 375

Assessing the impact of perceived service quality of retail websites and consumer purchase intention with the mediating effect of consumer trust

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The internet is becoming essential for every business activity whereas the marketplace has become more digitized while creating more pathways to the global marketplace. Furthermore, the revolution of the internet has greatly increased during Covid-19 pandemic. With the increase of the popularity of e-commerce, such as e-retailing, online shopping, businesses around the world now try to enhance their competitive advantages by focusing their resources on the virtual business environment. Online business and e-retailers is a booming business in Sri Lanka which flourished especially during recent years. Thus, this study focused on the e-retail web service quality and consumer purchase intention towards the consumer trust as a mediator analysis in a Sri Lankan context. The purpose of this study was to gain insight on the impact of e-service quality dimensions and customer purchase intention of e-retail websites with the role of customer trust as a mediating variable. Study adopted a quantitative research methodology where a self-administered online questionnaire was used to collect data and 300 customers who shopped at a variety of e-retailers across product variables and the services qualities. The sample was chosen from the Western Province- Sri Lanka by adopting a multi stage sampling method. The researcher adopted SPSS 25 software for data analysis and main analysis methods; Descriptive statistics, Pearson correlation and regression analysis were used to analyze the data. Further, the mediating effect to the relationship is assessed through the Barron and Kenny mediator analysis model and Sobel test. According to the findings e- service quality dimensions has a strong correlation with consumer purchase intention of retail websites and mediation results confirmed that the mediator, customer trust, highly mediates the e-service quality and consumer purchase intention of retail websites. In here researcher mainly considered the consumer trust based on the electronic transaction. This will be very significant in getting knowledge for the academies and marketers as well. The overall research findings provide the managerial and theoretical implication for the further enhancement of the digital marketing contest in Sri Lanka.

Keywords: E-retail; Internet; Purchase intention; Quality; Trust; Website

Paper ID: IRCUWU2022-426

Business environmental pressure and business model innovation in SMEs during the pandemic situation in Sri Lanka

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Small and medium-sized enterprises (SMEs) play a vital role in the Sri Lankan economy. However, the success of SMEs is influenced by a number of entrepreneurial, external, and internal factors. There is a wide variety of environmental pressures that influence how SMEs respond to the sustainability of businesses. Moreover, environmental pressures are influencing the performance of SMEs. On the other hand, the Covid-19 pandemic has had a huge impact on SMEs worldwide. In this scenario, business model innovation is vital for SMEs seeking to gain competitive advantages and survive in the business world. This study investigated how environmental pressures affect business model innovations in SMEs. Based on a sample of 346 productions oriented SMES, this study adopted the quantitative approach to investigate the research question. The data were collected through an online structured questionnaire using purposive sample technique. Data analysis was performed through descriptive analysis, path coefficient analysis and regression analysis. The study results revealed a strong positive relationship between business environmental pressure and business model innovations in SMEs in Sri Lanka and business environmental pressure significantly and positively affects business model innovations in SMEs in Sri Lanka. And also, findings of the study revealed that customer pressure was identified as the most influential factor among five independent variables. The outcomes of the research will lead policymakers to make strategic decisions to increase the activities related to environmental pressure. The overall research findings provide managerial and theoretical implications for further enhancement of business environmental pressure on business model innovations in SMEs. However, the business model innovations of SMEs have increased during Covid-19 compared to pre-Covid-19. Findings suggest that SMEs should develop and maintain business model innovations-related activities for the improvement of business performance in order to survive in the market in future pandemic situations.

Keywords: Business model innovation; Covid-19 pandemic situation; Environmental pressure; SMEs

Paper ID: IRCUWU2022-434

Strategic responses of social enterprises to Covid-19 pandemic situation

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Social entrepreneurship involves delivering sustainable solutions for the social issues neither the government nor the private sector organizations make their active involvement. Being "mission-driven" organizations, social enterprises are highly vulnerable to external shocks such as pandemics and economic recessions compared to for-profit organizations. The situation forces them to search for different strategic approaches to survive in the markets as financially viable organizations specifically in times of crisis. Thus, this study explored diverse strategic responses of social enterprises adapt to survive and thrive in the Covid-19 pandemic. Taking a qualitative approach, this study interviewed 12 social entrepreneurs to collect data and data were analyzed by using thematic sampling techniques. Our qualitative findings suggest cutting down unnecessary expenses within organizations, negotiating with financial institutions and getting benefits from modern technology such as digital media platforms to survive this kind of crisis. The overall research findings provide theoretical and practical significance to strategic responses of social enterprises to the Covid-19 pandemic situation in Sri Lanka.

Keywords: Covid-19 pandemic; Social entrepreneurship; Social enterprise; Strategic responses

Paper ID: IRCUWU2022-436

Value co-creation orientation and social innovation within social enterprises: Moderating effect of environmental dynamism

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The academic scrutiny on value co-creation has increased since the approach persuades active collaboration with stakeholders in creating the desired value. This study investigated the impact, association, and existing usage of value co-creation orientation on social innovations within Sri Lankan social enterprises with the moderating effect of environmental dynamism. Being "mission-driven" organizations, the primary purpose of social enterprises is to deliver a positive social impact in lieu of wealth accumulation. The scope of social enterprises urges them to stay closer to the beneficiaries since understanding their true needs matters in delivering the social mission and sustaining as financially viable organizations. The data was gathered by issuing a self-developed questionnaire to 284 social enterprises in Sri Lanka. Data analysis was performed through descriptive analysis and Structural Equation Modeling. The findings of the study concluded that there is a positive relationship between value co-creation and social innovation, while environmental dynamism is negatively moderated. The current level of value co-creation usage within social enterprises is also satisfactory. As per the descriptive statistics, the majority of the service-oriented social enterprises are using the value co-creation concept rather than product-oriented social enterprises within the Sri Lanka context. The research findings will influence policymakers to expand actions connected to value co-creation and social innovation, which are crucial in developing nations like Sri Lanka. The overall research findings provide managerial and theoretical implications for further improving value co-creation and social innovation within social enterprises in Sri Lanka. The outcome of this study recommends social entrepreneurs and policymakers have a mechanism to improve value-creation to enhance social innovations.

Keywords: Environmental dynamism; Social enterprises; Social innovation; Value co-creation orientation

Paper ID: IRCUWU2022-442

Impact of dynamic capabilities on SME innovation (special reference to Colombo District)

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Modern business environments are hypercompetitive, highly unpredictable and the consumer preferences are rapidly changing. It requires businesses to identify and grab market opportunities to maintain their existence. The situation forces business organizations to nurture specific competencies to survive and grow. Dynamic capabilities refer to a firm's ability to combine, develop, and rearrange its inner and outer abilities in order to respond to ever-changing business circumstances. Since, Small and Medium Enterprises (SMEs) are the enterprises that arise as a result of entrepreneurial activities, dynamic capabilities can contribute more to generate successful innovations by being a major driving force. Impact of dynamic capabilities on SME innovation has been little examined related to Sri Lankan SMEs in the existing literature. Therefore, this research was conducted to find whether dynamic capabilities (sensing capability, coordinating capability, integrating capability and reconfiguring capability) influence SME innovation, the most significant factor influences SME innovation and the association between dynamic capabilities and SME innovation. Primary data required for the study were collected by distributing a self-developed questionnaire across 380 manufacturing SMEs in Colombo District using stratified random sampling technique. Data analysis was performed through SPSS Statistics software 22 version by practicing descriptive analysis, Pearson's correlation coefficient analysis, multiple linear regression analysis and simple linear regression analysis. The study results indicated that there is a positive and significant impact of dynamic capabilities on generating innovations, coordinating capability is the most significant factor influence for innovations while integrating, sensing and reconfiguring capabilities influence respectively and dynamic capabilities have a weak positive relationship towards innovation. Further, outcomes of the research will lead practitioners for the strategic decision making process to enhance industrial innovations while using the outcomes as a practical guide in generating innovations. Moreover, it will lead policy makers to empower SMEs with various training programs to engage in various innovation practices while making policies. The overall research findings provide knowledge implications regarding the concepts of dynamic capabilities and innovation for the field of research and managerial implications for further enhancement of dynamic capabilities on SME innovation within Sri Lankan context.

Keywords: Coordinating capability; Innovation; Integrating capability; Reconfiguring capability; Sensing capability; Small and medium enterprises

COMPUTING & INFORMATICS

Paper ID: IRCUWU2022-036

Studying automatic document classification for different writing styles using ensemble learning approach

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With the progression of technology, many individuals are enticed to involve the web for tracking down data. Individuals can acquire an assortment of records on the web, for example, research articles, journal articles, academic books, etc. These documents can be classified as formal and informal. There are linguistic variations that are unique to that style. In this way, there ought to be a method for recognizing consequently whether the documents have a place formal or informal. We found very little research on formal and informal document classification. Moreover, existing research focused only on two or three classification algorithms with a small dataset. The objective of this research is to devise a technique for recognizing whether given documents are formal or informal with overcoming the limitations of previous work. Prior to assembling this model, perceived the attributes of the formal and informal styles, such as contrasts between words, phrases, articulations, jargon and etc. After identifying the characteristics of the formal style and informal style separately, we used tokenization, lowercase conversion, stop word removal, and lemmatization as preprocessing methods. After preprocessing step need to extract features. For that, we used the Tf-Idf vectorizer as a feature extraction method. Then classification model is built using six different classification algorithms. This model is created using a 5-fold cross-validation method. In the classification stage firstly used five machine learning algorithms namely Random Forest, Decision Tree, Support Vector Machine, Naïve Bayes, and Multilayer Perception. From these five algorithms, the Random Forest algorithm obtained good accuracy of 87.43% than the other four individual algorithms. As well as it obtained high values for precision, recall, and f-measure. In the second experiment, we used the Ensemble Learning algorithm based on the Vote algorithm by combining five algorithm results. The vote algorithm obtained an accuracy of 91.95% than the Random Forest algorithm. Precision, recall, and f-measure values of the Vote algorithm are also higher than the Random Forest algorithm. Hence, better accuracy can be obtained from the Ensemble Learning algorithm by combining the number of classification algorithms in comparison to getting separate accuracy from individual algorithms.

Keywords: Document classification; Ensemble learning; Formal style; Informal style; Machine learning

Paper ID: IRCUWU2022-066

Sentiment analysis of Twitter data: measuring the positive or negative perception toward e-learning during the Covid-19 pandemic

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With the Covid-19 epidemic, e-learning has become a required component of practically every country's educational system. Even while this method appears to benefit both students and teachers, its performance is dependent on several circumstances. For instance, the availability of internet services and the users' economic well-being due to the cost of the necessary equipment and components. The main purpose of this study is to highlight individuals' educational experiences all around the world, evaluate students' cognitive practices, as well as construct a standard to forecast the chance of pupils adjusting to e-learning in the forthcoming following this pandemic. Today, Twitter is becoming the more data and opinion-sharing place all over the world. Because of that, we have collected Twitter data to fulfil the above objective. In the data collection step, we have collected 8976 tweets using the Twitter API. Out of the 8976 tweets, 4486 tweets were positive about the e-learning process, whereas 4490 were negative. Then in the data pre-processing step we removed Twitter handles, special characters, numbers, punctuations, short words, and stop words, lowercasing, tokenization, and stemming. Python was used as the main programming language. After cleaning the data, feature extraction from the cleaned data was required. The Term Frequency-Inverse Document Frequency (TF-IDF) technique was used to determine how many times a word could appear in the document. After all of the preceding steps were accomplished, the training data was input into the Support Vector Machine (SVM) and Artificial Neural Network (ANN). The trained classifiers were put to the test with the testing dataset, as well as the classifiers only with the best results were picked based on accuracy, Precision, Recall, F-measure, MSE, and RMSE. According to the results, ANN beat SVM and achieved an accuracy of 81.97% with higher precision, recall, f-measure values, and lowest error values. In the future, we plan to expand the collected data and employ a different feature vector creation method for comparison. Also planning to increase the number of target categories of the model and apply another artificial neural network such as long short-term memory for the result comparison.

Keywords: ANN; Covid-19; E-learning; Machine learning; SVM

Paper ID: IRCUWU2022-069

Machine learning algorithms to identify the level of human stress based on sleeping habits

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Stress is a mental or emotional state that is generated by unavoidable or difficult circumstances. Stress not only affects your mood, energy level, relationships, and work performance, but it can also cause or aggravate a variety of medical conditions. Sleep disruptions are linked to a variety of medical, psychological, and social issues. But, it is critical to recognize human stress levels in order to prevent unpleasant events in one's life. The existing research only discusses the relationship between stress and sleeping habits there is no further research on stress detection based on sleeping habits using a comparison of Machine Learning (ML) algorithms. This study's main purpose is to examine how ML algorithms can detect stress in people based on their sleep habits. The obtained data includes various sleeping habits such as snoring range, respiration rate, body temperature, limb movement rate, blood oxygen level, eye movement, sleep time, heart rate, and stress levels. After preprocessing the data, six ML algorithms were utilized at the classification level to compare and identify the most accurate findings, including Random Forest, Support Vector Machine (SVM), Decision Tree, Multilayer Perception (MLP), Logistic regression, and Naïve Bayes. The Waikato Environment for Knowledge Analysis (WEKA) data mining tool, was used for preprocessing and 10-fold cross-validation to get better accuracy. When compared to other methods, the experiment findings demonstrate that the proposed solution using a Naive Bayes algorithm can classify the data with 91.27% accuracy, high precision, recall, f-measure values, and the lowest error rate in Mean Absolute Error (MAE) and Root Mean Squared Error (RMSE). Based on the results, we can estimate stress levels using ML algorithms and address pertinent concerns as soon as possible. That results will be helpful to avoid unnecessary situations which can happen because of the high human stress. In the future, we are planning to increase the number of data and apply the ensemble learning algorithm by combining these six algorithms to improve the accuracy of the results.

Keywords: Classification; Human stress; Machine learning; Sleeping habits

Paper ID: IRCUWU2022-071

Prediction of employee satisfaction on online working after the Covid-19 pandemic a case study on Sri Lankan employees

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As a result of the Covid-19 outbreak, millions of employees all over the world have shifted to the concept of online working with little or no preparation The online working concept is a key opportunity and can give a competitive advantage to organizations in times of pandemics, such as the Covid-19, where containing the disease's spread is critical. Some industries are already preparing for a future in which their employees will work entirely online. Because it allows them to care for their families, online working is thought to improve a person's work-life balance. As a result, it's more important than ever to identify employees' ideas and predict their willingness to keep the online working concept going in the future. So, the main purpose of this study is, to predict employee satisfaction on online working after the Covid-19 pandemic. The study was conducted with a sample of around 325 employees, who worked online during the Covid-19 pandemic. Randomly selected and surveyed about their preference for online working through the questionnaires via the Google form. After the preprocessing, Naïve Bayes, Decision Tree (J48), Random Forest, Multi-Layer Perceptron (MLP), Support Vector Machine (SVM), and Logistic Regression six classification algorithms were used in the prediction model. The Waikato Environment for Knowledge Analysis (WEKA) data mining tool is used with 77% of the percentage split method to evaluate the model. With the comparison of the other six algorithms, the Random Forest algorithm has the best accuracy results of 87.84% and also based on the evaluation results of precision, recall, f-measure, Mean Absolute Error (MAE), and Root Mean Square Error (RMSE) values it showed the best results. Further, can predict the employee preference for online work using this proposed prediction model, and also, can suggest the suitability of the online working concept to the country in the future. In future work, planning to increase the dataset and apply an ensemble learning algorithm to improve the result.

Keywords: Covid-19 pandemic; Machine learning; Online working; Prediction

Paper ID: IRCUWU2022-106

Vehicle recommendation system based on required vehicle features of the buyers in the Sri Lankan context

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Transportation has always been a significant component and a requirement of humanity since the dawn of civilization. It has evolved and modified as of the present and will continue. Hence, there is a vigilant trend among the people in acquiring a vehicle to satisfy their transportation needs. People have different kinds of interests in vehicles, and they differ from person to person, regarding their needs, wealth status and where they live. In Sri Lanka, there is quite a significant number of vehicle models available in the market. Moreover, each vehicle model contains different grades with slight changes in the vehicle features. Thus, finding a single expertise to guide the buyers to select the best-expected vehicle model with the required features and the available budget is difficult. Even though e-advertisement platforms facilitate vehicle feature filtering options, they will not cover the buyers' entire expectations. This study was conducted to build up expert knowledge to recommend the best-suited vehicle model as per the given specification by the buyer by mapping the available online vehicle advertisements considering the geographical location on one platform. The recommendation system will suggest the best vehicle model(s) considering the vehicle grades. The motor traffic act and e-advertising platforms have been used to collect related data and developed Competency Questions (CQs) to identify the domain, concepts, terms and relationships which used in knowledge base. Using Prolog 8.4.2-1 the created RDF (Resource Description Framework) diagrams were converted to knowledge base. The concept was modeled creating objects and creating the relationships between each object. Prolog query results confirmed that the knowledge base design matches the real-world scenario. The e-advertisements available in the online vehicle buying and selling platforms based on the geographical location of the buyer for the selected vehicle models are crawled using developed WebCrawler, using python beautifulsoup library. A front end is presented to the user using Prolog JPL Library for user friendly interaction with the system. The accuracy of the created model was tested using Prolog queries based on CQs and it gave the expected outcome with the crawled e-advertisements based on the buyers' geographical locations.

Keywords: Knowledge base; Prolog; Python; Vehicle model; WebCrawler

Paper ID: IRCUWU2022-129

Factors influencing the adoption of online payment procedures within small and medium-sized enterprises (SME) in the District of Badulla, Sri Lanka

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The rapid development and popularity of online payment systems have been fueled by the technological and communication revolution. The goal of this study is to investigate online payment acceptance among SMEs in the Badulla District of Sri Lanka and to identify the important factors that influence online payment adoption. This research looked at the phenomenon of online payments from the point of view of the business. The current study is quantitative, and the model was created based on the construct of the Unified Theory of Acceptance and Use of Technology model and empirical findings, resulting in a generally validated and dependable model. The study's primary data came from 43 SME owners who had expanded their enterprises to virtual platforms. According to the findings, relative advantage and absorptive capacity, perceived transaction convenience, and compatibility have a significant impact on online payment adoption among informal virtual entrepreneurs in the SME context in Sri Lanka, while perceived risk has a significant negative impact. Furthermore, social influence has no bearing on the acceptance of online payments. The results of the study are useful for developers, vendors, policymakers, and SME entrepreneurs in identifying the demands of most growth sectors of the economy, and the model produced from the current study can be used for future studies by eliminating the restrictions of the same study.

Keywords: Online payment; SMS; Technology adoption; Unified theory of acceptance; Use of technology model

Paper ID: IRCUWU2022-131

Hyperbolic localization with triangulation for locating unauthorized activities in the forest

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Forest ecosystems are said to be degraded when they lose their ability to deliver important goods and services to humans and the environment. Forest degradation can develop for a variety of reasons. Illicit human activities have a substantial impact that can be mitigated by constant monitoring of forests that have been particularly designated as probable sites of illegal activity. The goal of this proposal is to provide an experimental setup for locating the sound source using the hyperbolic localization method with triangulation. Hyperbolic localization is a method for determining sound source position coordinates based on the time difference of arrival of sound waves to microphone pairs. Integrating signals from every two microphones can be used to produce one time-difference of arrival (TDOA) value that's where triangulation applied. In addition, this research may lead to the discovery of hidden patterns in species behavior, species census, and human capture of unlawful actions. Forests also help to mitigate climate change by acting as a carbon sink. Illegal logging deprives governments of essential resources, has a severe impact on people's lives, and promotes corruption and violence. Forest degradation is responsible for up to 20% of global human CO2 emissions. Various attempts have been made to carry out successful surveillance of huge forest covered areas. hyperbolic localization and triangulation, a cost-effective and practical long-range forest monitoring architecture based on sound detection has yet to be realized. Autonomous Recording Unit (ARU), used for acoustic data collection for sound-producing animals such as birds and human activities such as illegal cutting trees. ARUs can continuously record for hours without disturbing the animals being studied, allowing the researcher to conduct other types of observation or research. Localization approaches are carried out in two stages, that estimation of time delay or intensity level differences and location calculation. All the preliminary tasks have been carried out such as familiarizing sound waves and its behavior and related technologies and analyzed frequency domain, time domain and spectrogram. Furthermore, there are findings to extract distinct features like Low Pass Filter, High Pass Filter and autocorrelation and set up the Experimental ARU.

Keywords: Acoustic; Autocorrelation; Autonomous recording unit; Forest degradation; Hyperbolic localization; Triangulation

Paper ID: IRCUWU2022-145

A framework to analyze student's satisfaction in real-time and modify teaching methods in online education

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Most educators widely believed that understanding students' learning styles can benefit both students and teachers. During the current situation in Sri Lanka, online education plays a vital role. In online education, students have different kinds of learning styles, and comparatively, teachers have different kinds of teaching styles. Student's performance levels are most likely based on teachers' teaching styles. It should accurately determine the performance of students and ensure that the teaching style of the teachers is in line with the learning style of the students. It is impossible to change teachers' teaching styles according to each of the students and all students haven't the same ability to grasp how the teacher teaches. As a result of this, there is potential to decline students' academic performance and satisfaction. But teachers have the ability to modify their teaching style as more consistent with students learning styles. This study examines the different types of students' learning and lecturers' teaching styles in online education at the Uva Wellassa University of Sri Lanka by using 150 students who are in the Faculty of Applied Sciences and Management. Design-Based Research is used as a research methodology to improve educational activities/practices. This research aims to identify the most preferred learning style of the students, introduce the teaching style with suitable teaching aids within a theoretical framework. The majority of students' learning style, students' satisfaction of the current teaching style and students' satisfaction after following the new teaching style are analyzed by using SPSS tool. The effectiveness of theoretical framework is evaluated using a built web application. It identifies the majority of learning style and predicts suitable teaching style with teaching aids. Further mobile application develops according to the web application. The study focuses on improving the student's academic performance efficiently and effectively and make the ability to improve teaching aids adopts with learning style for students who have online education in the higher education in Sri Lanka.

Keywords: Academic performance; Online education; Satisfaction; Teaching aids; Theoretical framework

Paper ID: IRCUWU2022-173

Web-based application for gold price prediction with machine learning techniques

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In recent years, investors have paid significant attention to gold price because they can earn huge profits in the future. Gold can be used as cash, Jewelry and for other purposes such as a medium for money or exchange because of its limited supply and high value. In this paper, traditional machine learning algorithms have been used for modeling the gold price. The two performance measures, the coefficient of determination (R2), root mean squared error (RMSE) are utilized to evaluate the performances of different models developed. The research employs monthly gold price from November 18th 2011 to January 1st 2019. All the required information for the study has been retrieved from the kaggle website. Next, the study has analyzed data using appropriate charts and scatter plots. Correlation analyze performed to determine the relationship between the gold price and selected variables for the study. To transform features to be on a similar scale normalization has been performed. This also improves the performance and accuracy. Train test split and model building is the next step. In model building this research has used SVR as the bench mark model. Next, review benchmark model and all the solution models based on evaluation metrics and compared RMSE of benchmark and all solution models. After train selected modals multiple times, cross-validation has been performed. After validation on comparing the Benchmark model – Decision Tree with solution models ensemble model, Bayesian ridge and Lasso CV has very lesser RMSE in comparison to benchmark model's RMSE. Both ANN and traditional machine learning techniques have their advantages and disadvantages. The ANN models are very efficient in adapting and learning, but on the negative side they have the negative attribute of the "black box". This will be beneficial for investors and central banks to decide when to invest in this commodity.

Keywords: Gold price; Linear regression; Machine learning; Random forests; SVR

Paper ID: IRCUWU2022-178

Mobile application for self-screening of the Covid-19 infection based on the breathing sounds using machine learning approach

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Covid-19 is a deadly virus that caused a significant outbreak worldwide. It has driven a considerable impact socially, economically, and politically. Therefore, we need to take precautions not to spread the virus to others. We have taken the breathing audio dataset as a source to identify the Covid-19 individuals who will help prevent others from getting infected. The breathing audio dataset has been selected from an open-access database called Coswara, a project conducted by the Indian Institute of Science (IISc) Bangalore to develop tools for diagnosing Covid-19, which consists of both healthy and positive up-to-date, accurate audio with well-defined labels. It is subdivided as breathing shallow and breathing heavy. The dataset consists of 599 healthy and 432 positive breathing audios. We have considered 80% of it as training and 20% of it as testing data. These data are being renamed by assigning a unique ID which is much more helpful to do pre-processing of the dataset. Mel Frequency Cepstral Coefficients (MFCC) feature extraction was used to get around 40 features from the audio sample. To train the model, an Artificial Neural Network (ANN) was selected due to following reasons, storing information on the entire network, storing information in the whole network, and Having fault tolerance. The model gives around 81.55% accuracy for 500epochs and 32 batch sizes. F1-Score of the model for both classes, 'Negative' and 'Positive' is 70% and 65%, respectively. Precisions for these classes are 67% for the 'Negative' class and 69% for the 'Positive' class.

Keywords: Artificial neural network (ANN); Coswara; Machine learning, Mel frequency cepstral coefficients (MFCC)

Paper ID: IRCUWU2022-183

Remote monitoring of domesticated pets using IOT and machine learning techniques: a case study of common domestic dog species in Sri Lanka

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Pets are companions of humans since the dawn of civilizations with the domestication of animals. Dogs (Canis familiaris) and cats (Felis catus) are the most common types of pets found across the globe and societies. In certain instances, the owners require temporarily moving away from the pet dog by leaving the dog home or in someone else's care. Therefore, the owners have to spend additional costs to take care their pets. Thus, this study attempts to provide a technological solution to the prevailing gap by introducing a smart pet collar that utilizes the Internet of Things (IoT) and Machine learning techniques. The study aimed to develop the designated device and field test it to assess its capabilities for measuring the emotional, behavioral and health characteristics of the pets whose owners are not present nearby. The collar utilized barking patterns and heartbeat rates to determine the emotional and behavioral states of the pet dog. The pulse rate was specially used to assess the health of the animal. An experimental design was employed using a sample of 1842 Sri Lankan common domestic dogs to assess the effectiveness of the collar involving three barking patterns and pulse rate; aggressive, happy and sad. To visualize audio, a spectrogram was used. Spectrogram is derived from the two fundamental components of sounds, which are amplitude and frequency. For visualization, python and librosa were used. Librosa is a python package for audio data analysis. The ANN (Artificial Neural Network) model and Sequential deep learning model (Keras model) and the development of the admin app facilitated the users to monitor the emotional and physical state of their pet dogs. Forty features were extracted by using MFCC. Results revealed that the collar was 89.54% accurate with an epoch of 200.

Keywords: ANN; IoT; Machine learning, Pets; Remote monitoring

Paper ID: IRCUWU2022-188

Automatically generate MCQs with end-to-end answers using BERT and NLTK technologies

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The manual creation and evaluation of MCQs are time-consuming and labor intensive. Therefore, recent research has focused on the automatic generation of MCQs with minimal human interactions. During the Covid-19 pandemic, many advanced institutes shifted from conducting assessments physically to virtual due to many restrictions. Therefore, these evaluations are mostly MCQ-based, but manually prepared. Even though there exist several MCQ question generation systems, they are heavily based on heuristic rules. In addition, most of the earlier question generation systems used complicated models/processing. Hence, the main objective of this research is to build an answer-aware question generation system that can be used to build MCQ tests in an effective and efficient way through recent NLP techniques. In an answer-aware question generation approach, the generated answer could be inferred by the given paragraph. Our proposed system consists of two parts: 1) an intelligent MCQ generation model using NLP Techniques and 2) an advanced score calculation system for MCQ generation applications. The MCQ generation module is based on three sub-models and implemented as a multi-task model to improve the process of high-quality question and answer generation. These three sub-modules are: i) the T5 model – to remove duplicate sentences where the spans are considered, ii) the e2e-qg (end-to-end question generation) model - to train end-to-end question generation tasks to extract answers though multiple objects, and data are passed through the model parameter, and iii) BERT (Bidirectional Encoder Representations from Transformers) model - to generate questions based on the answer from user inputs. With the above-mentioned techniques, the proposed system can generate a set of MCQs for a given paragraph with a correct answer to the questions with higher accuracy. Developed question generation method utilized pre-trained transformers (particularly seq-2-seq models) and simple end-to-end procedures without the use of expensive pipelines. Developed score calculation system in the research presents a set of random questions from a database, and then, students can attend quizzes and view the result in real-time.

Keywords: BERT; MCQs; NLP; NLTK

Paper ID: IRCUWU2022-195

Topics detection Tweets related to Covid-19 vaccinations: A transfer learning approach

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The Covid-19 pandemic has influenced the everyday life of people around the globe and it has triggered a major discussion on many social media sites to state general feelings about the pandemic. It is necessary to vaccinate an estimated 55%-82% of the population to create herd immunity and slow the spread of a pandemic. However, people have different perception on vaccination. To analyze this behavior, we used two datasets belongs to the initial period of Covid-19 vaccination in the U.S.A. and the second dataset consists of tweets that are released one year after the introduction of the vaccines. Similar researches can be found in recent literature. However, there are some limitations to those proposed techniques such as; the title assigned to each text might be misleading, methods are not efficient to analyze large-scale data streams, less focus on the semantic relationships between words, huge running time and convergence time, and, not appropriate for huge datasets. Therefore, in this research, we try to address those issues and proposed an automatic topic detection procedure using the latest transfer learning pre-trained model. Our main objective is to analyze the ability of transfer learning techniques to detect tweets containing opinions and emotions toward Covid-19 vaccines, to extract emerging topics in a focused tweet category using transfer learning techniques, and to gather public perceptions on Covid-19 vaccines to understand their awareness. We have performed an emotions analysis in order to identify how emotions represent the data related to Covid-19 vaccines. Then, we performed topic detection in order to identify what are the emerging topics related to Covid-19 vaccines. We proposed a novel multi-modal approach by combining the Covid-Twitter-BERT (CT-BERT) model and Support Vector Machines (SVMs) followed by emotional analysis. And then, we performed topic modeling using the BERTopic model targeting a Covid-19 vaccine-related Twitter dataset released from January 1, 2020, to December 31, 2021. The proposed novel multi-model approach outperformed other machine learning baseline models (logistic regression, random forest, and support vector machine). Our model has scored 0.93 accuracies on emotion detection and leads to detect hot topics related to Covid-19 vaccination accurately. Overall, the proposed model automatically detects the public perception of Covid-19 vaccination from real-time data on Twitter, which can also be generalized to other domains.

Keywords: BerTopic; BerTweet; Covid-19; CT Bert; Vaccination

Paper ID: IRCUWU2022-197

Detecting audience excitation and boredom using facial images in an online meeting

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Due to Covid-19 pandemic, the trend of using online meetings for learning purposes has increased. It has evolved as an emerging way of acquiring knowledge by making face-to-face meetings impossible. Even though numerous studies have been explored under facial emotion recognition, there is no explicit mechanism to recognize facial emotions in online meetings. Hence, the purpose of this study is to develop an improved convolutional neural network for detecting facial emotions in online meetings using Image Processing and Deep Learning. The proposed system captures facial images through video frames, extracting facial features and classifying facial expressions using deep learning methods. Initially, a Python-based application was developed to create an original dataset and around 1500 facial images were gathered using that application. Since the amount of data gathered was not sufficient to train the models, an open source dataset containing more than 20,000 images was also considered. The dataset was labeled into five emotion categories as happy, anger, disgust, neutral, and surprised. The neural network has been implemented using the Sequential Model. OpenCV, Haar Cascade Algorithm and ImageDataGenerator have been used for image processing and Adam optimizer has been applied to improve the model's performance. Finally the model has achieved 77.32% prediction accuracy for five specific emotions. The training accuracy of the model is 92.38% for 50 epochs. The algorithm may be slightly biased on class imbalance since the dataset gathered from the class called "Disgust" was quite low compared to other classes. However, overall this model is an excellent utilization for detecting facial emotions in real-time compared to existing investigations. In future, this model will be embedded into applications so that the instructors can easily grab the students' emotions in order to inspire them for a qualitative online learning mechanism.

Keywords: Emotion recognition; Deep learning; Online learning

Paper ID: IRCUWU2022-199

Exploring and analyzing the data visualization literacy in Sri Lanka using Covid-19 and Sri Lankan tourism as a supportive use case

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The need to derive information and insights from today's huge volumes of data has posed a challenge to researchers in a variety of sectors, including computing, applied social sciences, communication, and health. From a specific scenario involving tourist data in Sri Lanka, we discovered that field experts do not use proper data visualization strategies and principles for analyzing and presenting data in decision-making. This may jeopardize the extraction of useful information and understanding of these data. Tourism has been identified as one of the primary sources of foreign exchange earnings for most developing countries such as Sri Lanka. Here the effect of Covid-19 on the Sri Lankan tourism industry has been considered a supportive use case for the study conducted. In this study, 8 different data visualization design principles and their level of difficulty were taken into consideration. To explore the level of understanding and knowledge of the data visualization domain among the Sri Lankan public, a questionnaire was carried out. 83.06% of the total respondents have been able to correctly identify the "Easy" visualizations, 72.58% have been able to identify the "Moderate" visualizations, and only 17.74% of respondents have identified the "Hard" visualizations. Furthermore, the study was focused on developing customized visualizations, aimed at understanding the usage of proper data visualization principles in the Sri Lankan context. This will assist the domain experts evaluate the data and analyze the most effective strategy to reach their target audience. This work would provide these professionals with a new way of thinking about how to present their data, with the help of better data visualization principles.

Keywords: Covid-19; Data visualization; Human data interaction; Sri Lankan tourism

Paper ID: IRCUWU2022-235

Descriptive analysis and data visualization on Agile-ITIL integration on Business as Asual (BAU) activities in it industry

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The projects which lead to an effective formation or adjustments of IT services are not directly managed through the Information Technology Infrastructure Library (ITIL) processes, though ITIL aims at managing the whole life cycle of an IT service. However, researchers explained the way to combine the Waterfall life cycle, conventional software development methodology with the whole ITIL literature, and they failed to combine agile methodology with ITIL to function the project life cycle effectively. Thus, A-ITIL (Agile-ITIL combined framework) is proposed to smooth the Business As Usual (BAU) activities in the IT sector. This study is designed to analyze the requirement of integrating Agile methodology with ITIL on BAU activities in the IT industry. Furthermore, it determines the compatibility points in software and IT-related BAU activities when combining Agile and ITIL. The sample data is gathered via an online questionnaire, and the questions are categorized as general, experience on ITIL, experience on Agile, and Agile-ITIL combination on BAU. By going through the survey, while accepting the requirement to integrate Agile with ITIL in their organization, most are practicing transferring BAU between Agile and ITIL (66.7%). Out of this sample, 87.5% have supposed that there is an average difficulty in transferring BAU activities between ITIL and Agile teams. Problematic acquisition of continuous feedback, resource allocation, and inaccurate time card management (62.5%) are identified as the main difficulties when transferring BAU tasks between Agile and ITIL. Most people unaware of a framework that helps to manage BAU transmission between Agile and ITIL affirmed a need for such a framework, and they defined the essential feature of such a framework as providing more realistic timelines. According to the analysis, the potential is there for integrating Agile methodology with ITIL on BAU activities in the IT industry with higher demand (80%). This research has been able to illustrate the importance of A-ITIL framework to smooth the BAU activities in the IT sector.

Keywords: Agile; A-ITIL; BAU; ITIL; Waterfall life cycle

Paper ID: IRCUWU2022-279

Ontology based legal support system on domestic violence in Sri Lanka

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At present, most people have severely become victims of Domestic violences. There are various ways to get legal advice in Sri Lanka. Although there are many legal consulting firms in Sri Lanka, there is no reduction in legal issues because of these issues, there is a need to set up a legal expert system for people to seek advice on their legal issues. In this research context, the issue of access to basic legal measures is addressed for domestic violence is addressed. The reported cases are collected and then extracted the domestic violence types. According to that at the end of the process, the system are provided with what options can get initially as well as provided guidance on to approach for legal actions as query results. Ontology is developed using Protégé 5.50 and is tested by running SPARQL queries. OWL file is sent to the python script connected with the Fuseki Jena server. Python 3 is used as a backend language for ontology and interface integration. Front-end is developed using Flask Library in Python 3 and is presented for the users to ease the interaction with the system. The ultimate goal of the recommender system is to recommend an accurate legal solution for the specific user's issue instead of getting focusing on solutions that waste time. Further users can be able to get the legal process and the information related to the legal actions. Using the Ontology Pitfall Scanner, ontology will be evaluated after every complete enhancement as well as consistency will be checked using the HermiT reasoner. Accuracy and correctness are checked by addressing the competency questions and by domain experts' inspections.

Keywords: Domestic violence; Ontology; Protégé; Python; SPARQL

Paper ID: IRCUWU2022-334

Human behaviour identification system for elderly care

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In Existing elderly care, there are several caretakers to take care elders. Sometimes each elder has the same number of caretakers to take care of elders according to their situations. It is time-consuming, costly and sometimes elders feel inconvenience and it may limit the freedom of elders. And it is not easy to keep an eye on one person in every single second is not possible for a human. By establishing proper system to identify human behaviors, it is possible keep an eye on elders in every single second. it improves the security of elders. There are several related researches done for monitor basic behaviors of elderly people at home. But there is no any accurate system to monitor behaviors of elders in elderly care. We proposed a system to identify human behaviors for elderly care using real time image processing, which captures real-time images of the elderly through the camera. In this we proposed to establish CCTV cameras on elderly care and capture real time images using CCTV videos. Then we introduce some extra ordinary human behaviors for the system. If there is any dangerous behavior occurred, the system will send a signal to inform the related people. (e.g.: Falling, fire occurred etc.) And also, we hope to train a Neural Network according to elders' anomalies like high heart rate to identify them and send a signal to inform the related people.

Keywords: Elderly care; Keras; Neural network; Python

Paper ID: IRCUWU2022-357

Consideration of sleeping habits to detect the stress in humans using XGBoost

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Stress is one of the common problems encountered by the human nowadays. Beyond the age limit, from teenagers to senior citizens face problems due the impact of stress. Stress can be classified into two major types such as acute and chronic. Acute stress is a normal human reaction which helps to adjust your body to new circumstances. In fact, this kind of stress affects in a positive way. But the second type, Chronic stress is a critical category of stress and actually, this study focused on identifying its status level of it in advance. This study analyzed the sleeping habit of selected humans by considering 8 attributes associated with them. The dataset utilized during this research was obtained from Kaggle. The considered attributes were snoring range where the user resides, body temperature, limb movement rate, blood oxygen levels, eye movement, amount of hours of sleep, heart rate, and the stress levels (0-low/normal, 1–medium low, 2-medium, 3-medium high, 4 – high).To develop the final prediction model, XGBoost was utilized. Boost's model produced the classification results with a higher accuracy of 96.29% and low error rate of 3.71%. Moreover, along with the basic evaluation-Fold cross validation was carried out with 5 folds to validate the model further for different percentages of training and testing data. After the cross-validation, mean accuracy yielded for the model with accuracy 92.31%. In addition, out of the 8 attributes considered, snoring range where the user resides, limb movement rate and blood oxygen levels attributes were identified as important to predict the status of the stress level in advance according to the contribution those attributes provide towards the target attribute. This study would be a promising start for the future researchers to focus more on the prediction of the stress level by considering the internal and external factors.

Keywords: Classification; Stress management; Supervised machine learning; XGBoost

Paper ID: IRCUWU2022-358

Spot struggling students in online learning using machine learning approach

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In the sense of improving the teaching and learning process, and at the same time reducing the dropout rate of the students and the students who are unable to grasp the knowledge from the learning process can be taken as an important set of groups that will benefit from these automation systems rather than traditional evaluation systems. The factors which are affecting the learning process of the students and the studying behaviors of the students will reveal a major number of details to edict the student's current performance and the outcome in the study-based activities such as exams, assignments, and group activities, etc. The aim of this study is to identify the difficulties of the students who are struggling in the process of the learning period in the university. From this study, the teachers will be able to identify the students who are struggling and see where they have struggled in the process and what kind of difficulties the students are facing. Moreover, through this system, it will be beneficial for the students and for the teachers to take the necessary actions before the students drop out of the university. Online learning platforms can be different from the traditional classroom, which can be easy to identify the struggling students via the modern analyzing tools, which can be used through online platforms. By analyzing the data that affect the struggling student, it will give the chance to the teachers to predict and take the necessary actions before the final evaluations. The data gathered for the LMS such as assignments marks, completion of assignments, number of downloads, interactions with discussion forum can be considered as the affecting factors. Recent research explains that such factors gathered through the LMS can increase the prediction quality by more than 70%, and those factors will be forwarded to the interactive web system to label the data through the oracle support system. The Oracle will label the data and the labeled data will be fed to a machine learning model which is based on a feedforward neural network.

Keywords: Active machine learning; Deep learning; Online education; Neural networks

Paper ID: IRCUWU2022-360

Machine learning based approach for software requirement classification

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Currently, software development has become a hedge trend all over the world. The basis of the high-quality software development process is Software requirements. There are mainly two types of software requirements named Functional Requirements (FR) and Non-Functional Requirements (NFR). The Single-step related to the Software requirements represents the needs and expectations of the software. Usually, categorising software requirements requires a lot of effort, mainly whenever the conditions are high. As a result, the automation of software requirements classification has been accomplished using Natural Language Processing (NLP) and Information Retrieval (IR) techniques; however, human effort is required to analyse and create features based on the set of requirements. The authors proposed a machine learning-based approach to classify software requirements as FR and NFR in this study. The researchers collected the data from the Kaggle website and some Sri Lankan software companies as the first step. The collected data were manually labelled using experts. At the end, 1896 FR and 1908 NFR were remained for further processing. As a usual step in NLP, the collected data set was preprocessed with stopword removal, special character removal, stemming, etc. Next, the authors constructed three machine learning-based algorithms named Decision Tree, Long Short-Term Memory (LSTM) with Word2Vec word embedding, and LSTM with GloVe word embedding to classify the software requirements. Finally, the authors evaluated the models and found that the LSTM + GloVe model (received 84.13% of accuracy) is suitable for this classification.

Keywords: Decision tree; Functional requirements; LSTM; Machine learning; Requirement engineering

ENGINEERING & TECHNOLOGY

Paper ID: IRCUWU2022-91

Self-activating soap and water battery imposed dispenser

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The corona pandemic is wreaking havoc over the world. To prevent the coronavirus from spreading, it is constantly monitored across the country. Medical personnel and nurses are working around the clock to treat people who have been infected and prevent the virus from spreading to the rest of the population. Hand washing is recommended regularly to prevent the spread of the virus and the demand for hand sanitizers has increased dramatically. It is ineffective when too little hand sanitizer is used or washed off before it has fully dried and even sanitizers with at least 60% alcohol content cannot eradicate all forms of bacteria and viruses. Soap and water are far more effective than hand sanitizers in killing germs and viruses. Existing products only regulate soap and there is no mechanism for controlling water and for levelling soap. The risk of viral transmission can be increased by coming into contact with the soap pump handle and the water tap handle. This paper aims to create a contact-free, automatic hand sanitizer system that regulates water and soap automatically. The system consists of two proximity sensors to detect the presence of a human hand, an IR sensor to detect the soap level in the tank and solenoid valve, and a pump to control water and soap respectively. If the main AC power supply fails, the system is powered by an inbuilt power module. A GSM mechanism has been installed to alert the operator in case of a low soap level. The product is more cost-effective and portable than traditional ones. It plays an essential role in contactless hand disinfection in public places and reduces the spread of the Covid-19 virus.

Keywords: Automatic; Covid-19; Hand wash dispenser; Sanitizer; Touchless

Paper ID: IRCUWU2022-102

Automatic billing system for Sri Lankan pastry shop

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With the advancement of information technology and artificial intelligence, employing science and technology to improve the food industry's low efficiency is a very effective approach. Many cafeterias in Sri Lanka and other countries have long queues for food payments because of the high volume of customers at particular times of the day. Queues can occur when the demand for a service exceeds the facility's ability to supply it. Most bakery goods and pastries in Sri Lanka are unique, and there is still no trained data set for identifying Sri Lankan pastry or bakery items. This paper solves this issue by including real-time image recognition techniques in the procedure. It is possible to eliminate the need for manual price computations by employing a camera to shoot a live picture at the checkout counter with an image recognition model, which produces the total invoice automatically. The recognition capacity of models determines the actual benefit of these systems under unconstrained conditions. A real-world dataset was gathered for testing the algorithms. The images were captured in a real bakery shop, with pastries arranged in various ways on a tray. Each tray can hold between one and seven pastries. A collection of ten different categories was gathered. TensorFlow SSD MobileNet V1 was used to train, validate, and test the image recognition model, including 2000 dataset images. The overall technique can be defined as detecting Sri Lankan pastries using Convolutional Neural Networks and developing a user interface in Python using Tkinter. According to the experimental data, the recognition accuracy of individual entrees was around 90%, and that of the full tray was approximately 95%. The advanced training may improve the model's accuracy on a larger dataset, and using the approach during the checkout will become more practicable.

Keywords: Artificial intelligence; Convolutional neural networks; Food payments; Real-time image recognition; TensorFlow SSD MobileNet V1

Paper ID: IRCUWU2022-103

Design a plant irrigation water sprinkler robot

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Agriculture is one of the most essential and crucial sectors for humans to survive. Irrigation in agriculture is essential for plant survival since they cannot produce a crop or thrive without the right amount of water. Several technical advancements in the agriculture area have occurred since ancient times. With the fast technological advancement in the world, innovations are becoming common in agriculture as well as in all other fields. Considering the present situation, the objective of this study was to overcome some of the problems in the irrigation systems in the agriculture field such as low efficiency, time consumption, and a lack of labourers for the cultivation irrigation system by designing a fully automated plant irrigation water sprinkler robot. This research designed a water sprinkler robot for chilli plants (*Capsicum annum*) as a sample. The robot system used a robot with an arm that moves through the field and provides the required water quantity to the plants after measuring the water levels using soil moisture sensors based on the ESP 32 microcontrollers. This design consisted of a sonar sensor system for robot navigation. This system consisted of another main system; Field Module with Testing Soil Moisture System and Red Tag Identification System. The water sprinkler robot consisted of microcontrollers, servo motors, a DC motor, an onboard water reservoir, and an attached water pump to build a fully automated robot system. In addition, a research on the overall design of the plant irrigation water sprinkler robot for small-scale agriculture fields is in progress. The water tank capacity of this system was approximately 7.5 L, and this design can hold approximately 88.9 N. Its performance includes following the plants' path in the cultivated field, measuring the amount of required water, and providing that level without any human labour.

Keywords: Navigation system, Plant irrigation; Soil moisture system; Water sprinkler robot

Paper ID: IRCUWU2022-109

A study on distributed and centralized power factor correction: A case study

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With the increased reactive power demand from the power system, a poor power factor at industrial sites can cause problems such as increased losses, stability, power quality, and higher utility rates. As a result, capacitor banks are necessary for improving power factors among industrial users. A properly sized capacitor bank is directly connected to the terminals of each load in distributed Power Factor Correction (PFC), whereas a single capacitor is directly installed in the main distribution switchboards in centralized power factor correction. The goal of this research was to use a simulation interface to conduct a technical assessment of distributed and centralized power factor correction methods on an industrial load. The case study was conducted at a leading garment factory in Sri Lanka. Past electricity consumption data and data gathered by interviewing employees were used to determine the operating condition of the motors throughout the day and to model the company's electrical drawings on a simulation interface. The power factor, active power, apparent power, and reactive power were all examined. In centralized power factor correction, a single capacitor bank was selected to obtain the desired power factor. To avoid power factor overcorrection, distributed power factor correction connected a capacitor to each induction motor to compensate for 95 percent of the no-load reactive power. The result showed that if the capacitor bank is connected throughout the day, the advantage of centralized power factor correction with a capacitor bank during peak demand periods can be compromised during the light load condition, and a variable capacitor bank that changes the capacitance according to the reactive power requirement is recommended for the factory if the centralized power factor correction method is used. However, the results revealed that the distributed power factor correction method can regulate the power factor nearly at a constant value in an industrial load condition for whatever the load condition.

Keywords: Induction motor; Maximum demand; Power factor; Reactive power; Simulation

Paper ID: IRCUWU2022-110

Identification of electrical appliances via analyzing the harmonics in voltage and current waveforms

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Appliance load identification is advantageous in energy management techniques that address many challenging tasks with increasing electricity demand. The appliance identification and load monitoring enable optimum supply with minimum cost attained by detailed appliance connectivity to the electrical network in a smart grid system. In this research, an analysis of non-intrusive load recognition using appliances' steady-state voltage and current harmonics was utilized for identifying general domestic appliances using a power analyzer. This study allowed the competency of formulating detailed information on appliances switched on and prosumers receive the advantage from customized energy administration offers by utility. Further, utility could implement smart metering technology introducing appliance level information as well. We proposed algorithms for non-intrusive load recognition using combination of several methods and techniques. It was found that a higher accuracy of identification could be achieved when combinations of technique were used rather than using a single technique.

Keywords: Load identification; Load monitoring; Non-instructive loads; Power analyzer; Smart metering technology

Paper ID: IRCUWU2022-116

An investigation of energy consumption and energy-saving potentials of an industrial load

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The quality of electrical power is a critical aspect that affects both the economic and technical benefits of any industrial operation. The apparel industry uses much miscellaneous equipment, such as induction motors, transformers, etc. These induction loads absorb additional currents known as inductive reactive currents, and the impacts of these additional currents reduce the power factor, making the electrical network inefficient. A low power factor leads to significant power losses, and higher utility rates, and requires the electric power utility to meet high maximum demand. However, with appropriately designed power factor improvement methods and demand-side management techniques, the power factor can be improved. Most of the cases, capacitor banks with different capacitor bank installation methods have been used to improve the power factor. However, it cannot regulate the power factor due to fixed capacitor values. This paper describes a study performed at an industrial site using a capacitor bank and a solar photovoltaic system to improve the power factor and reduce energy demand, and an analysis of the technical and economic benefits. The electrical system of the site with the dynamic loads was modeled and analyzed using simulation software. The capacitor bank was sized to compensate for reactive power requirement at night and its connected duration was determined by observing the power factor, active power, and reactive power values throughout the day. The solar system was sized to cater to the peak active power demand of the site by analyzing the 24-h solar irradiance information at the location. The voltage source converter connected to the solar system was controlled to deliver the reactive power requirement to regulate the power factor during the daytime. The results showed that the proposed 40 kVAr capacitor bank and 553 kW solar system successfully improved power factor by 39% while reducing power factor overcorrection. Furthermore, the proposed system leads to a monthly savings of 905,806 LKR, resulting in a simple payback period of 6 years.

Keywords: Capacitor bank; Demand-side management; Energy demand; Power factor; Solar photovoltaic system

Paper ID: IRCUWU2022-133

Six-axis mini industrial robot arm for small scale industry

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The world of technology is rapidly evolving. Similarly, robots already perform nearly all human activities. Even a developing country as Sri Lanka is welcoming robot technology. Unfortunately, due to the expensive cost and lack of knowledge, only large-scale businesses use this robot arm technology. In some circumstances, people must do their work by hand in a very short amount of time. As a result, when humans accomplish something like that, they become exhausted. Robot arms are typically employed in assembling lines or loading lines to lift small objects with a separate movement that humans cannot endure for such a short length of time. Hence, popularizing this technology among small-scale entrepreneurs will also increase the efficiency of small-scale businesses. The main purpose of this study was to build a 6-axis robotic arm (6 DOF) machinery that can be controlled by a small business owner in Sri Lanka for a low cost and with minimum technical knowledge. The structure of the robot arm was designed using Solidworks modeling software to simulate the robot arm's force. The design can support a maximum weight of one kilogram. All arms were made of aluminium and iron purchased locally. NEMA type stepper motors were employed for motor control, with stepper motor drives DRV 6685 and TB6660. The forward and inverse kinematics was computed, and mathematical implementation based on D-H (Denavit–Hartenberg) parameters was defined.

Keywords: Six-axis robot arm (6 DOF); Large-scale business; Small-scale business; Stepper motors

Paper ID: IRCUWU2022-168

Design and development of an automatic irrigation system embedded with water leakage detection for green roofing

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A green roof is a layer of vegetation planted over a waterproofing system that is installed over a rooftop in urban areas. It minimises air toxins, saves energy consumption, and maintains the temperature of the building. Not providing water at the right time and leakage of water in the pipes cause major problems in green roofing. The pipe leakages cause structural damage to the building and wastage of water. Most of the available systems and researches have been focused on automatic irrigation. Therefore, there is a high demand for pipe-damage identification. To provide a solution, a microcontroller-based automated irrigation system embedded with a water leakage detection mechanism targeted for green roofing was proposed. It enabled the watering of the plants according to the moisture content of the soil, and it can notify the system status via an IoT-based web dashboard if there is any leakage in the pipe system. The resistive types of soil moisture sensors and flow sensors were used to identify the moisture content of soil and leakages, respectively. The solenoid valves were used to control the watering according to the sensor readings, which are below the pre-defined moisture content of 15%. The leakage detection process was based on the flow rate difference between any of the two adjacent sensors, which is above the pre-defined threshold of 5 L/h. The threshold value was estimated by the trial and error method by using the prototype. When leakage is detected, it can notify the pipe section where the leakage occurred. This avoids wastage of water and minimises the time taken to diagnose the leakage. In addition, it was developed with an ultrasonic sensor-based water level detection mechanism to manage and notify the level of water which is below 20% in the water reservoir. To test the effectiveness of the system, a pre-set water leakage and two soil samples were used. All trials were successful and it revealed that the system has a high potential to maintain the moisture content, detect and notify the leakage with damaged pipe section according to the set thresholds.

Keywords: Automated irrigation system; Green roofing; IoT; Water leak detection

Paper ID: IRCUWU2022-172

Design and develop an IoT-based street light Maintainers monitoring system

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The street lamps play a vital role at night. It provides several benefits such as minimizing road accidents, and unfortunate incidents and increasing the beauty of the surroundings. To maintain uninterrupted operation, the street light system should be maintained in a systematic manner, but some of the lampposts are not operating properly. It is due to improper awareness of the faults in the light system. Usually, street lamps are powered by separate AC supply or solar panels. It may have faults in the main bulb being burned, the power failure in the AC supply, does not generate the required amount of power in the solar panel, and failures in the battery. In order to provide a solution, an IoT-based maintenance monitoring system was proposed. The proposed system consisted of four subunits which were developed for pre-identified common failures, and an integrated battery unit to maintain the continuous operation of the monitoring system while power failures. They were; an HW522 current transformer to check the working condition of the bulb by measuring the current that consumes by the bulb at a pre-defined time slot, and an ACS712 sensor used to check the separate AC supply. A voltage divider was used for electricity generated from the solar panel by comparing voltages with pre-defined threshold values, and a voltage divider that tests the battery charging and charge level by checking voltages at battery terminals. The number of subunits required for each lamppost may vary according to the power source of the lamppost such as solar power and a separate AC supply. To monitor the status of the lamppost, the identified conditions of each subunit was displayed on a web-based dashboard and it was communicated via an online database. The dashboard was developed with an easy eye-catching graphical view. Then, the maintenance unit will be able to quickly identify the failure in the corresponding lamp and resolve the situation. To test the effectiveness, a prototype was constructed and tests were conducted for pre-defined failures. The results revealed that it has the ability to identify the common type of failure of the corresponding lampposts.

Keywords: ACS712; Current sensor; IoT; Maintains monitoring; Street lights; Voltage divider

Paper ID: IRCUWU2022-211

Motorbike assistance tool using image processing technique

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Accidents involving motor vehicles account for a significant number of deaths and injuries that occur each year in Sri Lanka. The rider's failure to be aware of vehicles following him and his inability to accurately estimate whether or not they will pass are two factors that frequently lead to collisions involving motorcycles. Even though there are several different technologies that can detect vehicles and lanes, the vast majority of them are not built for motorcyclists and even those that have additional drawbacks. This study proposed to create and develop a motorbike assistance tool that makes use of image processing techniques for road line recognition and behind vehicle detection in order to lower the average number of accidents that involve motorbikes each day. The novelty of this motorbike assistant tool is its ability of behind vehicle detection with the middle line detection. The Python programming language and the Open-CV library were utilized during the creation of this auxiliary tool. This program used the Counter Operation algorithm, which includes the open-cv library, to detect the behind lines. The open-cv package was also a part of this detection process. The TensorFlow object detection module was utilized largely for the purpose of recognizing vehicles from the back. A mobile application was created with Flutter to display those data. Using an ESP 32 camera, the hardware for video capture was developed. The ESP 32 camera and the mobile application were connected for final output. In addition to displaying the names of vehicles that were following the motorcycle, it also displayed the distance between the motorcycle and the center line of the road. According to the results, ninety percent of the attempts to detect the road lines were successful. Nevertheless, the identification of vehicles left behind was successful in a total of seventy percent of the cases. Some improvements such as solving the problem of detecting vehicles that pass the motorbike while coming from the front side should be done to this assistance tool.

Keywords: Image processing technique; Motorbike assistance; Road line detection; Vehicle detection

Paper ID: IRCUWU2022-218

Designing of automated roof gutter cleaner for houses in urban area

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Rainwater is collected by roof gutters. Rainwater cannot be collected effectively when the roof gutters and downspouts are clogged with leaves and debris. Water damage to the inside and outside of a home or building can occur when gutters overflow. A roof gutter design was introduced to function cost-effectively and efficiently. Therefore, the objectives of the project were (i) to design and develop roof gutter cleaner and (ii) to design and develop automated roof gutters for houses in urban areas. An automated roof gutter can also control the auger's spin direction, so that debris is propelled out of the gutter and away from home. Remote control, giving it semi- automatic control, makes cleaning and de-clogging of the gutter. Automated roof gutter was, just press the clean button on the wireless remote and the automated roof gutter travels along the gutter on its own, sensing and adapting to debris. Different structural gutter forms are utilized in household situations. A questionnaire was distributed via Google survey among friends and colleagues, by displaying available designs in four types (A-Rectangular, B-Curve, C-Slump, and D-Oval) where a question was asked to find what type of roof gutter arrangements are most common in residential and commercial settings. According to the survey, 34% of respondents preferred the rectangular shape (Type A). Therefore, Type A was designed for the roof gutter cleaner. The automated roof gutter cleaner was designed using three main components; head, rotor handle and brushes, and base/tank. Head helps to swallow garbage inside the gutter, and rotor handle and brushes clean the gutter while the base is used mainly to move this tool. After comparing existing technology, a small chip camera was additionally installed in the head and base to monitor the cleaning process. According to the results of a study, this technology helps to clean the gutter and store clean water in urban areas.

Keywords: Camera; Gutter design; Roof gutter; Survey; Tool

Paper ID: IRCUWU2022-281

Evolution review of the soft robotic hand rehabilitation exoskeleton

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Soft robotics is a subsection of robotics concerned with electromechanical and mechatronic systems built mainly of soft materials. The detrimental effects of a variety of neurologic illnesses on hand function have led to the development of rehabilitative robotic exoskeletons targeted at recovering hand function in these hands fully or partially disabled persons. There are thousands of robotic rehabilitation hand exoskeletons available. However, soft exoskeletons are more effective than hard exoskeletons. Therefore, this study summarized a prospective evolution of several soft robotic hand exoskeletons with various electromyography-based (EMG) and electroencephalography (EEG) equipment, design structure and controls for rehabilitation, and aid in daily living tasks. A total of 51 soft robotic hand exoskeletons were evaluated. There is no proper review of the soft hand exoskeleton with the criteria selected for this review between 2000 and 2021. The review follows two methodological frameworks: a mechanical design and a control system. The first step summarized the electrical, mechanical, and functional characteristics of several soft robotic hand exoskeleton designs from 2000 to 2021, such as actuator and motion type, input and feedback system, total Degree of Freedom (DOF), flexible deformation unit, and finger moment. Next step of this review analyzed research on the impacts and performance of soft robotic gloves for hand rehabilitation, as well as patient happiness whenever possible. Further, it predicted the future of soft robotic rehabilitation hand exoskeletons and some of its key design features. In addition, it evaluated the most successful development technologies and structures among these using patient feedbacks. Finally, this will help future researchers to implement their soft hand exoskeleton in more compliant, efficient, and successful manner. Depth results and analysis of each system concerning the significance, control algorithms, mechanical design, and power consumption can be selected to study the evolution of the exoskeleton in future.

Keywords: Evolution of soft exoskeleton; Hand exoskeletons; Rehabilitation; Soft robotics hand

Paper ID: IRCUWU2022-283

Implementation of combined cooling heating and power (CCHP) system at Biyagama export processing zone in Sri Lanka: A case study

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Most of the industrial zones in Sri Lanka generally consume electricity, heating, and cooling energy for their processes. The industries operate their own energy conversion systems to meet the thermal and cooling energy needs using fossil fuel, electricity or biomass. In place of these distributed energy conversion systems, the feasibility of having a Combine Cooling, Heating And Power (CCHP) system was analyzed in order to increase the overall efficiency. The Biyagama export processing zone which is one of the largest industrial processing zones in Sri Lanka was selected for the study. The study was initiated with the Walk-Through Energy Audit (WTEA) and then detailed energy data were gathered. The technical feasibility was then analyzed by considering the overall heat to electricity energy ratio and the phase shift between the thermal and electricity demand curves. The proposed CCHP plant follow the thermal load curve and the generated electricity can be exported to the national grid through a net metering system. For the proposed CCHP system the ranking cycle based back pressure steam turbine was used. The steam coming out of the back-pressure turbine can be used for industrial thermal energy needs. Upon the technical feasibility the financial feasibility was analyzed. The heat to electricity energy ratio of the Biyagama export processing zone was found to be within the range of 1.66 to 2.99 and the demand pattern was almost in phase. Therefore, the introduction of a CCHP system is technically feasible. The total thermal and electricity energy consumption was found to be 408,902 and 248,080 MWh/year. The CCHP system will provide the total thermal energy demand and about 17% of the electricity demand. The CCHP system consisted of 110 TPH, 48 bars biomass boiler and a 7 MW steam turbine. The financial analysis revealed that the simple payback period was less than five years. The proposed system will run on biomass and therefore, the petroleum fuel demand will be minimized. The expected CO_2 savings will be 30,568 MT/year. The well-established bio mass supply can be used to operate the CCHP plant.

Keywords: Biyagama export processing zone; Combine cooling heating and power (CCHP) system; Heat to electricity ratio; Ranking cycle

Paper ID: IRCUWU2022-318

Remote monitoring and controlling of an automobile system using NodeMCU

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Developing of remote monitoring and control systems for vehicles has been a significant concern in the automobile industry. It may be quite useful if we can monitor and track the movements of the vehicles remotely. This will help in the case of vehicle thefts. Further, if the vehicle key is not physically available, it is better if we can have a method to unlock the car and start the journey. There are vehicle tracking systems in the market. Howevr, their customization, investment and system reliability are few of the concerns for the system users. This paper presents design and implementation of a remote monitoring and controlling system for vehicles. An embedded remote controlling (doors unlocking and locking, park lights, power windows, engine start etc.) and monitoring system were designed and installed in a real car. The remote controlling was achieved using mobile Wi-Fi and Android applications of smart phones. Android Studio based mobile application sends control commands to the NodeMCU device through a Wi-Fi network. Then the microcontroller mounted in the vehicle responded to these incoming commands. A GPS based position tracker system was integrated using Internet of Things (IoT) and Wi-Fi enabled module and NodeMCU. The monitoring system also provided the vehicle background information like temperature and humidity. The mobile application was developed using the firebase database which acts as a medium for data transfer and visualization. This technology will help the user to remotely control and track their vehicles using a mobile application.

Keywords: Automobile system; Firebase; IoT; NodeMCU board

Paper ID: IRCUWU2022-325

Solid waste power plant for a rural area

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The disposal of solid waste has become a major environmental issue in Sri Lanka, and it is often cited as a key cause of environmental pollution. Energy recovery from waste is attracting the attention of many researchers due to several reasons. The present research presents a study on designing a solid waste power plant in a rural area of Sri Lanka. Because of poor waste collection, waste accumulation in rural areas in Sri Lanka is high. Solid waste power generation is a concept based on thermal heat power generation systems to generate power using steam. The area selected for this study was a small village in Elston State Upper Division, Puwakpitiya Municipality, Sri Lanka, and it generates waste on an average of 127.79 kg/day and 3,833.37 kg/month. In this work, waste that can be burnt and other non-combustibles were used for reuse or recycling. There were many different types of waste, such as garden, animal, plastic, polyethene, organic, and metal waste. The combustible wastes used as fuel have a 29,763.9 KJ/kg heat value. Data collected from a survey on daily waste generation and monthly electricity bills were used to determine the waste and electricity consumption in the village. A total of 44 domestic customers in the village consume 2937 kWh/month. THERMOFLEX software was used for detailed modelling and simulation of the solid waste power plant. The process of combustion of solid waste generated the thermal power to generate steam, and the steam turbine was driven to generate electricity. THERMOFLEX simulation used components such as de-heater, economizer, super-heater, electrostatic precipitator, fabric filter header/pump furnace SRC, stack, steam turbine, water-cooled condenser, and water pump. The designed solid waste power plant using THERMOFLEX 21 showed an output of 0.5693 kW. The designed power plant provided 13.6632 kWh/day. The output result of the power plant was 0.00147 kg/s in the selected area. The plant produced 13.6632 KWh to partially cover the daily electricity requirement of 100 kWh.

Keywords: Energy; Pollution; Simulation; Solid waste power plant; Steam

Paper ID: IRCUWU2022-383

Image processing based automated fabric label placing system for textile and garment industry

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Being the largest export income generator in Sri Lanka, textiles and garments have a high potential to conceive large market share in the world. Still the textile and garment industries suffer from certain technological gaps that can be filled to streamline its operations. The researcher has focused on the fabric label printing of readymade garments which is still done manually. It was further identified that manual printing of fabric label creates issues in accuracy, positioning, time and cost effectiveness of its process that can be addressed by automation. Thus, an automated mechanical solution based on image processing and electromechanical methods was developed to select the correct label and place it on the garment automatically in the accurate place. This newly introduced mechanism belonged to the 3-axis type of pick, and place mechanism that travels on three axes (X, Y, and Z). This system consisted of a Raspberry Pi 4 minicomputer which processes the images of fabric label by running a python program written to implement an optical character recognition algorithm. This is a programmable mechanism that picks up a fabric label from the fabric label box, uses the image processing concept, and places it in the location identified by the camera module. A vacuum unit with a suction cup was used to pick and place the fabric label at the appropriate location and had the ability to place 15 fabric labels per minute compared to manual way. Therefore, it is clear that this newly proposed automated fabric label printing machine can improve efficiency, effectiveness of the process with special development in enhancing accuracy in location identification of printing, amidst the changes in angles the clothing materials are input.

Keywords: Fabric label; Image processing; Optical character recognition; Raspberry Pi; Suction cup

Paper ID: IRCUWU2022-384

Design and development of structural health monitoring system to alert building collapses at the early stage of the damage

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This research presents new low-cost structural health monitoring system technology based on the sensor network for engineering structures (Building). Buildings of various heights are designed according to human needs. Factors such as weather (floods, earthquakes, winds), building location, failure of the building structure, design, and construction cause frequent building collapses around the world, causing damage to property and human lives. As a solution to this, Structural Health Monitoring (SHM) systems have been introduced to the world using modern technology. An SHM system is an electronic system that can give a signal before a building collapses. Other than early warning it can monitor the current status of the structures. SHM systems are currently on the market for high-rise buildings and are expensive. In addition, those systems use only the same type of sensors. As a solution, this project aimed to create an SHM system for small- and medium-sized buildings in countries like Sri Lanka using various sensors at a low cost. The reason for the low cost was that we used an Arduino board, Strain Gauges, an Accelerometer, etc. The reason why this project differs from the existing systems is that there are several types of sensors in one system and the cost is low and to prevent accidents due to building collapses and minimize the damage to property and human lives. Herein strain gauges were used to measure strain, and accelerometers were used to measure vibration and angle of beams. All sensors were connected to the Arduino board and several lab experiments were performed. First, nine concrete cubes (100 mm × 100 mm × 100 mm) and nine steel-reinforced concrete beams (240 mm × 60 mm × 100 mm) were prepared. The cubes were then tested using a universal testing machine and the compressive strength of the concrete was tested. The vibration testing was done.

Key Words: Accelerometer; Strain gauge; Structural health monitoring (SHM) system

Paper ID: IRCUWU2022-389

Smart house control kit

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Many smart house systems have been presented. However, there are some limitations in terms of cost, lack of functionality, and ease of use that are not sufficiently reliable and cannot be developed. Therefore, the aim of this research project was to design and develop a prototype for a smart house system and develop a user-friendly interface. That system was scalable and reliable by using an integrated system of hardware and software. The hardware, such as NodeMCU ESP8266, servo motors, temperature sensors, motion sensors and emergency power system, were utilized to develop the prototype of a smart house system. The internet of things (IoT) and motion sensing in Smart houses, denoted by Smart House Monitor & Manager (SHMM), were used to improve the house's convenience, safety, and energy efficiency in order to accomplish the intended optimal operation. A smart house can also provide a remote interface to home appliances or the automation system itself, via wireless transmission or the internet an android application, to provide control and monitoring via a smart phone or web browser. A smart home allows homeowners to remotely control devices, fans, lights, and other devices using a smartphone or tablet over an internet connection. Our design included advanced smart lighting systems, gas leak security systems, water appliance systems, security systems, and many other features. A mobile app was designed to control the system in a simple and user-friendly manner. In the future, a system that opens and closes the door using a mobile app will be developed. The Arduino compatible gas sensor module was utilized to detect gas leakage in this system. If a gas leak is detected, the system sends an alert and activates the gas leak alarm, as well as controlling the lights with a relay module by switching the signal from the mobile application.

Keywords: Android application; IoT; NodeMCU; Servo motor; Smart house

Paper ID: IRCUWU2022-400

Development of an IoT based automated colony counter

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Microorganisms are small-sized organisms that cannot be seen without a microscope. They grow on solid media as colonies. A colony is defined as the visible mass of microorganisms originating from a single mother cell. Recent studies have shown that temperature, humidity, time, and many other factors affect the growth of microorganisms. Scientists use incubators which are insulated enclosures to regulate humidity, temperature, and other environmental conditions at optimal levels for the growth and reproduction of microorganisms. When considering microbiological research, most depend on an accurate count of bacterial and fungal colonies. Colony forming unit (CFU) is indispensable in estimating microbial content, measuring cytotoxicity, and functions of specific genes. Therefore, researchers have to enumerate these colonies manually. Traditional manual methods are time-consuming, tedious, and error prone. A colony counter is an instrument used to count microbial colonies on a petri dish. Some automated colony counters based on image processing techniques are already available in the market. Not only that, some researchers have developed algorithms and methods to enumerate the microbial colonies count. However, in all these colony counters, researchers have to move the petri dish to the colony counter from the incubator to count the colonies. When researchers want to enumerate colony counting several times, it is subjective, and the changing environmental conditions have highly affected the growth of microorganisms and the final result of research. Therefore, this paper introduced an IoT-based automated colony counter that can place inside the incubator as well as enumerate and upload colony counting data to a web server (Google Drive API and Google Sheet API) in real-time using an IoT-based (WIFI) ESP32 camera module and video processing (OPEN-CV Python), with interfaces (PyQt5) using the laptop-computer to evade the problems mentioned above. The 3-D model of the counter was designed using CAD software and printed using the 3-D printer with PLA material. This device is the world's first real-time updating IoT-based automated microbial colony counter that can be placed inside the incubator with a dedicated application for distanced monitoring. The accuracy of the novel colony counter was above 95% in identifying and counting colonies and it is more accurate compared with the manual colony counters.

Keywords: Colony counter; IoT; IoT-based automated microbial colony counter; OPEN-CV; Video processing

Paper ID: IRCUWU2022-407

Recognition of Sinhala machine-printed text for postal address interpretation and postal automation

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While other Sri Lankan sectors are automating, the Sri Lankan postal system still uses manual intervention for mail sorting and processing. It takes more time to sort the mail according to the postal codes in the central nail exchange, even with the staff having a lot of experience and with the high number of employees while working overtime. The Sinhala language is used by the majority of Sri Lankans in their daily lives. On the other hand, less research has been done on Sinhala letter identification. Several systems have been established for this purpose in other languages including English. However, these types of systems are not available much in Sinhala due to the complexity of the language. Still, the findings have not been highlighted except in the above-mentioned research. Optical Character Recognition (OCR) and image processing technologies were used in the proposed system to recognize Sinhala printed addresses. The Google Tesseract was utilized to produce better optimal results faster and more accurately. Training, testing, and validation were done for the images taken from the printed postal envelopes. The model was trained and tested using the image data obtained under various criteria. Out of 15 Sinhala fonts, this system had an accuracy of 86.67%. A particular type of format was used to write the given addresses. This system can be expanded to include other formats in the future to automate the postal address classification system completely.

Keywords: Image processing; Machine learning; Postal address sorting; Sinhala OCR

Paper ID: IRCUWU2022-420

Design and development of mobile solar dryer for food drying

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Since ancient times, sun drying was used to extend the shelf life of certain food items. The method was simple and the food items to be dried was kept for extended time on an open space under the direct sun light. Lately, greater emphasis was given to use solar energy sources in this process due to the high prices and shortages of fossil fuels. However, the method has its drawbacks. Large space is required for this type of drying and it is difficult to protect food materials from insects. Uniform drying is a challenge attached to traditional sun drying. Additionally, the method is weather dependent. In most cases, there is no shelter available in an event of rain. To overcome these difficulties and at the same time harness the solar energy for the food drying process, various solar dryers are used extensively. However, most of these methods are attached with inherent drawbacks. Portability, compact size, and high cost of manufacture are few main concerns of these methods. Therefore, addressing these issues, it was proposed to construct an energy efficient portable solar dryer which could be manufactured using local material at a reduced cost. This project presented the design and construction of a domestic passive solar dryer. The dryer was composed of a solar collector, air heater and a solar drying chamber constraining rack of three net trays both being integrated together. The air allowed in through the air inlet is heated up in the solar collector and channelled through the drying chamber where it is utilized in drying. At the end of the design, a simulation was done as to monitor the capacity of drying and results suggested an economical drying action.

Keywords: Convection; Food dryers; Preservation of food; Solar energy; Solar radiation

Paper ID: IRCUWU2022-429

Development of wind turbine system for electric and hybrid cars

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Electric and hybrid vehicles are emerging as solutions to fossil fuel shortages. However, to travel a long distance, battery power may be insufficient, and electric car recharge durations may be lengthy. Previous research on wind turbine technologies had a direct impact on the appearance of the car. This research paper studied the development of a vehicle-mounted horizontal axis wind turbine for use in electric and hybrid vehicles. In the research horizontal axis, Archimedes wind turbine was used since it can effectively handle the urban wind conditions and it further has the property of drawing air stream into the turbine. Two air turbines will be mounted on the front bumper. These air turbines are expected to use wind energy to charge the battery of the electric or hybrid vehicle and increase the driving range. The objectives were to design the wind turbines, a sedan-type car that was modified and that could be simulated and tested in the field. Five-blade and three air foil wind turbines were developed using Qblade software. The Archimedes wind turbine models were then developed using Solidworks software. The drag force increased as the Archimedes wind turbine angle increased. The rotation speed decreased as the angle decreased. As a result, two separate average values were used. The size and number of wind turbines were determined by the type of the automobile and the size of the front bumper. The three-blade Archimedes wind turbine gave a better power coefficient and aerodynamics performance. The same turbine was tested in the field and showed positive results. As a limitation of this study, it was found that the wind turbine-mounted vehicle was not performing well under flat and ascending road conditions due to drag force on the vehicle. Therefore, vehicles with wind turbines can operate effectively when the car is descending. Further, the turbine system can also operate effectively while the vehicle is stopped since it can operate at low wind speeds and can operate while breaking the car.

Keywords: Archimedes wind turbine; Electrical cars; Horizontal wind turbine; Hybrid cars

Paper ID: IRCUWU2021-488

Design of micro-scale wind turbine for low-speed applications

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Usage of renewable energy plays a vital role due to the increasing economic, social, and environmental challenges posed by the use of fossil fuels. In this context, wind energy can be considered a better alternative energy resource. The main objective of this research was to design a micro-scale Horizontal Axis Wind Turbine (HAWT) that can be installed on rooftops or slowly moving vehicles such as bicycles, sailboats etc. This five-bladed wind turbine was designed using Q-blade software. The developed wind turbine model was then tested against varying wind speed conditions. To achieve the optimum design for the wind turbine, different blade geometries were analyzed using the blade element momentum concept. The optimized design for the five-blade wind turbine was then derived with the critical specifications of 0.78 m diameter, 3.9 cm hub radius and 6.5 tip-speed ratios. The turbine has 435 W power output, 85.3% efficiency and 0.445 power coefficient at a wind speed of 12 m/s. This design can be used effectively for micro-level power applications like charging low-power devices.

Keywords: 3D printing; Five bladed; HAWT; Renewable energy; Wind energy

ENVIRONMENTAL SCIENCES

Paper ID: IRCUWU2022-107

Public perception on controlling plastic pollution: A case study in Modara, Sri Lanka

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Plastic pollution is a growing global issue where its abatement requires lifestyle alternatives and public behavioral change. As an island, Sri Lanka faces a broader degree of plastic pollution across its coastal and marine regions. In this regard, human consumption reduction and management and/or control of daily plastic usage play key roles in managing such environmental issues. Thus, understanding public perceptions about plastic pollution could be a valuable source to eradicate this. This study aimed to understand and evaluate the public opinions on plastic pollution and the sociodemographic factors regarding the issue in the coastal areas of Modara, Sri Lanka. The study was performed with a structured questionnaire survey targeted toward the coastal community (n=100) in the selected site. The majority of the respondents (78%) stated that they dispose different plastic wastes of which 92% is polyethylene. While 76% of them dispose their waste after segregation to the municipal collection center, none practice reusing or recycling. In addition, 82% of the community was aware of plastic pollution whereas 74% of them had been actively involved in beach clean-ups. Overall, results showed that there is a general awareness about plastic pollution among the respondents. The data from this study could help understand public behavior and awareness and facilitate authorities to take proper actions involving increasing community awareness to foster plastic pollution abatement.

Keywords: Awareness; Coastal; Marine; Plastic pollution; Pollution abatement; Public perception

Paper ID: IRCUWU2022-177

Microplastic pollution in Beeralla stream (a tributary of Kirindi Oya) in Badulla District, Sri Lanka

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Beeralla stream is a tributary of Kirindioya, which flows through Ella, a quaint city and popular tourist destination in Uva Province. The stream is highly susceptible to microplastic pollution from tourism-based and domestic activities. The present study intended to assess the levels of microplastic pollution in the surface water of the Beeralla stream. After identification of different land use patterns by a preliminary survey and Google Earth Pro, five sampling sites were selected for the study. Surface water samples were collected from March to December 2020, and microplastic levels were determined using the wet peroxide oxidation method. Results revealed that microplastic density was between the average count of 5–12 Nos/L. The spatial variation of mean microplastic density levels was not significant ($p>0.05$); however, the temporal variation of microplastic levels was significant ($p<0.05$). Out of all the samples, the dominant class of particle size was 1.0–1.5 mm (22.30%), followed by 1.5–2.0 mm (16.22%). The major proportion of microplastics was identified as filaments: microfibers (99.32%) in the water samples. Synthetic textiles could be the major source of microfibers, which are discharged by household activities and commercial operations of hotels and restaurants through greywater including laundry water and sewage. The most common colour categories of identified microplastics were blue (30.26%), followed by black (21.05%), transparent (23.03%), red (7.89%), green (3.29%), white (7.89%), yellow (5.26%), and purple (1.32%) across all the microplastics. However, colour categories of microplastics did not vary significantly between samples, either spatially or temporally ($p>0.05$). Survey results further confirmed that 80% of hotels and restaurants directly discharge untreated wastewater into the stream. Further, nearby dumpsite within 1 km of vicinity could result in surface water contamination. Accordingly, solid waste mismanagement and uncontrolled discharge of untreated wastewater were the major sources of microplastic pollution in this freshwater ecosystem. In conclusion, all study sites of the Beeralla stream were contaminated with microplastics. Our findings may be used as reference or baseline data for the identification and comparison of plastic contamination of freshwater ecosystems in Sri Lanka.

Keywords: Freshwater ecosystems; Microfibers; Waste mismanagement

Paper ID: IRCUWU2022-193

How do morphological adaptations comfort the Guppy's (*Poecilia reticulata* Peter 1859) survive?

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Successful establishment of invasive species in a range of habitats has often been reported in Sri Lanka. Hence, understanding factors related to their invasiveness are important. Guppies (*Poecilia reticulata*) have been introduced to Sri Lanka for natural control of Malaria mosquitoes. However, due to rapid distribution, they are known to be an invasive species. Such species may exhibit spectacular adaptive potentials to novel environments by changing their morphology, life-history traits, or behavior. Understanding those local adaptations of the different populations can provide important insight to control their potential invasiveness. In this study, we attempted to quantify possible morphological adaptations for their potential invasiveness using the geometric morphometrics approach. Guppies were collected from three distinct locations (P1: drainage canal in Kaluthara, P2: drainage canal in Kurunegala, P3: Uma oya in Welimada) with varying levels of predation pressure and habitat characteristics. Ten landmark coordinates on the body of mature male guppy (n=180) were digitized and all coordinate configurations were adapted for size correction (i.e. Procrustes superimposition). The size-free shape variables were used for multivariate analyses. The results revealed that P3 was significantly different (p<0.05) from other two locations where low predation pressure was observed. Guppies at high predation (P3) showed a streamlined body and elongated caudal peduncle which could be adaptive for enhancing the swimming performance against predators. However, these adaptations could also be attributed to other environmental factors. Moreover, guppies found at high predation had a comparatively sub-terminal mouth which enables them to adapt to the pelagic feeding habit. In contrast, guppies at polluted drainage canals (P1 and P2) had supra-terminal mouth, seems they have adapted to respiration at the water column due to hypoxic conditions. Our findings demonstrated that guppies appear to have an extent of body shape that may favor their potential invasive success. Observed adaptive changes might be combinations of environmental factors, hence, further studies are required to assess the dominant invasion potential factors of guppies.

Keywords: Adaptations; Geometric morphometrics; Invasiveness; Morphology; *Poecilia reticulata*

Paper ID: IRCUWU2022-202

Microplastics in cosmetics and personal care products: First study from Sri Lanka

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Microplastic pollution has become a global environmental problem in past few decades. There are growing evidences of new microplastic emission pathways, abundance, and their consequences. Cosmetics and personal care products are one of the potential sources of microplastics and due to the adverse impacts of microplastics, 14 countries in the world has banned the usage of microbeads in personal care products and cosmetics. However, in Sri Lankan context, there is no such policy or scientific studies to support the development of relevant polices. Therefore, the present study will fill that void and act as the first scientific study to identify and characterize microplastics in cosmetics and personal care products in Sri Lanka. This study was based on five categories of personal care and cosmetic products (face wash [FW], facial scrubs [FS], baby creams [BC], shaving creams [SC], and skin creams [SK]). Three highly utilized brands from each category were selected and three samples were taken from each brand through a questionnaire survey. All samples (n=45) were treated with fenton reagent and potential microplastics were extracted. As a preliminary screening process, Nile Red staining was used to eliminate non-microplastic containing products. Each of the Nile Red stained particles was observed using ultraviolet light and if luminesce properties were observed such particles were suspected to be plastics. In order to confirm the chemical composition and the accuracy of the Nile Red staining, extracted particles were subjected to FT-IR spectroscopy. Seven out of the fifteen brands showed luminesce nature under Nile Red staining, and only six were confirmed to be plastics according to FT-IR analysis. Low-density polyethylene and ethylene-propylene copolymer were the dominant plastic types among recorded particles. Among the 15 brands, isolatable microplastics were found in FS-01 and FW-03, at 3.3 and 0.15 g/product, respectively. The present study provides a much needed insight into the availability of microplastics in personal care and cosmetics products in Sri Lanka. Therefore, the study results could be used as a baseline research for future studies and policy development activities.

Keywords: Cosmetics; FT-IR; Microplastics; Nile red staining; Personal care products

Paper ID: IRCUWU2022-205

Rainfall trends in Northern and Eastern coastal belt of Sri Lanka from 1980 to 2020

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The dry zone region of Sri Lanka is highly responsible for agricultural activities, especially paddy cultivation. The success of agriculture basically depends on the timely and adequate rainfall and the patterns of the rainfall. Northern and Eastern coastal belt of Sri Lanka receives heavy rainfalls during the second inter-monsoon (SIM) and Northeast monsoon (NEM) seasons. Due to the hydrological and topographical variations, certain areas along this belt suffer from frequent floods as well as droughts. This creates different socio-economic problems and crop failures. Therefore, studying the rainfall pattern and trends in this area are important for planning agricultural, civil engineering, and other socio-economic activities. This study was focused on studying the rainfall patterns and trends in the Northern and Eastern coastal belts of Sri Lanka during the past four decades. Daily rainfall data for past 40 years (1981-2019) at five gauging locations (Jaffna, Kannukkerni tank, Trincomalee, Batticaloa, and Pottuvil) were collected from the Department of Meteorology, Sri Lanka. Annual and four seasonal *viz*, first inter-monsoon (FIM), South West monsoon (SWM), second inter-monsoon (SIM) and North East monsoon (NEM)) rainfall data were plotted against the time and a five-point moving average curve was fitted for studying the general rainfall pattern. Annual and seasonal rainfall trends were detected by Mann-Kendall statistics and the magnitude of the trend was calculated by Sen's Slope estimator. Finally, regression models were developed for data series. Results revealed that Kannukkeni tank and Batticaloa had similar rainfall pattern during the SIM while Trincomalee and Batticaloa had similar pattern during the NEM. Rainfall patterns of Jaffna were totally different from those. All the stations showed positive trends in the annual rainfall except Jaffna. Batticaloa showed significantly increasing trend in annual rainfall (17.46 mm/year) and in SIM season (7.34 mm/year). It can be concluded that the annual rainfall of Eastern coastal belt of Sri Lanka is increasing while it is decreasing in the far Northern coastal belt.

Keywords: Annual and seasonal rainfall trends; Mann-Kendall statistics; Moving average curve; Sen's slope estimator

Paper ID: IRCUWU2022-229

Public perceptions of the use of native plants in landscaping

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The incorporation of native plants in landscaping is an important aspect of achieving sustainable landscapes. It has the potential to increase the ecological and economic values of the environment. Even though Sri Lanka has a large number of native plants, there is a low demand for native plants among the customers. Hence, exotics are purchased and maintained unknowingly in most the residential gardens, due to limited knowledge of natives. Therefore, this study was carried out in the Diyataha Flower Market, the largest garden centre for ornamental plants in Sri Lanka, to analyse consumers' knowledge, attitudes, and practices concerning the use of native plants. The socio-demographic information, knowledge, attitudes, and practices of 147 customers on the use of native plants in landscaping were collected using a pre-tested interviewer-administered questionnaire. The association between purchasing native plants and demographic parameters, knowledge, attitude, and practice of the respondents were tested using the Pearson chi-square test. The majority of participants (91.1%) had a highly favourable attitude towards native plants. However, only 34% had purchased native plants for landscaping purposes. The results revealed that the occupation (p=0.034), landscaping practice (p=0.003), attitudes (p=0.049), and the respondents' knowledge of native plants (p=0.008) significantly influence the purchasing intention of native plants for landscaping. Limited diversity (61.9%), poor knowledge of native plant species (51.7%), and unavailability of native plants in the nurseries (29.9%) were recognized as the main reasons for not purchasing native plants. Among the respondents, only 42 % denoted a low preference for using natives in their home gardens. However, insect attraction was marked by only 3.4% of respondents as a reason for purchasing native plants. This suggested a limited interest in the concept of wildlife gardening and pollinator conservation among the respondents. This indicateed that while individuals favour native plants in principle, they do not prefer incorporating them in landscaping. Therefore, educating the general public and school children is a timely requirement to promote native plants in landscaping to design and develop sustainable landscapes in Sri Lanka.

Keywords: Knowledge; Native plants; Public perception; Sustainable landscapes

Paper ID: IRCUWU2022-232

Application of drone (UAV) technology for mapping seagrass beds compared to high-resolution Sentinel-2 satellite images

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Seagrass ecosystems play an important role in primary production, carbon storage, coastal protection, fisheries, tourism, etc. However, mapping seagrass beds are much more difficult with the depth of the water column, water clarity, and the state of the sea. Therefore, a study was developed to compare seagrass mapping by high-resolution Sentinel-2 satellite imagery and unmanned aerial vehicle (UAV) drone imaging technology. Two reasonably large seagrass beds, Adukkuparu and Salli Beach, contain only two similar appearing seagrass species (*Thalassia hemprichii* and *Cymodocea rotundata*) on the East coast of Sri Lanka. For UAV drone imaging, a DJI Mavic Air 2 drone (20 m altitude, 5 ms^{-1} speed) was used, and the GPS path was created with the Litchi mobile app. The Drone Deploy website was used to create orthomosaic maps. Extraction, supervised classification, and unsupervised classification methods were performed by ArcGIS 10.8 software to distinguish seagrass patches from survey locations for both drone and satellite imagery maps. A field survey was conducted to collect valid data points (200 reference points) from both sites to calculate overall and Kappa accuracy. For drone mapping in Adukkuparu, the overall accuracy of 49, 38, and 91% and kappa accuracy of 23, 22, and 79% were resulted for supervised classification, unsupervised classification, and extraction, respectively. For drone mapping in Salli beach, the overall accuracy of 70%, 61%, and 93% and kappa accuracy of 58, 45, and 82% were resulted for supervised classification, unsupervised classification, and extraction, respectively. For Sentinel-2 image mapping in Adukkuparu, the overall accuracy; of 71, 38, and 53% and kappa accuracy of 54, 18, and 2% were obtained for supervised classification, unsupervised classification, and extraction, respectively. For Sentinel-2 image mapping in Salli beach, the overall accuracy of 73, 53, and 41% and kappa accuracy of 57, 2, and 8% were obtained for supervised classification, unsupervised classification, and extraction, respectively. Therefore, the extraction method for drone mapping and the supervised classification for Sentinel-2 imagery were the best methods for seagrass mapping under above-mentioned conditions.

Keywords: Drone images; Orthomosaic; Seagrass meadows; Sentinel-2

Paper ID: IRCUWU2022-236

Microplastic pollution of coral reef ecosystems in the Eastern coast of Sri Lanka

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Marine microplastics are ubiquitous in every mere corner of the ocean from surface waters to deep sediments. Even though the threat of marine microplastic pollution has become a global concern, very little attention has been paid to microplastic pollution in coral reef ecosystems in Sri Lanka. The present study investigated the abundance and characteristics of microplastic (0.1 - 5.0 mm) in surface water, surface sediments, and scleractinian coral species belonging to three genera (*Acropora*, *Pocillopora*, and *Montipora*) at six coral reef ecosystems (Pasikudah, Kalkudah, Adukkuparu, Pigeon Island, Kayankerni, and Salli beach) in the Eastern coast of Sri Lanka. Microplastics were isolated under laboratory conditions using standard methods. Isolated microplastic was quantified in terms of abundance, shape, size, color, and polymer type followed by FTIR analysis. Results confirmed that surface water, surface sediments, and corals were contaminated with microplastic. The average abundances of microplastic in surface water and surface sediments were 11.98±2.01 items/m^3 and 42.22±5.94 items/kg (dry weight), respectively. The average abundance of microplastic in three genera of corals *Acropora, Pocillopora,* and *Montipora* were 668.7±169.7 items/kg, 579.23±143.8 items/kg, and 228±73.3 items/kg, respectively. The most abundant color and shape of microplastic in water, sediments, and corals were blue coloured fibers. Moreover, out of all microplastic found in water and corals, over 58% were large microplastic (1–5 mm) while 59.21% were small microplastic (0.1–1 mm) in sediments. Low density polyethylene (42.73%) was the most common type of polymer found in surface water, sediments, and corals. Corals of genus *Acropora* exhibited to accumulate high amount of microplastic compared to the other two genera of corals. Furthermore, there were no significant differences (p>0.05) in microplastic abundance between sampling sites of surface water, sediments, and corals. The significant differences (p<0.05) in average microplastic abundances among the coral species suggested that microplastic accumulation in corals could be species-specific. These results infer that coral reef ecosystems in the Eastern coast of Sri Lanka are contaminated with microplastic and Scleractinian corals pose a potential sinker for floating microplastic in coral-dominated areas.

Keywords: Acropora; Microplastic pollution; Montipora; Pocillopora; Scleractinian corals; Threats to coral reefs

Paper ID: IRCUWU2022-240

Long term variations of sea surface temperature in the Exclusive Economic Zone (EEZ) and the territorial sea of Sri Lanka from 2003 to 2021

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Sea surface temperature (SST) is considered an essential climate variable by the World Meteorological Organization as it is a strong indicator of climate change. On top of that, with the changes in SST, several other oceanic physicochemical and biological variables change. Being a tropical island, Sri Lanka may have a significant impact of SST variation on its economy, marine biodiversity, weather, and climate, and it can be determined by analyzing long-term SST variations. However, a long-term analysis of SST in the Indian Ocean around Sri Lanka has not been reported well previously. This study investigated the long-term SST pattern in the two maritime zones, the Exclusive Economic Zone (EEZ) and the Territorial Sea of Sri Lanka from 2003 to 2021, using the Moderate Resolution Imaging Spectroradiometer (MODIS)-Aqua and Terra Level-2, 11µm daytime sea surface temperature data, as four images each month. The satellite images were geocoded and re-projected using SeaDAS 7.5.3 software. ArcGIS 10.8 software was then used for image processing and data extraction. The results showed that during the past 19 years, mean SST of the EEZ and the Territorial Sea are 26.43±0.96°C and 27.28 ± 0.10°C, respectively. Statistically significant positive trends were recorded in the mean SST as 0.050°C/yr in the EEZ and 0.041°C/yr in the territorial sea at 95% confidence level. During the study period, the maximum mean SST of the EEZ (27.20°C) was observed in 2020 and that of the Territorial Sea (27.88°C) was observed in 2015. The year 2008 was the year of minimum mean SST of both the EEZ (25.65°C) and the Territorial Sea (26.53°C). Throughout the period, the mean SST of the Territorial Sea is significantly (p<0.05) higher than that of the EEZ. Frequent marine heat waves, global warming, changing wind speeds, and ocean-atmosphere coupled climate phenomena may be the major causes of SST elevation and fluctuations. However, it needs to be further investigated through future studies.

Keywords: Climate change; Maritime zones; MODIS; Sea surface temperature; Trend

Paper ID: IRCUWU2022-248

Optimization of bacteria consortium to reduce COD in landfill leachate: Step toward a green economy

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Landfill leachate (LFL) is one of the highly contaminated wastewater types with very high chemical oxygen demand (COD). The COD is a critical water quality parameter that refers to the amount of oxygen equivalent to oxidizing organic matter with strong chemical oxidants. The LFL with high COD causes a number of environmental problems. Therefore, the present study was carried out to develop a low-cost bacteria consortium to reduce the COD of LFL as a green approach. The bacterial consortium (ABC) was prepared using three bacterial strains (A, B, C) isolated from soil, leachate, and solid waste at Karadiyana control open dump site that showed more than 50% of initial COD reduction. The prepared consortium was optimized under different pH conditions and temperatures and with different Co-factors. The metal catalyst ions of Fe^{+2}, Ni^{+2}, Cd^{+2}, Cu^{+2}, Co^{+2}, and Zn^{+2} were introduced to sterilized leachate sample in four different concentrations including 1, 0.1, 0.01, and 0.001 ppm. The results indicated that the optimum pH and the temperature for the efficient COD removal were 6.80±0.2 and 30.5±0.5^{o}C, respectively. The consortium introduced to the control sample reduced the COD of leachate to 55.5±1% under 14 days of period without having any co-factors. Interestingly, out of the introduced co-factors, the Cu^{+2} with 0.01 ppm had reduced the COD of the sample significantly while achieving the COD reduction of 72.52±1% for 14 days under 30.5± 0.5^{o}C temperature. In contrast, the sample which introduced Cd^{+2} and Zn^{+2} could remove the COD only up to 38±1% and 44±1%, respectively by suppressing the biochemical reactions of the consortium bacteria. Hence, the prepared bacterial consortium can be used effectively to reduce the COD of LFL, and further studies are in progress on the characterization of specific enzymes to formulate a green microbial solution.

Keywords: Bacteria consortium; Biological treatment; Chemical oxygen demand; Enzyme co-factors; Landfill leachate

Paper ID: IRCUWU2022-278

Water quality and microbial contamination status of ground and surface water in high prevalence chronic kidney disease of uncertain aetiology (CKDu) areas in Anuradhapura District, Sri Lanka

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During the past few decades, water resources have been subjugated towards anthropogenic activities such as municipal water supply for drinking and household usage, power generation, agriculture, food production, etc. Around 60% of Sri Lanka's population depends on shallow dug wells for water, while the rest relies on surface water reservoirs. Catchment characteristics, anthropogenic activities, and land usage practices may influence the quality of ground and surface water. The study aimed to identify the consumable water quality in the human settlements and the high prevalence chronic kidney disease of uncertain aetiology (CKDu) areas in Anuradhapura district. The present study identified the microbial and physio-chemical characteristics in 35 sources (27 groundwater and 8 surface water). All the sampling and laboratory analyses were conducted following the standard protocols. The results of the study showed that 19 locations were contaminated with fecal and coliform bacteria including 2 surface water reservoirs and 17 groundwater wells were not compatible with Sri Lankan Standards (SLS) and World Health Organization (WHO) drinking water quality standards. The reservoir water pH was around 8.00 except for Balaya Wewa-Padaviya (6.53). The groundwater pH (7.84-6.34) was within the acceptable levels according to the water quality standards with minimum variations. The highest electrical conductivity was recorded from Negampaha-Medawachchiya (2640 µS/cm), showing high conductive ions from dissolved salts and inorganic materials. Total nitrogen concentrations in the study area were below the acceptable ranges according to the SLS drinking water quality standards for ammonia (0.05 mg/L), nitrate (50 mg/L), and nitrite (3 mg/L). The highest alkalinity was recorded at Negampaha-Medawachchiya as 322.00 mg/L, and the majority of the total hardness levels in the sampling locations exceeded the SLS drinking water quality standards, while Rajanganaya-Yaya-1 recorded the highest concentration of total hardness (644 mg/L). The results expressed that the majority of the water bodies had high mineral and metallic compounds that may influence human health with an effect on internal organ damage. Catchment areas are high prevalence hotspots for the CKDu, and the unacceptable levels in the quality of drinking water could cause kidney damage.

Keywords: Anuradhapura district; CKDu; Ground and surface water; Microbial contamination; Water quality

Paper ID: IRCUWU2022-315

Microbial analysis of well water contamination in Nallur area of Jaffna District, Sri Lanka

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Waterborne diseases caused by pathogenic organisms are associated with the consumption of contaminated water and only limited studies are available in the literature on well water contamination in Jaffna district. Therefore, in this study bacteriological analysis of domestic well water in Nallur Divisional Secretariat, Jaffna was performed to identify the level of contamination. A total of 20 well water samples together with the relevant details such as the distance between the well and pit latrine and hygienic conditions of the well were collected. Bacterial species were identified on Xylose Lysine Deoxycholate agar based on morphology and biochemical tests and the total bacterial count was determined. The factors that influence the total bacterial count were analyzed using the Chi-square test. A correlation analysis was performed to find the association between the distance of the well from the septic tank and bacterial count. It was found that all the studied samples were contaminated with coliforms and pathogenic bacteria and the total count varied from 860-8820 CFU/mL, which indicates a severe degree of contamination. Nine different bacterial species: *Klebsiella, Enterobacter, Escherichia coli, Salmonella, Shigella, Citrobacter, Yersinia, Serratia,* and *Acinetobacter* and 72 bacterial isolates were identified. More than half of 72 isolates (56.9%) belonged to the coliform group indicating recent faecal contamination. Nearly 56% of the isolates (*Salmonella, Shigella, Klebsiella, E. coli, Yersinia,* and *Acinetobacter)* had the pathogenic potential. The total bacterial count had an inverse correlation with the distance of the toilet from the well (R^2=0.506). The presence of pathogenic bacteria in the well water with a high degree of contamination implicit the study area was at great risk for human health and therefore, proper preventive measures need to be adapted to disinfect the water before direct human consumption.

Keywords: Bacterial analysis; Coliforms; Contamination; Pathogenic potential

Paper ID: IRCUWU2022-319

Structural complexity of tropical seaweeds as a determinant factor for macrofauna abundance

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The role of structural complexity on macrofaunal abundance in seaweeds is known for few temperate seaweeds, however such studies are scanty for tropical regions including Sri Lanka. Filling this study gap was the main aim of the current study. According to the literature, the fractal dimension, which is a numerical indicator of complexity, can be taken as a measurement of the structural complexity of seaweeds. Based on this concept, three replicates from each of the three seaweeds; *Halimeda opuntia*, *Padina boergesenii*, and *Gracilaria sp.* were randomly harvested from the intertidal zone of Parawi Wella, Tangalle in February 2022. The macrofauna abundances were microscopically counted for each replicate with the help of identification keys. Each replicate was clearly photographed laying its total surfaces on a flat surface. Fractal dimensions based on area (Da) and perimeter (Dp) for each above Image were separately obtained using the ImageJ software. A total of 32 different fauna types were identified. According to the Kruskal-Wallis test, the highest mean total macrofauna abundance (MTMA) per species was recorded (p<0.05) in *H. opuntia* (70±16.09) followed by *P. boergesenii* (19.7±7.57) and *Gracilaria* sp. (13±2.00). Based on one-way ANOVA, the MTMA per gram of seaweed (wet weight) was higheer (p<0.05) in *P. boergesenii* (2.9±0.19) than in *H. opuntia* (1.8±1.18) and *Gracilaria* sp. (0.5±0.14). The MTMA per gram of dry seaweeds was higher (p<0.05) in *P. boergesenii* (13.7±1.66) than in *H. opuntia* (5.9±3.24) and *Gracilaria* sp. (1.4±0.83). Based on Da, the highest structural complexity was reported (p<0.05) in *P. boergesenii* (1.92±0.012) followed by *H.opuntia* (1.80±0.017) and *Gracilaria* sp. (1.69±0.034). The Dp was higher (p<0.05) in *Gracilaria* sp. (1.20±0.02) than in *H. opuntia* (1.17±0.01) and *P. boergesenii* (1.04±0.01). There were positive trends (p<0.05) between Da and MTMA per gram of seaweed wet weight. Thus, the structural complexity and macrofauna abundance showed a rather positive association highlighting the structural complexity as a determinant factor of macrofauna abundance in the above three tropical seaweeds.

Keywords: Fractal dimension; Macrofauna abundance; Seaweed; Structural complexity

Paper ID: IRCUWU2022-330

Purification, characterization, and *in vitro* photoprotective potential of melanin-like pigment isolated from *Hypoxylon* spp.

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Melanins are widespread pigments present in all kingdoms with multidimensional bioactive and biotechnological applications. Fungal melanin serves as a strategy to protect itself from harsh environmental conditions like ultraviolet (UV) light, ionization radiation, and oxidizing agents. *Hypoxylon* spp. is one of the strongest melanin producers in the fungal kingdom. However, the structure of this pigment is poorly defined due to its insolubility in water and in organic solvents. This study aimed at isolation, purification, preliminary characterization, and determination of the *in vitro* photoprotective ability of dark brown to black melanin-like extracellular pigment produced by *Hypoxylon* spp. (isolate DD 38) isolated from decaying hardwoods in Sri Lanka. To isolate the extracellular fungal pigment, the Saboroud Dextrose broth supplemented with chloramphenicol (25 µg/mL) was inoculated with mycelial plugs obtained from actively growing edges of a seven-day-old fungal culture. The crude melanin pigment was isolated using harsh acid-alkaline treatment of the mycelia-free culture obtained after the incubation at room temperature for 28 days on a rotary incubator operated at 100 rpm. The recovered melanin was then dried and further purified by treating it with distilled water, chloroform, ethyl acetate, and absolute ethanol and analyzed by UV-visible spectrophotometry, FT-IR and SEM. The preliminary characterization of the pigment showed that the dried pigment was only soluble under basic conditions, while it was completely insoluble under acidic conditions and in organic solvents. The pigment was decolorized when treated with H_2O_2 and $KMnO_4$. The UV-visible spectrum of the pigment showed a monotone increase in absorption at shorter wavelengths, which is a hallmark of the UV spectrum of the melanin pigment. The FT-IR spectrum obtained with the KBr method also gave characteristic bands of the melanin pigment. Scanning electron microscopy revealed that the pigment contains amorphous structures with irregular shapes. The *in vitro* Sun Protection Factor (SPF) analysis showed that the fungal melanin has impressive UV-B protective ability with an SPF value of 29.30±0.14 at a concentration of 0.2 mg/mL at pH 8. As the dark brown to black pigment produced by *Hypoxylon* spp. showed characteristic features of melanin-like pigment with the photoprotective property it has the potential to be a new source for the development of sunscreen formulations.

Keywords: Colorant; Fungal pigments; *Hypoxylon* spp.; Melanin; Photoprotection

Acknowledgment: Financial assistance provided by the National Research Council, Sri Lanka (NRC ID Grant No: 20–051) is acknowledged.

Paper ID: IRCUWU2022-373

Soil carbon mineralization in Kanneliya and Pitadeniya tropical rainforests in Sri Lanka

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Tropical rainforests (TRFs) play a vital role in the global carbon (C) cycle. Understanding spatial variation in soil C mineralization in TRFs is crucial to determining the net C balance. The objective of the present study was to determine variation in soil C mineralization rate along an elevation gradient in Kanneliya and Pitadeniya TRFs in Sri Lanka. Soil samples were collected up to 25 cm depth from four different permanent sampling plots (PSPs) in a long term experiment: 117 (Kanneliya-1), 174 (Kanneliya-2), 509 (Pitadeniya-1) and 618 above msl (Pitadeniya-2). A 60-day laboratory incubation study was conducted to investigate CO_2 evolution from TRFs soils. The amount of CO_2 trapped in the alkali solution was determined by titrating a 20 mL aliquot with standardized 1 N HCl after the addition of 5 mL of 0.2 N $BaCl_2$ solution. A blank trap was used in each run to correct for atmospheric CO_2. Basic soil physico-chemical properties *i.e*. pH, electrical conductivity (EC), redox potential (Eh), cation exchange capacity (CEC), organic carbon (OC) content, volumetric water content (VWC), bulk density and soil porosity were also determined. The results showed that there was a significant (P<0.05) effect of elevation on the rate of CO_2 evolution rate, cumulative CO_2 emission and some soil properties: soil pH, EC, Eh, CEC, OC and VWC. Pitadeniya-2 had the highest average CO_2 emission rate (50.2±10.2 mg C kg^{-1} soil day^{-1}) whereas Kanneliya-2 had the lowest (33.0±4.1 mg C kg^{-1} soil day^{-1}). The rate became stable after 30-50 days. Among the PSPs, Pitadeniya-2 had the highest cumulative CO_2 emission (3014 mg C kg^{-1} soil), followed by Pitadeniya-1, Kanneliya-1 and Kanneliya-2 (2342, 2199 and 1982 mg C kg^{-1} soil, respectively). There was a significant (p<0.05) positive correlation between cumulative CO_2 emission with OC content, EC, VWC and soil porosity. However, the cumulative CO_2 emission had significant (p<0.05) negative correlations with Eh and bulk density. In conclusion, the present findings suggest that CO_2 evolution showed a spatial variation in the tested TRFs and that variation is supported by the variation of soil physico-chemical properties of the PSPs.

Keywords: Tropical rainforests; carbon mineralization; CO_2 emission

Paper ID: IRCUWU2022-373

Microplastic pollution of surface waters in the Indian Ocean: A meta-analysis and ecological risk assessment

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Plastic pollution has been reported in all the oceans. Microplastics in marine waters may pose risk to the environment and human health. The Indian Ocean is the third-largest ocean in the world and bears the second-largest plastic load after the Pacific Ocean. The approach of this research was to understand the contamination state of microplastics in the Indian Ocean. The main objectives of this study were to identify microplastic pollution and determine the toxicity and hazardous effect of microplastics in surface waters in the Indian Ocean. Literature was filtered through Scopus, Web of Science, and Google Scholar databases, collecting articles from 2010 to 2022. After excluding 27 articles due to a lack of quality control and quality assurance procedures, 26 articles were included in this study. Concentrations of microplastics in the Indian Ocean ranged from 0.099 to 372,000 items/m^3. The abundance of microplastics in terms of polymer composition was polyethylene > polypropylene > polyamide > polystyrene > polyvinyl chloride. The abundance of plastic shapes followed the order fibers > fragments > films > filaments. There was no significant difference in the accumulation of microplastics between the Western and Eastern Indian Oceans (p>0.05). Polymer hazard index was calculated for ecological risk assessment of surface waters in the Indian Ocean. Hazard categories in the Indian Ocean were IV and V (Hazard category: IV; 100–1000, V; >1000). It was corresponding to the risk categories "danger" and "extreme danger", respectively. The results indicated that the microplastic concentrations across the Indian Ocean were in a wide range. microplastic risk increased with the presence of polyvinyl chloride and polyamide due to their high hazardous scores. The high level of fisheries-related activities in the Indian Ocean might be the reason for appearing fibers predominantly in the Indian Ocean. Overall results indicated that the surface waters of the Indian Ocean are in the high-risk category due to the elevated levels of microplastic pollution.

Keywords: Indian Ocean; Meta-analysis; Microplastics; Polymer hazard index; Risk assessment; Surface waters

Paper ID: IRCUWU2022-392

Screening for microplastics in surface water and sediment in Uma Oya, around Welimada area

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Inland freshwater is the main receptors and transport routes of microplastics to the marine environments. However, several studies have subjected to marine environment, limited studies are focused on the microplastic pollution of inland water bodies in Sri Lanka. This study focused on investigating the occurrence, quantification, and qualitative characterization of microplastics in surface water and sediments along Uma Oya around Welimada area. Five sampling sites were selected and surface water samples were collected by dragging the neuston type of floating net with an average mesh size of 300 µm along the surface water layer. Sediment samples were collected by using a stainless-steel scoop up to a depth of 5 cm below the surface of the sediment layer. The collected surface water and sediment samples were analyzed using standard methods (WPO) under quality assurance and quality control measures. The abundance, size, color, shape, and compound composition of microplastics were studied. At five sampling locations, the average abundance of microplastics was 13.90±3.49 items/m^3 and 7.66±3.01 items/kg for surface waters and sediments, respectively. Sampling locations had no significant difference (p>0.05) on the overall average microplastic abundance in surface water and sediments. Microplastics less than 1 mm in size consisted of 50.35% in surface water and 57.56% in sediments of the total number of microplastics. Fibers were the dominant shape category in both surface water (59.81%) and sediments (57.97%). The color categorization of microplastics indicated that black-colored particles were abundant in surface waters (44.52%) and sediment (44.92%) in Uma Oya. The microplastic type was further confirmed by Fourier-transform infrared spectroscopy (FT-IR). Polyethylene (40%), polypropylene (30%), polystyrene (10%), and polyvinyl chloride (10%) were the common polymer types identified using FT-IR. Based on the results of the litter survey carried out polythene packages were identified as the major plastic waste type. The study provides the insights of the microplastic pollution which can be used as the baseline information for future waste management approaches in the fresh water bodies.

Keywords: Fresh water; Microplastics; Sediment; Surface water; Uma Oya

Paper ID: IRCUWU2022-410

Possibility of using morphometric features of phytoliths of Zingiberaceae species in the research arena

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Phytoliths are the silica particles found in plants. These could be valuable contenders for the identification of plant taxa in taxonomic, archaeobotanical, and paleoenvironmental investigations due to their unique appearance and/or durability in the soil. The present study examined the morphometric features including the shapes of phytoliths in six Zingiberaceae species (*Alpinia calcarata*, *Alpinia galanga*, *Costus malortieanus*, *Costus speciosus*, *Curcuma aromatica*, and *Curcuma zedoaria*) in order to reveal their features of taxonomic significance and to quantify the amount of phytoliths in a unit plant weight in order to understand the potential availability of these in the soil. Phytoliths in leaves, stems, petioles, fruits, and flowers in three plants per above species were isolated using the wet oxidation method, their shapes were described using ICPN 2.0 nomenclature, and the mass of extracted phytoliths (per unit plant weight) were quantified. Results revealed that the shape of phytoliths allowed to distinguish the examined *Alpinia*, *Costus*, and *Curcuma* species to their respective genus. The shape of phytoliths did not vary with the plant part ($p>0.05$), but the average size of phytoliths varied with the plant part ($p<0.05$). This implies that the shape of phytoliths can be used to discriminate examined plants into the genus level but the size of phytoliths may not be a good indicator of taxonomic identification. Further, the quantity of extracted phytoliths significantly varied with the plant species ($p<0.05$), confirming the inability of predicting common plant genera in past vegetations based on the abundance of phytoliths of the respective taxa in the soil.

Keywords: Shape of phytoliths; Size of phytoliths; Taxonomic; Wet oxidation method

Paper ID: IRCUWU2022-437

Green synthesis of iron nanoparticles using aqueous extraction of Kata Kela (*Bridelia retusa*) leaves

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Green synthesis is a novel approach employed to produce metal and metal oxide nanoparticles. This novelty is gaining popularity as a simple and eco-friendly process. The green synthesis method simply refers to the synthesis of metal and metal oxide nanoparticles from the extract of plant materials. In this study, aqueous extract of the Kata Kela (*Bridelia retusa*) leaves was used as reducing and stabilizing agents in the synthesis of iron nanoparticles (FeNPs). At room temperature, the aqueous extract of the dry leaves of Kata Kela can reduce from Fe^{3+} into iron nanoparticles (Fe^0). The green synthesized iron nanoparticles were characterized by using scanning electron microscope (SEM) analysis, energy dispersive X-Ray (EDX) analysis, X-ray diffraction (XRD) analysis, and UV-visible spectroscopy (UV-Vis) analysis. The SEM images revealed that the particles appeared spherical in shape with a diameter range between 40-60 nm. The EDX analysis showed the presence of elemental iron and indicated that the nanoparticles were essentially present in metal form. The XRD spectrum showed four different diffraction peaks (2θ values) corresponding to the crystal planes of synthesized iron nanoparticles. The UV-visible analysis revealed the absorption peaks at the 255-285 nm region due to the excitation of surface plasmon vibrations of the FeNPs and the maximum peak was shown at 272 nm. The green synthesis technique using manufactured FeNPs can be used in a wide variety of industrial applications.

Keywords: Aqueous extract; *Bridelia retusa*; Green synthesis; Iron nanoparticles; Reducing agent; Room temperature

Paper ID: IRCUWU2022-458

Determination of toxic effect of fluoride ions using zebrafish (*Danio rerio*) embryo toxicity testing

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Fluorine is the most reactive element among halogens. Industrial waste water (glass, ceramic, steel, etc.) contains fluorides at higher levels. The ecotoxicity of fluoride ions and their impact on aquatic animals have been less studied in the Sri Lankan context. This study aimed to determine the acute toxic effects and median lethal concentration (LC_{50}) of fluoride ions using the zebrafish embryo (*Danio rerio*) model. Fish embryo toxicity (FET) test using wild-type zebrafish embryos was conducted according to Organization for Economic Co-operation and Development (OECD) Test Guideline 236. Sodium fluoride was used as the fluoride source in this study. Zebrafish embryos (21 embryos at 16 cell stage per concentration) were exposed for 96 h inside 24 well plates and 24-hourly mortality was recorded. Embryos exposed to a concentration range of 1 to 500 ppm (1, 5, 10, 50, 100, 200, 300, 400, and 500 ppm) were observed for apical endpoints (coagulation of embryo, lack of somite formation, lack of detachment of tail bud, and lack of heartbeat) for 96 h post-fertilization (hpf) which is known as after fertilization changes. LC_{50} value was obtained using a 100-300 ppm range (100, 150, 200, 250, and 300 ppm). Results showed 100% cumulative mortality after 200 ppm and less than 50% mortality below 100 ppm. Delayed hatching was observed over 50 ppm concentration. The effect of fluoride ions on zebrafish embryos can be divided into deformities before and after they hatch. Scoliosis and pericardial edema-like sub-lethal deformities were observed after hatched larval stages even at low concentrations such as 5 ppm. However, 100% mortality was reported within three to four days after hatching in all concentrations except 1 ppm. The LC_{50} value was 113.88 ppm (99.88–126.59 ppm) indicating a wide range of acute toxicity levels in zebrafish embryos. Based on the findings, fluoride acute toxicity affects severely on the survival of zebrafish although it has a wide toxicity margin.

Keywords: Ecotoxicity; FET test; Fluoride toxicity; Zebrafish embryo

Paper ID: IRCUWU2022-477

Contamination status of selected heavy metals in Kalu ganga river mouth and nearby coastal waters, Sri Lanka: A baseline study

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Heavy metals are considered one of the major threats to coastal and marine environments due to their toxicity, persistence, and bioaccumulation capability in aquatic ecosystems. The present study was conducted to determine the contamination status of some selected heavy metals in the Kalu Ganga river mouth and nearby coastal waters. Based on the random sampling technique, ten sampling locations were selected for the study. Four sampling locations were selected from the river mouth including two locations from each side of the river mouth bank. Six sampling locations were selected from the coastal water including three locations along the right-side coastline and three locations along the left-side coastline from the river mouth. Surface water sampling was carried out in September 2020, during the South-West monsoon season and February 2021, during the North-East monsoon season. The samples were subjected to the analysis of seven heavy metals including Fe (Fe^{3+}), Cr (Cr^{3+}), Zn (Zn^{2+}), Cu (Cu^{2+}), Mn (Mn^{2+}), Cd (Cd^{2+}) and Pb (Pb^{2+}) using atomic absorption spectrometry (AAS). The mean metal concentrations showed a dominance in order of Zn > Fe > Pb > Cu > Mn > Cr > Cd, respectively. Consequently, with the exception of Fe, Mn, and Cd, all other mean heavy metal concentrations were reported above the maximum permissible levels of proposed Sri Lankan coastal water quality standards under the categories of the fishery of shellfish, fishery of finfish, and non-consumption use. Cd was reported below the detection limit (<0.001 mg/L). Except for Pb, Mn, and Cd, all other selected metal concentrations were significantly different between the two seasons (p<0.05). The heavy metal pollution index (HPI) was calculated to illustrate the overall impact of heavy metal pollution in the study area by using proposed quality standards for each category, separately. The HPI values for the above three categories exceeded the critical level of HPI value (>100) indicating a high level of heavy metal pollution in the area. According to the calculated HPI values, the area is unsuitable for fishery of shellfish and finfish as well as for non-consumption use. Further studies including metal contamination of sediments of the study area are highly recommended. The findings of the study can be used in the implementation of coastal pollution control strategies in the study area.

Keywords: Coastal waters; Heavy metals; Kalu Ganga; Pollution index; River mouth

Paper ID: IRCUWU2021-571

Diversity and abundance of dragonflies and damselflies in Rambukpotha Oya tributary, Badulla, Sri Lanka

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Anisoptera (dragonflies) and Zygoptera (damselflies) are the two main sub orders that belong to the order Odonata. Dragonflies are large insects compared to damselflies and these two groups separate each other using their wing positioning. Wetlands, forests, grasslands, agricultural fields and coastal forests have been identified as the most preferred habitats of these odonates. They prefer such habitats since part of their life cycle completes in the aquatic environment. The objective of this research was to investigate the diversity and abundance of dragonfly and damselfly species in Rambukpotha Oya tributary, Badulla. Visual observations were carried out adapting internationally accepted techniques for sampling of flying insects to identify and quantify dragonflies. Characteristics of the aquatic environment and riverbank characteristics were also studied. A total number of 21 Odonata species including 10 dragonfly and 11 damselfly species was recorded. Nine of them were endemic to Sri Lanka. There were six vulnerable, four near threatened, three endangered, and eight least concerned species according to the IUCN Red list 2012. Euphaea splendens and Trithemis festiva were the most common species and Trithemis festiva was the most abundant species recorded in Rambukpotha Oya tributary. The highest Shannon Weiner index (2.15), Simpson's index (0.85), and richness (17) were reported from site 01. This signifies that site 01 has comparatively higher diversity. The lowest Shannon Weiner index (1.49), Simpson's index (0.61), and richness (13) were reported from site 04. Stagnant water bodies were low due to high flow rate in the site 04 than other three sites. Due to very low plant cover in site 04, dragonflies and damselflies did not receive enough food, substrates, and habitats for their egg laying and perching behavior. The alternation of natural waterways subjected to human interactions, as well as predator action were identified as the main reasons for low diversity in the site 04.The low similarity coefficient among sampling sites (site 02 and 04) indicated a unique assemblage of odonate species in each habitat. Results of the current study revealed that sandy substrates with slow moving water and undisturbed areas have higher odonate diversity.

Keywords: Diversity indices; Odonata; Rambukpotha Oya; Shannon Weiner index; Simpson's index; Species richness

FOOD SCIENCE & BIOPROCESSES

Paper ID: IRCUWU2022-029

Development of ovalbumin-based beverage

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Ovalbumin is a major egg white protein that plays a central role in the food industry due to its nutritional value and functional properties. Peptides derived from ovalbumin have shown antioxidant, antimicrobial, and ACE-inhibitory activities. The objective of this study was to develop a new value-added beverage of ovalbumin and its hydrolysates as a protein-rich drink. After separating ovotransferrin using $(NH_4)_2SO_4$ and citric acid combination, lyophilized ovalbumin was utilized to formulate a beverage with sugar, salt, and vanilla extract. Different percentages of ovalbumin were dissolved by changing pH to identify the ideal combination for the beverage. Pasteurization was done at 56.7°C for 3.5 min (OVA). Hydrolysis of ovalbumin was done with two enzyme combinations, Pepsin from porcine gastric mucosa (pH 2.5, 37°C for 3 h) followed by Protease from *Bacillus licheniformis* (pH 6.5, 37°C for 3 h) (PePr) and Protease from *B. licheniformis* (pH 6.5, 37°C for 3 h) followed by Trypsin from bovine pancreas (pH 7.8, 37°C for 3 h) (PrTr). Solubility index and viscosity of OVA were tested with storage time up to day 14. The yield of hydrolysates in hydrolyzed drinks and total soluble solids for three beverages were tested. SDS-PAGE (15%) was conducted to confirm the hydrolysis of ovalbumin. Beverages were tested for functional properties such as ACE-inhibitory activity, antioxidant activity (TBAR assay, DPPH radical scavenging activity), and Fe^{2+}-chelating activity. Accordingly, the beverage with PrTr showed the highest Fe^{2+}-chelating activity (13.37%±0.47) and the second-highest DPPH radical scavenging activity (20.97%±5.23). Fe^{2+}-chelating activity was not observed in the ovalbumin-based control sample, yet the highest DPPH radical scavenging activity was recorded (21.85%±0.97). No sample showed any ACE-inhibitory activity. The pH, TSS, acidity, and viscosity were analyzed as quality parameters. A significant difference in pH was observed (OVA; 9.94±0.02, PePr; 5.81±0.12, PrTr; 7.21±0.08 on day 1 reduced to 9.44±0.07, 4.79±0.15, 6.86±0.15 in day 10) on day 10 (p<0.05). The TSS values of OVA; 11.20±0.20, PePr; 12.20±0.20, PrTr; 13.93±0.23 on day 1 increased significantly up to 15.90±0.14, 14.80±0.20, 16.20±0.1 day 10, respectively. In conclusion, ovalbumin hydrolysate is suitable for developing a functional beverage.

Keywords: Functional properties; Hydrolysis; Ovalbumin; Protein beverage

Paper ID: IRCUWU2022-031

Associated factors of anaemia among pregnant women attending antenatal care clinic at Kattankudy D.S. Division, Batticaloa District, Sri Lanka

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Anaemia remains the most significant public health concern worldwide with the highest prevalence in developing countries. Anaemia is mainly preventable and treated in most circumstances if identified earlier. In the study area, data on the underlying factors of anaemia, particularly in pregnant women, is inadequate. The objective of this research was to check whether there is a relationship between anaemia and sociodemographic and baseline factors among pregnant women in the Kattankudy D.S. Division, Batticaloa district, Sri Lanka. A total of 352 pregnant women took part in the cross-sectional survey. A semi-structured survey was designed to collect each individual's sociodemographic and baseline data. By using consecutive sampling, all available pregnant women were included in the sample. Data were analysed by SPSS version 25.0. Descriptive and inferential statistics (Friedman test) were used to analyze the data. The association of anaemia with each of the explanatory variables like age, education level of women, monthly income, diet pattern, women's occupation, the number of pregnancies, pregnancy interval, affordability of iron foods, and amount of menstrual bleeding was determined using Wilcoxon signed-rank test. According to the results, there was a significant association (p<0.05) between anaemia and age, educational level, monthly income, diet pattern, number of pregnancies, pregnancy interval, affordability of iron foods, and amount of menstrual bleeding. However, there was no significant relationship (p>0.05) between anaemia and women's occupation. It might be due to the fact that the women in this area are well aware of the anaemic condition irrespective of their occupation. As a result, community-based interventions should be strengthened in perspective of the identified risk factors for pregnant women.

Keywords: Anaemia; Interventions; Pregnant women; Sociodemographic factors.

Paper ID: IRCUWU2022-039

Manufacturing of ash plantains, carrots, mushrooms, chickpea flour and oats incorporated sausage analogues

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Concerns about public health, religious norms, parental and peer influence, animal welfare and environmental issues with meat products are the main contributory factors to the increase in demand for vegetarian foods. Therefore, food processing industries are interested in formulating sausage analogues possessing quality parameters that are comparable to meat-based sausages. Moreover, a limited number of sausage analogue types are available in a few selected supermarkets. Therefore, the objective of this study was to formulate a sausage analogue using plant-based materials such as vegetables, cereals, and legumes as the main ingredients. Having conducted many preliminary studies, ash plantains (blanched at 80°C for 5 min), carrots (blanched at 90°C for 3 to 5 min), mushrooms (blanched at 80°C for 3 min), chickpea flour and oats were selected as the main plant-based ingredients. Three formulae containing varying amounts of main ingredients (12-15% ash plantains, 10-13% carrots, 5-10% mushrooms, 5-10% chickpea flour, and 5.0-7.5% oats), emulsion and spice mixtures and other minor ingredients were assessed based on preference for key sensory attributes (appearance, colour, aroma, flavour, texture and juiciness) and overall acceptability using 30 consumer panellists and a 5-point hedonic scale. Similarly, preference for sensory attributes and overall acceptability of the selected formulae and a market sample was compared. Physico-chemical parameters of the selected formulae stored at -18°C for 1 week were analyzed. Cooking loss of 0.53±0.12% and moisture, crude protein, crude fat, crude fiber, and total ash contents of 57.47±2.50, 29.47±0.55, 36.70±0.58, 9.34±0.95, and 5.31±1.29% were evident, respectively. Water holding capacity, pH, and 2-thiobarbituric acid reactive substances values were 51.98±0.83%, 6.8±0.09, and 0.57±0.06 mg of malondialdehyde/kg, respectively. Preference for all the sensory attributes and overall acceptability, except for aroma, of the selected formulae was found to be significantly better (p<0.05) than that of the market sample, revealing its potential as a competitive sausage analogue. Therefore, ash plantains (12%), carrots (10%), mushrooms (9%), chickpea flour (5%) and oats (5%) can be recommended as the main plant-based ingredients for manufacturing sausage analogues possessing sound quality parameters.

Keywords: Analogue; Meat; Quality; TBARS; Vegan

Paper ID: IRCUWU2022-041

Effect of milk protein genetic variants on milk coagulation properties of indigenous and exotic cattle breeds/types in Sri Lanka

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The processability of milk and functional quality aspects of dairy products are mostly governed by the milk protein genetic variants. This study was conducted to assess the variations of milk coagulation properties (MCP) among two indigenous cattle types (Thamankaduwa White [TW] and Lankan cattle [LC]) and two exotic cattle breeds (Friesian and Jersey) in relation to distinctive milk protein compositions. Milk samples were allowed to coagulate employing both enzymatic and acid-induced processes. A rennet solution was used for the enzymatic coagulation while commercial starter culture containing *Streptococcus thermophillus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* was used in the acid coagulation. MCP traits including rennet coagulation time (RCT), curd firmness, meltability, and coagulum yield were measured. The protein profile of each breed/type was analyzed using capillary zone electrophoresis. Milk calcium content was measured using an inductively coupled plasma-optical emission spectrometer (ICP-OES) while somatic cell count was measured using a Delaval cell counter. A significantly lower RCT was observed in indigenous cattle types of TW and LC than in exotic breeds ($p<0.05$). However, curd firmness was not significantly different among the breeds/types ($p>0.05$). The significantly highest coagulum yield was recorded in milk from indigenous cattle types. The results revealed that the κ-casein concentration was significantly higher in TW milk compared to the other three breeds/types ($p<0.05$). None of the other milk protein variants showed significant differences among the four breeds/types ($p<0.05$). The Ca contents of milk were significantly different ($p<0.05$) among four breeds/types where LC milk had the highest Ca content (723 mg/kg) followed by TW, Jersey, and Friesian milk, respectively. High κ-casein content in combination with high Ca content in TW milk may have led to better coagulation properties than the milk from other breeds/ types. The highest somatic cell score (SCS) was estimated for the Friesian breed while there were no significant differences ($p>0.05$) among the other three breeds/types. Overall results indicated the superior MCP properties in TW milk, emphasizing the value of native breeds which could be exploited in the development of niche dairy products while supporting the conservation effort of the native cattle gene pool.

Keywords: Calcium content; Enzymatic coagulation; Milk coagulation properties; Protein genetic variants

Paper ID: IRCUWU2022-075

SeamDock reveals the potential antiviral activity of Luteolin against Senecavirus A 3C protease

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Senecavirus A (SVA) is a single-stranded, non-enveloped, +RNA virus of the genus *Senecavirus*, family *Picornaviridae*. The virus produces four structural proteins, namely VP1, VP2, VP3, and VP4, and seven non-structural proteins (2A, 2B, 2C, 3A, 3B, 3C, and 3D). SVA has been mainly prevailing in the USA and Canada in association with swine idiopathic vesicular disease (IVD) for many years and was in charge of epidemic transient neonatal losses (ETNL) and SVA-vesicular disease (SVA-VD) outbreaks. Lekcharoensuk and colleagues recently uncovered *in vitro* antiviral activity of Luteolin against Foot-and-mouth-disease virus (FMDV) 3C protease ($3C^{pro}$), which is a central protease crucial in the picornavirus life cycle. FMDV and SVA share structural similarities; FMDV (UniProtKB-P03305) and SVA $3C^{pro}$ (UniProtKB-Q155Z9) have 26.02% identity plus 90% query sequence coverage. Therefore, our approach was to identify whether Luteolin performs a similar function on SVA $3C^{pro}$ that has been found to inhibit stress granule formation by disrupting eIF4GI-G3BP1 interaction, mediate the cleavage of nucleolin, Gasdermin D, and PABPC1 for virus replication. The docking analysis was performed using SeamDock, an online tool that combines multiple docking engines with an interactive NGL viewer. The 3D conformer of Luteolin was downloaded as an SDF file from PubChem (ID:5280445), and the canonical SMILES were employed for the docking analysis. The crystal structure SVA $3C^{pro}$ (PDB ID: 6L0T) was acquired from Research Collaboratory for Structural Bioinformatics (RCSB). Docking results revealed that SVA $3C^{pro}$-Luteolin binding occurred at -8.3 kcal/mol. Luteolin C8, C12, and C2 atoms formed hydrophobic bonds with SVA $3C^{pro}$ at H48, T49, and Q142. A list of hydrogen bonds includes ligand O1 (H48 and N52), O2 (H48), O3 (Q33, C160, Y122, and K157), and O6 (S140) plus two weak hydrogen bonds; C13 (Q33) and C7 (H48). These interactions presumably provided an excellent lead antiviral agent for developing therapeutic drugs against SVA since there are no commercially available vaccines. Therefore, we strongly suggest executing *in vitro* assays to further confirm the suitableness of Luteolin as a potential antiviral drug against SVA similar to FMDV.

Keywords: 3C protease ($3C^{pro}$); Foot-and-mouth-disease virus (FMDV); Seamdock senecavirus A (SVA)

Paper ID: IRCUWU2022-080

Isoginkgetin binding to 3C protease demonstrates antiviral potentiality against Senecavirus A infection

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Herbal and purified natural phytochemicals are rich in antiviral constituents. Identifying such compounds opens new research avenues to avoid viral infections; most drugs can interfere with the virus life cycle, such as virus entry, replication, virion assembly, and release. Further, they are non-cytotoxic to the host, safe to use, and can be combined with existing therapeutics. Flavonoids include plant polyphenolic compounds that exhibit anticancer, antioxidant, anti-inflammatory, antimicrobial, and antiviral activities. In this study, we found the plausibility of a flavonoid isoginkgetin against the Senecavirus A (SVA) targeting its 3C protease ($3C^{pro}$) because isoginkgetin has been recently found to be a promising antiviral agent for Foot-and-mouth-disease virus (FMDV) $3C^{pro}$. Both SVA and FMDV are single-stranded, non-enveloped, +RNA viruses of the same family *Picornaviridae* and thus share structural similarities; SVA $3C^{pro}$ (UniProtKB-Q155Z9) and FMDV (UniProtKB-P03305) have 26.02% identity plus 90% query sequence coverage. The *in silico* assessment of protein receptor interaction was performed using SeamDock, an online tool that combines multiple docking engines with an interactive NGL viewer. For ligand preparation, the 3D conformer of isoginkgetin (PubChem ID: 5318569) was employed, and the crystal structure SVA $3C^{pro}$ (PDB ID: 6L0T) was acquired from Research Collaboratory for Structural Bioinformatics (RCSB) as the receptor. Our docking results revealed that SVA $3C^{pro}$-isoginkgetin binding occurred at -9.9 kcal/mol affinity, isoginkgetin C28, C30, C5, C9, C24, and C15 atoms form hydrophobic bonds with SVA $3C^{pro}$ at L31, L31, H48, Y145, K157, and A180. A list of hydrogen bonds included ligand O6 (Q33, K157, Y122) and O9 (Q33 and Y122) plus one cation-pi interaction between ligand atom C11 and receptor H48. SVA $3C^{pro}$ was found to inhibit stress granule formation by disrupting eIF4GI-G3BP1 interaction and mediating cleavage of nucleolin, Gasdermin D, and PABPC1 for virus replication. Therefore, *in silico* SVA $3C^{pro}$-isoginkgetin interaction presumably provided an excellent lead antiviral agent that should be validated *in vitro* and *in vivo* for developing a therapeutic drug against SVA since there are no commercially available vaccines to date.

Keywords: 3C protease ($3C^{pro}$); Foot-and-mouth-disease virus (FMDV); SeamDock; Isoginkgetin; Senecavirus A (SVA)

Paper ID: IRCUWU2022-114

Effect of chilling temperature of separated raw cream on free fatty acids (FFAs) content of butter in MILCO (Pvt) Ltd., Ambewela

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Butter is a popular dairy product that is produced by the churning of raw cream. Free fatty acids (FFAs) content of butter plays a vital role in the quality of butter and increasing the required level causes off flavor due to hydrolytic rancidity. The free fatty acids content of salted butter should be less than 0.3% according to the MILCO standards 2017. However, the FFA level of the butter exceeds the required amount in the MILCO (Pvt) Ltd, Ambewela and it causes rancid flavor due to the temperature increment of raw cream during the storage period. Lypase-producing microorganisms can survive and increase the colonies during the storage period. After the cream separation, the pasteurization process is practised. Heat-resistant microorganisms can survive any heat treatment hence pasteurization process was not sufficient to inactivate such microorganisms. The establishment of a chiller for the raw cream separation unit was the solution to reduce the raw cream storage temperature. In this research, raw cream samples were examined for total colony count (TCC), and yeast and mold counts with the storage temperature before the pasteurization process. Butter samples were examined for lipolytic count (LC) and FFAs content. All the samples were examined before and after establishing the chiller to identify the effectiveness in the reduction of FFAs. The chilling temperature ranges of the stored raw cream were 24.5-30°C and 11.5-18°C before and after establishing the chiller, respectively. TCC values of raw cream were significantly lower (p=0.000) than after establishing the chiller. The yeast count in the raw cream was increased by 4.26 CFU/mL with each 1°C increment in the temperature. Mean values of FFA before and after establishing the chiller were 0.37% and 0.29%, respectively. In conclusion, the temperature of the raw cream during the storage period significantly affects the FFAs concentration of butter.

Keywords: Free fatty acids; Lipolytic count; Raw cream; Salted butter

Paper ID: IRCUWU2022-128

Utilization of lycopene as a natural antioxidant and colorant in butter

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Tomatoes (*Solanum lycopersicum*), watermelon (*Citrullus lanatus*), and red bell pepper (*Capsicum annuum*) are locally prominent fruits having lycopene that can be used as an antioxidant and colorant in foods. The present study investigated the use of microencapsulated, spray-dried powder from tomatoes, watermelon, and red bell pepper to develop a functional butter. Fruits were cleaned, pulverized in a blender, filtered, mixed with 9% maltodextrin, and spray dried separately to obtain microencapsulated powders. Three microencapsulated powders and fresh fruits were analyzed for DPPH radical scavenging activity (RSA), total phenolic content (TPC), and lycopene yield. Fourier-transform infrared spectroscopy (FT-IR) and UV-visible spectrum analyses were carried out for lycopene extracted from both fresh fruits and microencapsulated spray dried powder and compared with commercial lycopene. Nine butter samples were prepared separately by incorporating 4, 6, and 10% of tomato, watermelon, and bell pepper microencapsulated powders. No microencapsulated powder incorporated butter was used as the control. Sensory attributes of prepared butter samples were assessed using 30 untrained panelists with a 9-point hedonic scale. RSA and pH analyses were conducted for all butter samples. Lycopene yields of fresh tomatoes, watermelon, and red bell pepper were 79.12±0.09, 63.94±0.97, and 2.62±0.13 mg/kg, respectively. The lycopene yield of microencapsulated spray dried powder was 43.72±0.05 mg/kg for tomatoes, 41.61±0.05 mg/kg for watermelon, and 1.24±0.03 mg/kg for red bell pepper. FT-IR and UV-visible spectra confirmed the presence of lycopene in fresh and microencapsulated samples. The highest RSA was observed in red bell pepper, in both microencapsulated (47.89±0.27%) and fresh (78.17±0.71%) forms. The highest TPC was displayed in tomatoes in both microencapsulated (13.87±0.01 mg GAE/g) and fresh (19.29± 0.03 mg GAE/g) forms. A significantly higher ($p \leq 0.05$) overall acceptability was shown in 4% tomato powder incorporated butter. RSA of the butter was significantly increased with increasing levels of microencapsulated powder. Butter incorporated with 10% tomato powder and 10% red bell pepper displayed higher RSA (99.01±0.25% and 96.3±0.43%, respectively) at the refrigerated storage ($p \leq 0.05$). The results revealed that functional butter with high RSA can be developed by incorporating microencapsulated tomato powder.

Keywords: Antioxidant; Butter; FT-IR; Lycopene; Microencapsulated powder

Paper ID: IRCUWU2022-154

Evaluation of bioactive properties of herbal tea developed using pink and white colour *Nelumbo nucifera* petals

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There is a growing interest in herbal teas from different plant materials due to their health-promoting properties. Sacred lotus (*Nelumbo nucifera*) is a popular underutilized aquatic plant in Sri Lanka that contains high antioxidant properties This study examined the potential to develop herbal tea using *Nelumbo nucifera* petals (pink and white) as a functional beverage. Fresh flowers were purchased from the local market. Petals were separated, cleaned, blanched, and dehydrated using a drying oven (50°C for 6 h) and ground to a coarse powder. Herbal teas were prepared separately by brewing 2 g of powder for 3 and 5 min in hot water (90°C) and analysed for total phenolics (Folin-ciocalteu method), total flavonoids ($AlCl_3$ method), total tannins (Folin-ciocalteu method), free radical scavenging activity (DPPH method), antidiabetic property (starch-iodine method), anthocyanin content, and sensory properties. Significantly higher total phenolic content (90.54±13.22 mg GAE/g), total flavonoid content (52.82±4.31 mg RE/g), and total tannin content (75.62±7.40 mg TAE/g) were shown by 5 min brewed white petal herbal tea compared to 5 min brewed pink petal herbal tea. The highest DPPH radical scavenging activity (95.65±4.54%) was reported in 5 min brewed white petal herbal tea. A significantly (p<0.05) higher anthocyanin content (1.47±0.09 μgC3GE/L) was shown in 5 min brewed pink petal herbal tea. The alkaloid content of white petal herbal tea powder (37.92±2.91 mg/g) was significantly higher than that of the pink petal herbal tea powder (22.40±1.50 mg/g). The saponin content of white petal herbal tea powder (1.00±0.04 mg/g) was significantly higher than that of the pink petal herbal tea powder (0.99±0.16 mg/g). The pink petal herbal tea brewed for 5 min showed the highest α-amylase inhibitory activity (IC_{50}=0.12±0.06 mg/mL). The sensory evaluation revealed higher overall acceptability for 3 min brewed white petal herbal tea (p<0.05). The 5 min brewed white petal herbal tea was higher in phytochemical compounds and antioxidant activity. Longer brewing time significantly increased the amount of phytochemicals and antioxidant activity. Results revealed that *Nelumbo nucifera* petal powder could be used as a potential natural source of phytochemicals for herbal tea.

Keywords: Antioxidant; Herbal tea; Lotus petals

Paper ID: IRCUWU2022-175

The public perspective of natural derived remedies for diseases: An online survey in Sri Lanka

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Sri Lanka is reputed for using traditional medicine extracted from natural sources since ancient times. However, their pros and cons have not been investigated and some people do not have any faith in those the advancement of western medicine. There are no studies reported in Sri Lanka regarding the perspective of people for natural derived remedies (NDR) usage. Thus, the objective of the current study was to determine the public perspective on using NDR for treating/preventing diseases or health promotion. A standardized questionnaire was distributed among the general public through a google form in both Sinhala and English via social media. A Chi-square test was performed to determine the effect of age, gender, education level, and monthly income of the general public using NDR. A total of 250 participants took part in the survey and among them, 68.4% were aged between 18-30, 12.4% between 31-50, 15.6% between 51-70, and 3.6% were above 70. Among the participants, 62% were females and 38% were males. According to the survey, 92% of respondents use NDR for multiple health benefits to treat an illness (28%), to prevent an illness (13.6%), to promote health (14.8%) or for all purposes (19.2%). Seventy six percent of respondents agreed/strongly agreed that NDR is more effective and safer than western/modern medicines and 24% disagreed/strongly disagreed with the same opinion. A majority (66.8%) had experienced side effects due to consuming western/modern medicines and 38.4% of respondents had experienced side effects of using NDR. Further, gender had no effect ($\chi 2$, $p>0.05$) on using NDR while age, education level and monthly income had a significant effect ($\chi 2$, $p<0.05$) on the public perspective of using NDR. This study showed that the majority of people in Sri Lanka use natural derived remedies to treat/prevent diseases or to promote health while age, education level and monthly income affect this perspective.

Keywords: Natural derived remedies; Perspective; Sri Lanka; Survey; Traditional medicine

Paper ID: IRCUWU2022-187

Implementation of a Hazard Analysis and Critical Control Point (HACCP) plan for the yoghurt production line at MILCO (Pvt) Ltd, Polonnaruwa

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As consumers become much more aware of the significance of safe, high-quality dairy products, food manufacturers are adopting a variety of quality assurance systems. HACCP is a strategy for systematically detecting, analyzing, and controlling all potential hazards in a dairy chain. This study was designed to evaluate and develop a HACCP plan for the yoghurt production line at MILCO (Pvt) Ltd, Polonnaruwa. A gap analysis was performed to identify all the existing pre-requisite programmes with the current status of the yoghurt processing line. Good manufacturing practices (GMP), Sanitation standard operating procedures (SSOP), and Standard operating procedures (SOP) manuals were developed to fulfil the pre-requisite programmes. Preliminary steps were followed by assembling the HACCP team, product description and intended use and constructing a flow diagram of the yoghurt production line. All potential hazards associated with each processing step from raw milk reception to dispatch of yoghurts were evaluated and recorded. Chilling milk in silos, mix pasteurization, the addition of starter culture, and cold storage were identified as critical control points (CCPs) in the yoghurt production line using the Codex CCP decision tree. The critical limits for the identified CCPs were established. The critical limit for chilling milk in silos was identified as 4°C temperature and less than 24 h of holding time. It was followed by 95°C temperature in 3 min holding time for mix pasteurization and 20 min agitating time, 0.155 of acidity for the addition of starter culture. A critical limit of cold storage was established to be 4-8°C temperature in less than 10 h. Each step was followed with effective monitoring procedures and corrective actions. Verification procedures were followed by optimal documentation and record-keeping procedure. With pre-requisite programmes (PRPs) and critical control points (CCPs), it is expected to produce yoghurt products at MILCO (Pvt) Ltd, Polonnaruwa under internationally accepted quality standards.

Keywords: Critical control points; HACCP; Hazards; Yoghurt

Paper ID: IRCUWU2022-212

Low-fat yoghurt supplemented with novel probiotic *Lactobacillus plantarum* 200655 attenuates oxidative stress and enhances antioxidant activity

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The present study was aimed to develop a functional yoghurt enriched with *Lactobacillus plantarum* 200655, and to evaluate its probiotic viability, antioxidant activity, reactive oxygen species (ROS), and sensory properties. The yoghurt samples were manufactured with a commercial starter culture, and probiotics (*L. plantarum* KCTC 3108, *Lactobacillus rhamnosus* GG and *L. plantraum* 200655). Yoghurt samples were labelled as GG (*L. rhamnosus* GG), R (*L. plantarum* KCTC 3108), S (*L. plantraum* 200655), and a control sample without probiotics (C). The samples were stored at 4±1°C for 14 days. The viability of lactic acid bacteria (LAB) was determined at 0 and 14 days. To determine the functional properties of the yoghurts, a water-soluble extract was prepared. The DPPH and ABTS radical scavenging activity assays were employed to measure the antioxidant activity of the water-soluble extract. The protective effect of low-fat yoghurt against oxidative stress was determined by the reduction of ROS production in human colon adenocarcinoma cell lines (HT-29). Sensory evaluation was performed by 10 trained panelists using a hedonic scale after seven days of storage. The count remained above 8 log cfu/mL throughout the storage period in the GG and S samples. The high antioxidant activity was observed for the S sample (DPPH assay: 35.17%, ABTS assay: 62.51%) compared to the other samples. Similarly, the lowest ROS level was observed for the S sample (0.67-fold). Sensory evaluation results confirmed that there was no significant difference in organoleptic properties of probiotic added samples compared with control. These results confirmed that *Lactobacillus plantraum* 200655 enhanced the functional properties of low-fat yoghurt and could be applied in the food industry for the production of functional fermented dairy products.

Keywords: Antioxidant activity; Low-fat yoghurt; Probiotics; Reactive oxygen species

Paper ID: IRCUWU2022-239

Impact of inulin and guar gum on the physicochemical, probiotic, and sensory properties of frozen yoghurt

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There is growing consumer demand for frozen yoghurt as a healthy alternative to ice cream. Soluble dietary fibers are added to the processing of frozen yoghurt to enhance the physicochemical, probiotic, and sensory priorities. Currently little is known about the impact of mixtures of soluble dietary fibers on the above properties of frozen yoghurt. The objective of this study was to produce a soluble dietary fiber (inulin and guar gum) containing frozen yoghurt, with acceptable consumer quality attributes. The individual and combined effect of inulin and gaur gum on physicochemical, probiotic, and sensory properties of frozen yoghurt were investigated for 21 days at -18ºC storage. Results showed that the addition of inulin and guar gum significantly affected the titratable acidity, pH, overrun and melting rate (p<0.05). A significant reduction in pH was noticed for all the tested samples during the storage period while the level of acidity was increased. The increment of acidity during storage was significantly higher in the samples treated only with inulin and the lowest pH values were also found in the same sample. Both inulin and guar gum significantly enhanced the rate of overrun while reducing the rate of melting but guar gum had a significantly higher impact on the overrun and rate of melting than that inulin. Results of survive assessment of *Bifidobacterium* (BB-12) and *Lactobacillus acidophilus* (LA-5) showed that there was a significant effect of the dietary fibers on the survival ability of probiotic bacteria during the frozen storage and this was more pronounced when both dietary fibers were used. There was no significant difference between the sensory attributes of freshly prepared fiber added frozen yoghurt samples and the control (p>0.05). This study has demonstrated that combining soluble dietary fiber, inulin with guar gum can significantly enhance the physicochemical and probiotic properties of frozen yoghurt with acceptable sensory attributes.

Keywords: Frozen yoghurt; Guar gum; Inulin; Physicochemical properties; Probiotics

Paper ID: IRCUWU2022-272

Study on authentication of palmyrah jaggery using chemical tests

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Palmyrah jaggery industry is one of the ancient and large cottage industries in northern Sri Lanka. There is increasing consumer demand for jaggery due to its health-promoting factors such as rich nutrient content and low glycemic index. Nevertheless, it is adulterated with substances like refined sugar and rice bran in order to increase the profit margin. The authenticity of jaggery is questionable in the market since there are no simple analytical methods existing to detect adulterations. This study was focused to identify the authenticity of palmyrah jaggery using chemical tests. Samples of genuine jaggery and jaggery adulterated with different levels of sugar and rice bran were prepared in triplicates. Samples were subjected to analysis of acidity and contents of sulfated ash, reducing sugar, non-reducing sugar, total ash, and materials insoluble in water. Genuine jaggery had significantly higher total ash (3.25±0.52 to 3.44±0.10%), matter insoluble in water (1.29±0.07 to 1.21±0.7%), and acidity as acetic acid (0.14±0.03 to 0.18±0.03%) as compared to adulterated jaggery. Reducing sugar and non-reducing sugar contents of genuine jaggery were in the range of 2.74±0.12 to 5.16±0.34% and 77.1±0.50 to 82.2±0.56% respectively. Adulteration of jaggery with different percentages of refined sugar influenced reducing and non-reducing sugar contents. Reduction in reducing sugar content and increase in non-reducing sugar content was observed in jaggery samples with the increase in adulteration with refined sugar. The sulfated ash content of genuine jaggery (3.46±0.53 to 3.65±0.35%) was significantly higher as compared to adulterated jaggery (3.14±0.36 to 0.32±0.04%). The results of this study showed that the acidity and contents of sulfated ash, reducing sugar, non-reducing sugar, total ash, and materials insoluble in water can be used as reliable parameters for the authentication of palmyrah jaggery.

Keywords: Adulteration; Authentication; Jaggery; Palmyrah; Sulfated ash

Paper ID: IRCUWU2022-303

Screening of phytochemicals and potential antibacterial activity of medicinally valued plant; *Croton laccifer* L.

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Biologically active chemical compounds extracted from medicinal plants have the potential to be developed into therapeutic drugs. *Croton laccifer* L. has been used widely in Southeast Asian countries as a remedy for various diseases. This study investigated the antibacterial activity of ethanol and hexane extracts obtained from *C. laccifer.* Extracts were screened with human pathogenic bacterial strains *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Escherichia coli* to study antibacterial activity with the disk diffusion method. Minimum inhibitory concentration (MIC) was determined through the micro-dilution method. Ethanol extract of leaves showed the maximum concentration of flavonoids (4.05±0.52 mg QE/g) followed by saponins (1.25±0.18 mg DE/g), alkaloids (0.78±0.01 mg AE/g), cardiac glycosides (0.47±0.15 mg securidaside/g), and phenols (0.24±0.05 mg GAE/g), respectively. Ethanolic extract of roots showed a maximum concentration of terpenoids (51.10±3.36%) and tannins (0.77±0.35 mg of TAE/g). The highest steroid concentration was observed in hexane roots extract (1.98±0.14 mg cycloartenol/g). Ethanolic roots and leaves extracts showed significant antibacterial activity against *S. aureus* (11.5±0.40 mm) and *P. aeruginosa* (11.2±0.70 mm), respectively. The disc diffusion analysis was fairly co-related with MIC results. MIC ranging from 5 μg/μL to 40 μg/μL was recorded. The results revealed that ethanol extracts of leaves and roots had potential antibacterial activity, indicating that *C. laccifer* plant can be a potential source for synthesizing antibacterial drugs. Further, studies on the active fractions obtained from *C. laccifer* extracts could lead to identifying pharmacologically important phytochemicals responsible for the observed antibacterial activity in this study.

Keywords: Antibacterial activity; *Croton laccifer* L.; Medicinal plant; Minimum inhibitory concentration phytochemicals

Paper ID: IRCUWU2022-361

Physiochemical properties and oxidative stability of freeze dried microencapsulated fish oil combined with tapioca, maltodextrin and milk protein concentrate

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Marine fish oil is considered to be the best source of omega-3 polyunsaturated fatty acids (PUFAs) and comprises a high amount of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) which are highly susceptible to oxidative deterioration. Microencapsulation is one of the best methods to protect PUFAs from oxidative degradation. The aim of this study was to develop a novel wall material (WM) combination using tapioca starch (TAP), maltodextrin (MD), and milk protein concentrate (MPC) and to analyze the impact of adding tapioca starch on the physicochemical properties and oxidative stability of microencapsulated fish oil powder (MEFOP) as a substitute for MD. The initial stable emulsion was prepared by using FO:MD:MPC =1:2.5:2.5 (F0) with FO:total WM as 1:5. Furthermore, three emulsions were prepared with different amounts of TAP as MD:TAP=1:1 (F1), MD:TAP=1:2 (F2), MD:TAP=1:3 (F3) and microencapsulated fish oil powder was obtained by freeze-drying and was stored at ambient temperature (28±2℃) for 30 days. MEFOPs were analyzed for microencapsulation efficiency (EE), bulk density (BD), tapped density (TD), moisture content (MC), and water activity (A_W). Peroxide value (PV) was measured to determine oxidative stability. EPA and DHA contents were analyzed by Gas Chromatography-Mass Spectrometry (GC-MS). The highest EE (p<0.05) was recorded by F3 as 68.07±1.26%. The highest BD and TD were recorded by F3 and F0 as 0.43±0.004 g/cm^3 and 0.69±0.002 g/cm^3, respectively. F2 showed the lowest MC and A_W as 2.96±0.007% and 0.31±0.007, respectively. PV significantly varied (p<0.05) among the treatments during the storage. F1 indicated the lowest PV as 4.25±0.26 mEq O_2/kg after 30 days of storage. There was no significant change in EPA and DHA contents during storage. The highest EPA and DHA contents were detected by F3 as 16.98±0.18% and 8.525±0.03%, respectively after 30 days. Results revealed that WM combination is suitable for microencapsulation of fish oil and tapioca starch can be used as a substitute for MD to achieve high EE with high oxidative stability of PUFAs.

Keywords: Emulsion; Gas chromatography-mass spectrometry; Microencapsulation omega-3

Acknowledgement: Financial assistance of AHEAD RIC Project "Encapsulation of Omega -3 fish oil from Sri Lankan fishes and development of Omega-3 fortified foods" of Faculty of Applied Sciences, Rajarata University of Sri Lanka, Mihintale is acknowledged.

Paper ID: IRCUWU2022-433

Evaluation of quality parameters on seaweed powder (*Kappaphycus alvarezii*) incorporated ice cream

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Increased attention to healthy and organic diets has led to a rising in the consumer demand for seaweed-based food products due to their nutritional and therapeutical benefits. Interest in functional foods has gained significant growth over the world. This study was aimed to develop and evaluate the quality of value-added *Kappaphycus alvarezii* seaweed powder (SWP) incorporated ice cream which can be introduced as a functional food to consumers. Fresh seaweeds were cleaned, blanched (88°C for 1 sec), oven-dried at 40°C for 48 h (until moisture content reached 10%), and ground to make a fine powder. Dehydrated seaweed powder was analyzed for radical scavenging activity (DPPH assay), total phenolic content (Folin-Ciocalteu method), and total flavonoid content ($AlCl_3$ colorimetric method). Seaweed powder incorporated ice cream was prepared with different levels of seaweed powder (0, 0.2, 0.5, 1.0% w/w) without replacing the stabilizer. Melting rate, titratable acidity, and radical scavenging activity (DPPH assay) were determined for the seaweed powder incorporated ice cream. Ice cream samples were organoleptically analysed by 30 untrained panellists using a 9-point hedonic scale. Total phenolic content, total flavonoid content, and DPPH free radical scavenging activity of SWP were 10.42 mg GAE/g, 15.51 mg rutin/g, and 21.43%, respectively. Ice cream with 0.5% SWP was selected as the most acceptable ice cream sample. The highest melting rate was observed in 0.2% SWP incorporated ice cream. There was a significant difference in melting rate among four ice cream samples ($p<0.05$). The ice cream incorporated with 0.5% SWP showed a melting rate of 1.67±0.06 mL/min. The highest titratable acidity was detected in the ice cream without seaweed powder ($p<0.05$). No significant difference was observed in DPPH radical scavenging activity among four ice cream samples ($p>0.05$). The highest DPPH radical scavenging activity was recorded in 0.2% SWP incorporated ice cream compared to other treatments. Results showed that 0.2% SWP incorporated ice cream had the highest antioxidant activity and melting rates compared to other samples. Sensory evaluation results revealed that the ice cream incorporated with 0.5% SWP was chosen as the most acceptable sample. According to the results, *Kappaphycus alvarezii* can be successfully incorporated into ice cream as a rich source of antioxidants with improved sensory attributes.

Keywords: Bioactive compounds; Functional foods; Ice cream; *Kappaphycus alvarezii*

Paper ID: IRCUWU2022-445

Development of pineapple incorporated yellowfin tuna (*Thunnus albacares*) jerky

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Commercial yellowfin tuna processing produces a number of offcuts that have less economic value. The objective of this research was to develop a tuna fish jerky by incorporating freeze-dried pineapple powder as a natural flavoring ingredient. Industrial offcuts of yellowfin tuna were minced and mixed with sugar, pepper, soy sauce, salt, and lime juice to produce the jerky. Preliminary trials were carried out to determine the optimum oven drying conditions. Best ratios were selected using a sensory evaluation with 30 untrained panelists. The developed final recipe included freeze-dried pineapple powder in various ratios (0, 0.05, 0.1, 0.15, and 0.2% [w/w]) considered as the treatments. Lipid oxidation of the jerky (TBARS and DPPH assays), pH, and texture properties were measured for the consumer-preferred, freeze-dried pineapple powder incorporated samples and the 0% pineapple incorporated, control sample up to 28 days of storage at 4°C. SDS-PAGE was carried out to determine the level of protein degradation. Myofibrillar fragmentation index was determined to detect the changes in the proteins during storage. According to the results, pH was not significantly changed during storage ($p>0.05$). Hardness, chewiness, and gumminess values from all the treatments had no significant difference ($p>0.05$). TBARS and DPPH assay results revealed that the lipid oxidation values were within the acceptable limit and had no significant increase up to 28 days ($p>0.05$). Myofibrillar fragmentation index reduced from 3.98 on day 7 to 0.62 on day 28. According to the sensory analysis, jerky incorporated with 0.2% freeze-dried pineapple powder showed the most preferred texture and higher overall acceptability compared with other freeze-dried pineapple powder incorporated jerky samples ($p<0.05$). In conclusion, the tuna fish jerky produced with 0.2% freeze-dried pineapple powder is more suitable as a value-added product and it can be stored at 4°C for 28 days.

Keywords: Jerky; Myofibrillar fragmentation index; Freeze-dried pineapple powder; Protein hydrolysis; TBARS; Yellowfin tuna

Paper ID: IRCUWU2022-450

Effect of gamma irradiation on physicochemical and microbiological properties of curry leaves (*Murraya koenigii*) powder

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Curry leaves are a popular leaf spice used in small amounts for their distinct aroma and taste that has a high demand in the market. Plant materials harbor a variety of microorganisms thus, curry leaves had much higher rates of microbial contamination than other herbs. The study was carried out to evaluate the effects of gamma irradiation on physicochemical parameters and microbiological quality of curry leaves powder. Samples were irradiated at the doses of 0, 3, 5, and 7 kGy using an industrial Co-60 gamma irradiator at the dose rate of 0.15 Gy/s. Samples were analyzed for moisture content, water activity (a_w), color of the powder and infusion as physical parameters, whereas the pH, total ash content, and antioxidant activity (DPPH assay) were determined under chemical parameters. Under the microbiological quality, total plate count, yeast and mold count, and total coliform counts were determined as per the ISO-modified methods. The mean value of moisture content and water activity of the irradiated curry leaves samples were 8.09±0.03% and 0.39±0.00, respectively. The mean value of L*, b*, and E hunter parameters of curry leaves powder were increased whereas the a* value was decreased with the increment of irradiation dose when compared to the control where the infusion color results were observed and vice versa. The mean total ash content and pH of irradiated samples were 10.95±0.03% and 5.85±0.03, respectively. The antioxidant content of the 5 kGy sample was not significantly different (p>0.05) from the control. Gamma irradiated samples showed a significant reduction (p<0.05) in the total plate count. Total coliform counts gradually decreased with the increasing irradiation dose. Yeast, mold, and *Escherichia coli* were not detected in any gamma-irradiated samples. The results of the study concluded that 5 kGy is the optimum dose for adequate microbial safety and preserving the physicochemical parameters of curry leaves powder.

Keywords: Curry leaves; Dose; Gamma irradiation; Microbial quality; Physicochemical properties

Paper ID: IRCUWU2022-452

Extraction of natural food colourant from canistel fruit (*Pouteria Campechiana*) and its possible food applications

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A food colourant is a food additive that can be any kind of dye, pigment, or substance added or applied to foods. Carotenoids are natural pigments with highly beneficial health properties. As artificial food colourants impart health hazards, the goal of this research was to extract carotenoids from Canistel fruits (*Pouteria campechiana*) as a natural food colourant substitute for artificial food colourants. Carotenoid extraction was done by the solvent extraction method using hexane:acetone:ethanol ratio of 70:15:15%. The instability of the carotenoid was one of the main drawbacks, and microencapsulation techniques were used to overcome this. In this regard maltodextrin (10%), arabic gum (10%), and maltodextrin (5%)+arabic gum (5%) mixture were tested as the wall material treatments in the encapsulation process. Encapsulation with maltodextrin (10%) showed an 11.91±0.29 g higher yield and higher total carotenoid content after spray drying. In addition, maltodextrin (10%) retained 45.64±5.3% more carotenoid concentration than other samples. The Chroma meter values of colour in three treatments were observed to have higher lightness and yellowness. The 2, 2-diphenyl-2-picrylhydrazyl (DPPH) assay method was used to find antioxidant activity. The highest antioxidant activity indicated the lowest IC_{50} value as recorded as 3.57±0.04 mg/mL, 4.38±0.20 mg/mL and 5.19±0.24 mg/mL from maltodextrin (10%), maltodextrin (5%)+arabic gum (5%) mixture, and arabic gum (10%), respectively. According to the observations, the physicochemical properties of encapsulated carotenoids depend on the applied wall material except for water activity as there was no difference between the three treatments (p>0.05). Results revealed that the carotenoids were successfully encapsulated by the spray drying technique. Maltodextrin (10%) was selected as the best wall material, and it was developed as a natural food colourant.

Keywords: Canistel fruit; Carotenoid; Encapsulation; Natural food colourant

Paper ID: IRCUWU2022-455

Oxidative stability of mechanically separated chicken meat incorporated with lime peel powder during frozen storage

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Mechanically separated chicken meat (MSCM) is one of the major by-products in the chicken meat industry. Mechanical separation enables the use of most of the meat remaining on the bones in different processed meat products. With the high lipid content in its composition, MSCM is easily susceptible to oxidative reactions leading to rancidity, which is responsible for off-flavors and unacceptable taste, and consumer rejection. Researchers are working on replacing synthetic antioxidants used in the meat industry with natural antioxidants due to certain health issues of the former. Lime peels, one of the main wastes of the fruit juice industry contain a higher proportion of natural antioxidants such as natural flavonoids, phenolic compounds, ascorbic acid, carotenoids, and reducing sugars. In this study, the effect of lime peel powder on lipid oxidation of MSCM was assessed. MSCM was separately mixed with lime peel powder (0, 1, 2, and 3%), ascorbic acid (0.1%), and tripolyphosphate (0.5%), vacuum packed and stored at -20^{o}C. The pH, color, thiobarbituric acid reactive substances (TBARS) value, and 2,2-diphenyl-1-picryl-hydrazyl-hydrate (DPPH) free radical scavenging activity of MSCM were measured during 60-d frozen storage. MSCM added with lime peel powder, ascorbic acid, and tripolyphosphate reported lower TBARS values as opposed to MSCM with no added antioxidants (control) at 45 and 60 d of frozen storage (p<0.05). TBARS value of the control sample significantly increased whereas those of MSCM added with lime peel powder and ascorbic acid were comparable during the 60-d frozen storage. DPPH values of MSCM had decreased over the storage, irrespective of the antioxidant used in MSCM. In conclusion, lime peel powder is effective in enhancing the oxidative stability of mechanically separated chicken meat over 60-d frozen storage.

Keywords: Antioxidants; DPPH; Lime peel powder; Lipid oxidation; Mechanically separated meat; TBARS

Paper ID: IRCUWU2022-456

Development of tomato sauce incorporating cocoyam (*Xanthosoma sagittifolium* (L.) Schott) flour as a natural thickening agent and evaluation of its quality attributes

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While cocoyams are good starchy aroids, they are mostly neglected and still underutilised. This study was conducted with the aim of investigating the potential use of cocoyam flour as a thickening agent in tomato sauce production. Mature good quality cocoyams were used to obtain flour. The proximate composition and functional properties of the cocoyam flour were compared with corn flour. Tomato sauce samples were prepared in accordance with the Sri Lankan Standards requirements for tomato sauce (SLS 260: 1989). Four batches of tomato sauce were prepared by adding different concentrations of cocoyam flour (1.07, 2.14, 3.21, and 4.28%). The best sample was selected through a sensory evaluation test with 30 untrained panelists. A tomato sauce sample with 2.14% cocoyam flour was selected as the best sample. Cocoyam flour contained 78.31±0.25% carbohydrate, 9.81±0.34% moisture, 5.06±0.21% crude protein, 3.66±0.11% total ash, 2.57±0.27% crude fibre, and 0.58±0.12% fat. Cocoyam flour contained 0.86±0.02 g/cm^3 bulk density, 2.37±0.21 mL/g water absorption capacity, 1.77±0.06 mL/g oil absorption capacity, 2.91±0.13 mL/g emulsifying capacity, 1.41±0.06% swelling index, 5.33±0.58% gelation capacity, and 11.47±0.54% foaming capacity. The microbial count (total plate count and yeast and mould count) of sauce samples was less than the standard maximum limits. Cocoyam flour incorporated with tomato sauce was shown a low serum separation. Titratable acidity and water activity were not significantly changed (p>0.05) while total soluble solids and pH significantly changed (p<0.05) during the storage period. According to the results of this investigation, cocoyam flour can be successfully used as a natural thickening agent in tomato sauce production.

Keywords: Cocoyam flour; Quality attributes; Thickening agent; Tomato sauce

Paper ID: IRCUWU2022-461

Physicochemical characteristics of crude collagen extracted from broiler chicken feet using different levels of citric acid monohydrate

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Chicken slaughterhouses generate huge quantities of chicken feet as waste or by-products. If not properly disposed of, poultry waste is one of the major pollutants. Instead of being turned into meals for animal feed, chicken feet might be used in considerable quantities to make collagen, which is valued for its particular functional characteristics. The objectives of this study were to elucidate the best citric acid monohydrate treatment for extracting collagen from chicken feet without bone and to evaluate the physicochemical properties of the separated collagen. The three stages of collagen extraction were pre-treatment, hydrolysis, and hydro-extraction. The pre-treatment stage involved a 6 h soak in a 0.5 M NaOH solution. For the hydrolysis, citric acid monohydrate concentrations of 0.1, 0.2, 0.3, 0.4, 0.5, and 0.6 M with a 1 h soaking period were used along with a control treatment of 0.5 M acetic acid. The swelling pH, swelling percentage, crude collagen yield (%), and Fourier transform infrared (FT-IR) spectrum of extracted collagen were examined. Chicken feet contained 12.93% crude protein, 12.04% fat, 1.58% ash, and 70.56% moisture. There was a significant difference in the swelling pH and swelling percentage when comparing citric acid monohydrate treatments with acetic acid treatments (p<0.05). As the citric acid monohydrate concentration increased, the swelling pH and swelling percentage declined significantly. The extracted collagen amino acid had amide A, amide B, amide I, amide II, and amide III groups as determined by FT-IR spectroscopy. According to the results, 0.2 M citric acid monohydrate concentration was the best level of hydrolysis condition when compared with other treatments.

Keywords: Chicken feet; Citric acid monohydrate; FT-IR; Hydrolysis; Pre-treatment

Paper ID: IRCUWU2022-499

Optimization of composition and physicochemical properties of soursop (*Annona muricata* L.) incorporated ice cream

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Ice cream is one of the world's most popular frozen desserts today, and its global consumption is on the rise. Soursop (*Annona muricata* L.) is categorized as underutilized fruit in Sri Lanka with a characteristic aroma and flavor. There is increasing consumer demand for soursop due to its superior health benefits and sensorial properties. This study focused to optimize the formulation of soursop flavored ice cream with desirable sensory attributes and superior physicochemical and textural properties using response surface methodology. The experiments were conducted using the central composite design (CCD) with two independent variables: level of soursop pulp (6-30% w/w) and sugar (4-12% w/w). Soursop pulp level and sugar level significantly ($p \leq 0.05$) affected the meltdown rate, deformation at hardness, viscosity, and overall acceptability of ice cream. This study also demonstrated that the addition of soursop pulp reduced the meltdown rate ($p \leq 0.0001$) and overall acceptability ($p \leq 0.05$) up to 0.21±0.02 mL/min. and 2.92±0.11, respectively. Further, the addition of soursop pulp increased the deformation at hardness ($p \leq 0.05$), viscosity ($p \leq 0.001$), and cohesiveness up to 3±0.25 mm, 590±0.21 m Pa/s, and 0.29±0.01 N, respectively. The addition of soursop pulp beyond 20% (w/w) resulted in a reduction ($p \leq 0.05$) of desirable sensory attributes namely flavor, taste, and texture of ice cream. Quadratic models were significant ($p \leq 0.0001$) for meltdown rate, viscosity, and cohesiveness and adjusted R^2 was more than 0.75 for all responses. In general, the results of the current study indicated that the addition of 19% (w/w) of soursop pulp and 6% (w/w) of sugar into ice cream could result in a soursop flavored ice cream with 0.912% desirability that maintains suitable properties during the tested period (21 days) of frozen storage (-18^{o}C).

Keywords: Ice cream; Optimization; Response surface method; Soursop

Paper ID: IRCUWU2021-571

Effect of ultrasound pretreatment on the growth of yoghurt starter culture containing *Bifidobacterium* spp.

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Fermentation is a major time-consuming step in the processed dairy product industry. Ultrasound is an emerging technique that can be used to promote the growth of lactic acid bacteria and thereby reduce the fermentation time. However, employing ultrasound at high energy densities will destroy the microbial cells by rupturing the bacterial cell membrane. Therefore, it is essential to select the desirable levels of ultrasound parameters such as frequency, duration, and acoustic intensity. This study investigated the effects of ultrasound pretreatment on the growth of *Streptococcus thermophiles*, *Lactobacillus bulgaricus*, and *Bifidobacterium* spp. in set-yoghurts prepared using cow milk. Ultrasound (234 W, 20 kHz) was applied to a mixed culture of *S. thermophiles* (7.26 log cfu/mL), *L. bulgaricus* (8.54 log cfu/mL), and *Bifidobactrium* spp. (7.85 log cfu/mL) at different energy densities as; 702 J/mL (2.5 min), 1404 J/mL (5 min), 2106 J/mL (7.5 min), 2808 J/mL (10 min), and 3510 J/mL (12.5 min). An untreated sample of lactic acid bacteria in cow milk was used as the control. *S. thermophilus*, *L. bulgaricus*, and *Bifidobactrium* spp. were enumerated on *S. thermophilus* isolation (ST) agar, Rogosa agar, and MRS agar supplemented with the Mupirocin, respectively using the pour plate method. The experiment was conducted as Completely Randomized Design and data were analyzed using Minitab 17 statistical software package. The results revealed that ultrasound application at 1404 J/mL, 702 J/mL, and 2808 J/mL increased (p<0.05) the population of *S. thermophilus* (7.40 log cfu/mL), *Bifidobacterium* spp. (9.01 log cfu/mL), and *L. bulgaricus* (8.85 log cfu/mL) compared to other treatments. The results of the current study indicate that ultrasound pretreatment can be a suitable method to enhance the growth of lactic acid bacteria including *Bifidobacterium* spp. in set-yoghurts. The optimum conditions of ultrasound promote cell growth in cow milk depending on the strain of bacteria.

Keywords: *Bifidobacterum* spp.; Fermentation; Lactic acid bacteria; Set-yoghurt; Ultrasound

HOSPITALITY & TOURISM

Paper ID: IRCUWU2022-009

Time series modelling of tourist arrivals to Sri Lanka: ARIMA approach

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Sri Lanka is one of the popular tourist destinations in Asia that attracts tourists from all regions of the world. The tourism industry in Sri Lanka is a major economic activity and hence contributes to the GDP of Sri Lanka massively while increasing foreign reserves and employment along with a vast indirect effect on other industries. Modelling and forecasting tourist arrivals to Sri Lanka are critical to the tourism industry and the economy of the country. The benefits of accurate forecasts of international tourist arrivals in short- and long-term policy planning are well documented in tourism research literature. The aim of this research was to identify a suitable time series model for tourist arrivals to Sri Lanka which helps predictions in the near future. Monthly tourist arrival data from January 2007 to April 2019 were obtained from the Annual Statistical Report published by the Sri Lanka Tourist Development Authority (SLTDA) for the study. The Auto Regressive Integrated Moving Average (ARIMA) model was considered to model the data. Further, Box-Jenkin's approach was employed to identify the best model. The appropriate model was selected based on AIC, BIC, and MSE criteria. ARIMA $(0, 1, 1) \times (0, 1, 0)_{12}$ was identified as the best fitting model for the monthly international tourist arrivals to Sri Lanka. Moreover, the identified best model can be used to predict tourist arrivals in the near future. The findings of this research will be useful for government agencies involved in tourism planning and promotion and the private establishments in the industry.

Keywords: ARIMA; Forecasting; Time series; Tourist arrivals

Paper ID: IRCUWU2022-030

Does the glass ceiling effect hinder career progress of female employees? Empirical evidence from hotel industry in Sri Lanka through the lenses of gendered organizational theory

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Hotel industry is considered as the most challenging environment for female employees for career progress and empowerment. This research focused on five main glass-ceiling determinants as independent variables. Women's empowerment was the mediator and women's career progress was the dependent variable. Research questions were to identify the impact of the glass ceiling effect on women's empowerment; to identify the determinants that affect women's career progress; to identify the impact of glass ceiling determinants on women's empowerment; and to identify the impact of the glass ceiling effect and women's career progress through women empowerment. According to the field survey, it was found that male representation at hotels was lower than female representation. As a percentage female employees were 7.40%. Primary data were collected through a self-administered questionnaire. The population was 190 and the sample size was 123. Simple random sampling method was used to reach respondents. The data was processed and analyzed using SPSS (descriptive analysis) and structural equation modelling in Smart PLS. According to hypothesis testing, only H2 and H8 were rejected (p<0.05). Other than IJM and LJPQ, the mediator had a significant impact on the dependent variable. The study recommends conducting awareness programs for the family members and society and encouraging colleagues groups to appreciate women workers, delegating authority and giving opportunities for the women employees for the job enrichment, and enlargement. Moreover, rebuilding job descriptions and specifications clearly, allocating flexible working hours, and designing a work-friendly environment led to women's career progress. Doing unbiased performance appraisals and providing training and rewards help the career growth of women. Providing scholarships and allocating flexible working environments to enhance the educational and professional qualifications of the women helps to achieve their personal goals while ending up with a qualified women workforce in the hotel sector. Future researchers can do qualitative research regarding the same research study to trace the true emotions of the respondents.

Keywords: Empowerment; Glass ceiling effect; Hotel industry; Organizational culture; Women career progress

Paper ID: IRCUWU2022-034

Identifying potentials for experience-based cultural tourism development in Polonnaruwa, Sri Lanka

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Promoting the scattered tourist attractions through emerging concepts in potential sites and developing such sites as marketable tourism products is a contemporary issue with both theoretical and empirical significance. This study focused to identify the potential of experience-based cultural tourism development in Polonnaruwa, Sri Lanka. Polonnaruwa (UNESCO World Heritage) is one of the key tourist destinations in Sri Lanka, especially for cultural and heritage visits. Danigala Circular Rock, Angammedilla National Park, Ancient Technology Museum & Wax Museum, "Bubula" Water Source, and Pimburaththewa Lake have been used as the research sites. The study aims to explore the motivation factors affecting tourists to visit the cultural sites in order to introduce new cultural activities, the roles of stakeholders, opportunities, and challenges in developing experience-based cultural tourism. A convenient sample of 15 tourism stakeholders and 70 tourists participated in the survey. Qualitative data were collected through semi-structured interviews with tour operators, residents, and government officers and quantitative data were collected through self-administered questionnaires from domestic and foreign travellers. Interview outcomes were analyzed using content analysis and explorative factor analysis through SPSS software, conducted to analyze the questionnaire outcomes under the mixed method. Findings revealed that safe consumption, learning about local culture, and emotional involvement to be motivation factors. It was revealed that the stakeholders have the power to influence tourists to experience destinations. In conclusion, the study discovered that with the support of stakeholders and through the introduction of new cultural activities, the destination can develop as an experience-based cultural tourism destination while suppressing economic and social challenges. Furthermore, it is recommended to introduce tourism-friendly government regulations with inventive tourism experiences while ensuring adequate marketing. Moreover, studying other destinations that experience-based cultural tourism can be introduced are potential areas for future research.

Keywords: Cultural tourism; Experience-based tourism; Polonnaruwa; Tourism development; Tourism potentials

Paper ID: IRCUWU2022-047

Impact of green human resource management practices on environmental performance: Empirical evidence from hotels in Southern Province in Sri Lanka

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Growing awareness of sustainability has encouraged stakeholders' broader participation in greener management. Green human resource management practices are emerging as a new concept for sustainable organizations and society. The practices stimulated employees with a sense of pride for participating in green initiatives while educating them on the complexities of environmental management. This study was undertaken to explore the impact of green human resource management practices on environmental performance in the hotel industry with special reference to 4 and 5-star hotels in Southern Province, Sri Lanka. This research is related to the Resource-Based View (RBV) Theory because the resource-based approach is a management paradigm for determining which strategic resources may be employed to gain a long-term competitive advantage. This study aimed to identify the impact of green human resource management practices on environmental performance and identify the intermediator effect of employee green behavior between green HRM practices and environmental performance in 4 and 5-star hotels in the Southern Province of Sri Lanka. The sample was selected using the purposive sampling method and the sample size consists of 100 respondents. Quantitative analysis methods were used to process primary data collected using a self-administrated questionnaire. Smart PLS software for partial least squares-structural equation modelling was used to test the proposed hypotheses. In this study, the positive impact of green HRM practices on environmental performance has been identified. Also, the intermediating effect of employee green behavior between green HRM practices and environmental performance has identified a positive impact of each variable. Future research areas suggested that it would be delighted to study about employee green behaviors between green HRM practices and environmental performance in the Western Province. In conclusion, it is worth noting that the green practices will lead to good performances of the 4- and 5-star hotels.

Keywords: Employee green behavior; Environment performance; Green human resource management; Hotel industry; Human resource management

Paper ID: IRCUWU2022-060

An analysis of user acceptance in mobile travel applications: Issues and opportunities

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While technology continues to evolve, the tourism sector has emerged to be one of the world's most dominating industries in the modern era. Mobile phones have become the most rapid expansion of any technological advancement, and mobile apps are proliferating indecently. Apps are utilized in a wide range of industries, especially in travel and tourism. Thus, the integration of navigation systems and travel service apps has become increasingly popular. Amidst these circumstances, people tend to use travel-related applications during their travels. However, there are still lacking points in mobile travel apps that need to be addressed. Hence, this study aimed to explore the user acceptance of Tour Planning Mobile applications using Davis Model of Technology Acceptance as a baseline theory and determine the present difficulties and opportunities from the user's point of view. This study utilized a mixed-method research approach consisting of structured interviews (qualitative) with 6-8 travel YouTube channel owners or travel social media page owners and an online questionnaire with 200 mobile travel app users. Majority of the respondents stated that pop-up advertising, inaccurate route suggestions, consuming a lot of phone space, and requiring a constant internet connection, as issues that travellers face. Ability to find hidden destinations, find routes to the destinations, ability to get directions without knowing about navigation technology and saving of time were recognized as opportunities. User acceptance testing indicated that perceived usefulness (r= 0.609) is the best predictor of customers' willingness to utilize smartphone applications for trip planning and perceived ease of use as the second greatest predictor with a β value of 0.300. This study proposed a model having variables primarily from TAM and including three other variables namely PU (perceived usefulness), PEU (perceived ease of use) and BIU (behavioral intention to use). However, many others have proved to have moderating effects in many studies on technology adoption. Future studies could consider the inclusion of these moderators.

Keywords: Mobile applications; M-tourism; Smart tourism; Technology acceptance

Paper ID: IRCUWU2022-065

The potentials and challenges of promoting caravan tourism concept as a new revival of tourism industry in Sri Lanka

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Caravans have grown in popularity as a form of tourism across the world. Tourists choose caravans because of the independence and desire to experience nature they provide. Sri Lanka is known for its natural beauty as a tourism destination. Every country that enjoys caravans is a top tourist source for Sri Lanka. Despite the fact that there is a resource and a foreign customer base, Sri Lankans are unaware of it, and Sri Lankan caravan tourism does not exist as a business. Therefore, with such a background, this study was conducted to find the potential and challenges of promoting caravan tourism as a new revival of the Sri Lankan tourism industry. The objectives of this study were to identify the potential of promoting caravan tourism as a new revival in Sri Lanka and to identify the challenges faced by caravan tourism operators in Sri Lanka. The researcher did this study using a qualitative approach. Also, the researcher got primary data from ten respondents including four caravan operators and six industry experts conducting semi-structured interviews. The researcher chose that sample using the purposive sampling method and used content analysis for data analysis. According to the first objective, the researcher found potentials like easy of managing, low environment damage and limited space, good investment opportunity, convert existing vehicle in to a caravan, alternative option for pandemic situation, providing for large-scale events, home living nature base camping experience, places with tourist attractions where construction is prohibited under 4Ps product, price, place and promotion. Lack of support from the government, lack of rules and regulation acts regarding caravan tourism, difficult to obtain bank loans, lack of infrastructure developed for caravans, Sri Lankans are not adopted and awareness under the sub categories political, economic and socio-environment to fulfil the second objective of the study were found to be the challenges. Further, some recommendations to promote caravan tourism are minimum specifications and maintenance regulations for caravans and caravan parks be implemented, focus was on ensuring the caravan industry's environmental sustainability through suitable policies and procedures.

Keywords: Caravan tourism; Challenges; Potentials; Service providers; Sri Lankan tourism

Paper ID: IRCUWU2022-074

Impact of artificial intelligence use in hotels on customer satisfaction (special reference to Down South area)

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Due to the improvements in artificial intelligence (AI) and associated technologies, the use of artificial intelligent automation in travel and tourism is likely to grow in the future. It affects many areas, including hospitality and tourism industry functions. Adaptation of technology not only improves customer satisfaction but also it helps to reduce the cost of business operations. With the competitive global market Sri Lankan hoteliers also introduced so many technological things for their guests. This study examines impact of artificial intelligence use in hotels on customer satisfaction (special reference to down South area). Key objective of the study was to identify what are the most technological tools preferred by the guests and what they expect from hoteliers in the future. From that hoteliers would be able to change and grab more guests by understanding the customer needs, wants and expectations. The study site was selected as the Down South hotels of five- and four-star categories. This study has conducted using qualitative approach and primary data was gathered through a series of in-depth interviews by using purposive sampling technique. Sample size was 12 respondents containing both locals and foreigners. Collected data was analyzed by using content analysis method. From the study it revealed that every guest was satisfied and aware about the AI tools used by the hoteliers. They mostly prefer chat bots and smart room concepts. It identified that guests prefer more human interaction than robotics. Furthermore, there are minimum payments methods available for guests. Based on the results, researchers recommend implementing more payment options, solving application problems and introducing VR technology.

Keywords: Artificial intelligence; Artificial intelligence tools; Hotel industry; Satisfaction; Service automation; Technology

Paper ID: IRCUWU2022-076

Revival of wildlife tourism operation after the pandemic: Service providers' perspective at Minneriya National Park

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Outstretching of Covid-19 pandemic has boosted unprecedented negative impacts with community transmission and travel restrictions. The wildlife tourism as a niche market segment was seriously affected during the pandemic, but is one of the best segments with a great potential to reboot the industry yield. However, sufficient measures were not staged to rejuvenate this market segment. Hence, this study expected to explore how wildlife tourism operations can be revived in the new normal condition of Covid-19 from the perspective of service providers at Minneriya National Park. Accordingly, the contemporary challenges they faced, during the pandemic and their readiness to rejuvenate the wildlife tourism industry after the pandemic was to be identified. In order to study the subject phenomenon, qualitative approach was used and study sample was selected purposively. Total of 16 wildlife tourism service providers at Minneriya National Park was interviewed using semi-structured direct interviews and transcribed data were analyzed using content analysis. The findings revealed that operational, financial, labor-related, communication, technology and economic impact as the major challenges in wildlife tourism operation during the pandemic. Introducing recreational activities, health and safety measures, technology, and policy planning were important to organize the sector for better functioning, regulate the administrative system of the national park and introducing soft adventure activities aligning with geographical features of the area to attract local travellers during a pandemic will generate many benefits from this niche segment. This study also identified a response mechanism to attract travellers for this niche market segment. Further, it has manifested the significance of grabbing value scale for operations even after future pandemics.

Keywords: Challenges; Covid-19; Pandemic; Readiness; Service providers; Wildlife tourism

Paper ID: IRCUWU2022-078

Street food as a promotional tool in sustainable gastronomic tourism in Sri Lanka

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Street food is a growing segment under gastronomic tourism that exhilarates visitors to destinations. The growing demand for street food can support destinations in instigating an authentic experience for travellers beyond mainstream tourism products. Street food and street food sellers are vital players in daily life across the world and they significantly incite visitors with a unique gastronomic experience. Hence, this study explored how street foods can contribute to promoting gastronomic tourism in Sri Lanka from the perspective of tourism stakeholders. Researchers made an effort to understand the subjective dynamics of the phenomenon using a qualitative approach achieving the objectives of exploring the potential of street food for stimulating gastronomic tourism, and the opportunities and challenges for developing street foods as a gastronomic tourism tool in Sri Lanka. Semi-structured interviews were conducted for 14 respondents selected through purposive sampling (including street food vendors and tourists from the sites of Galle Face and Dambulla, and officials from SLTDA). The collected data were transcribed and analysed using content analysis. The findings of the study revealed that awareness, governance, unique recipes and continuous ancestors are important in maintaining the authenticity of street foods. Perception, involvement and value addition are essentially important to developing the street food industry in Sri Lanka. Further, lack of policies and regulations, lack of government support, negative perception and lack of promotion activities are challenges to promoting street food as a part of the gastronomic industry. This study suggested some strategies for gastronomy tourism development in the country such as strategic promotion, improving the knowledge of the street food vendors, proper management, increasing government support, etc.

Keywords: Destinations; Gastronomy; Stakeholders; Street foods; Tourism promotion

Paper ID: IRCUWU2022-079

Social media usage of generation Y travellers in planning domestic tours

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Social media plays a prominent role as an information source for travellers. Among the other generations, generation Y travellers demonstrate a distinct desire in using social media to search for information on tour planning behaviour. Given that, this research was mainly focused on investigating how social media affects the intention and behaviour of generation Y travellers in domestic tour planning. Accordingly, the objectives of this research were to identify the determinants of social media usage to plan domestic tours, the relationship between the intention of using social media for tour planning and the actual usage of social media for domestic tour planning and the role of experience in the relationship between intention to use social media and actual usage of social media for domestic tour planning. A sample of 200 travellers among the generation Y domestic travellers in Sri Lanka was extracted through stratified sampling and convenience sampling techniques were employed to collect primary data. Data collected through a self-administered questionnaire at the selected research sites were analyzed using Structural Equation Modelling (SEM) (using Smart PLS). Confirmatory factor analysis was used to analyse the model and identified the factors that affect intention, by the descriptive analysis. The results revealed that perceived behavioural control, perceived ease of use and subjective norms positively affect the intention to use social media by generation Y in planning domestic travel and there is significantly positive relationship between intention and actual social media usage for planning domestic tours. Moreover, travellers' experience positively moderates the relationship between intention and the actual use of social media in domestic tour planning. Through this study, tourism promotional organizations, tourism marketers and future researchers could gain an understanding of the generation Y domestic travellers' social media usage for tour planning in Sri Lanka. In conclusion, concern about maintaining updated and reliable information on social media related to tour planning is highly recommended. Tourism marketers need to focus on these circumstances as well as extensive opportunities are necessary to pay extra attention to reconstructing their social media strategy with this novel knowledge.

Keywords: Actual behavior; Behavioral intention; Domestic travellers; Generation Y; Social media; Tour planning

Paper ID: IRCUWU2022-093

The socio-economic impacts of elephant tourism on the local community: A study of captive elephants in Sri Lanka

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Elephant tourism has become one of the trendy concepts in the tourism industry in the world due to its negative and positive impacts. Despite a large number of attractive destinations, visitors include seeing the elephant in Sri Lanka in their travel itineraries since elephants have a dominant position within the country's religions such as Buddhism, Hinduism in Sri Lankan culture. Also, they have always been a symbol of power, prosperity, peace, and pride. Therefore, most tourists make greater demand to engage in elephant-related activities during their holidays in Sri Lanka. Considering the background, local community encouragement should be placed in the elephant tourism sector for captive elephants as it creates socio-economic impacts on the local community. Hence, the objectives of the study were to identify the socio-economic impacts of elephant tourism on the local community in Sri Lanka and to identify the challenges and opportunities to promote elephant tourism among international tourists. This study was conducted using a qualitative approach and the primary data was collected from the 16 respondents that consisted of managers, accommodation providers, mahouts and residents of Udawalawa and Pinnawala areas. Further, purposive sampling technique was used to formulate the sample of the study and structured direct interviews were used to collect data from the respondents. Moreover, interview transcriptions were analyzed by using the thematic analysis method. The findings of this study revealed that elephant tourism is directly affected socially and economically by the local community and strong collaboration among stakeholders is very important to maximize the positive impacts. Furthermore, this study makes important recommendations; to conduct random inspections of elephant tourism organization, awareness programs, and specific policies for elephant tourism to develop elephant tourism in a sustainable manner. And also, there should be proper infrastructure and elephant tourism marketing strategies to promote tourism among international tourists and establishing elephant protection groups are also very important to protect this endangered species.

Keywords: Captive elephants; Elephant tourism; Local community; Socio-economic impacts

Paper ID: IRCUWU2022-111

Impacts of tipping on employee motivation and performance in restaurant operation in Colombo District

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A tip can be defined as a gift or a sum of money tendered for a service performed or anticipated and it is a common reward system nowadays and especially a trend in the hospitality industry. A tip is given either in monetary form or non-monetary form to express the satisfactory feeling towards the service personnel. Many studies on tipping have been conducted from the perspectives of customers, but not from aspect of employees. Hence, this research attempted to identify the impact of tipping on employee motivation and performance in restaurant operation in Colombo, Sri Lanka. The sample was 125 operational level employees who serve the food and beverage departments in 3- and 5-star category hotels. Purposive sampling technique was employed to collect primary data from the sample. The collected data was analyzed by applying the quantitative analysis approach using Structural Equation Modeling (SEM) with the Smart PLS & SPSS data analysis software. The outcomes of the study showed that majority of the respondents prefer to receive monetary tips when working rather than receipt of non-monitory tips and the relationship between tipping and employee motivation and performance and mediating impact of motivation in between tipping and performance. In addition, it is revealed that employees prefer "tip pooling" technique to distribute the tips received. Furthermore, this study recommended to investigate on the impact of tipping in relation to other main functional departments of hotels.

Keywords: Employee motivation; Employee performance; Tip distribution method; Tipping

Paper ID: IRCUWU2022-119

Role of host community in promoting cultural heritage tourism in Northern Sri Lanka: Special reference to Jaffna Peninsula

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Tourism is one of the world's fastest growing industries and is a major source of income for many countries. Cultural heritage tourism is considered as one of the rapidly growing sectors in the tourism industry. Sri Lankan tourism industry also indicated a rapid growth while becoming a famous destination among travelers. However, the cultural heritage tourism sector of Sri Lanka shows slow growth amidst the rapid development of other tourism sectors. The Jaffna Peninsula in Northern Sri Lanka, has a great potential to promote tourism, but the awareness and involvement of the host community in cultural heritage tourism appears quite less. Hence, the objectives of this study were to examine the role of the host community to promote cultural heritage tourism in Northern Sri Lanka and to identify the challenges and opportunities faced by the host community in promoting cultural heritage tourism. The purposive sampling technique was used to select 13 respondents from government and private sector related with the hospitality tourism sector and host people were interviewed. A qualitative research design was adopted in this research. The data was derived from direct structured interviews and content analysis was utilized for data analysis. Findings indicated that most of the time policy and decision makers, financial supporters or investor role play by government sector personnel. And also host communities act as information providers and facilitators, entrepreneurs for Cultural Heritage Tourism (CHT) in Jaffna Peninsula. Moreover, finding identifies government influences, lack of understanding about CHT, Covid 19 and economic instability, and connectivity and host people mindset as challenges and geographic location and potential for significance attraction and younger generation interest and digital platform as opportunities associated with Northern Sri Lankan CHT tourism promotion.

Keywords: Challenges; Cultural heritage tourism; Opportunities; Promotion; Role of host community

Paper ID: IRCUWU2022-216

The role of area tour guides and their impact on sustainable tourism development in Ella, Sri Lanka

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The tourism sector is a fast-growing industry. As a result, many diverse stakeholders are involved in the operating activities. The engagement of involved stakeholders and their partnerships is an important part of sustainable tourism development in each tourist location. Area tour guides should play an important role in Ella since travellers require a clear image of offers, laws and regulations, and other desired social behaviors. The main objective of this study was to explore the role of area tour guides and their impact on sustainable tourism development in Ella area and investigate challenges faced by area tour guides in moving towards sustainable tourism in Ella. The study adopted qualitative methods. The population is local tourism stakeholders in the Ella area. The sample was obtained from Uva Wellassa University lecturers, Ella tourists' police, Uva tourism ministry, area tour guides and hoteliers. Primary data was collected from 15 respondents by using structured interviews and the sample was selected by using the purposive sampling method. The content analysis method was used to analyze qualitative data. The study revealed loss of intellectual abilities, unregistered operators, bad presentation abilities, their lack of knowledge, unstable service quality, security and protection, harassment, lack of women area tour guides, problems that related to commissions, less engagement of environment conservation, lack of tour guide training programs, lack of ethics affects sustainable tourism development. Furthermore, the recommendations are the need to display the license of area tour guide, must have a good knowledge of technology, a proper procedure to ban unlicensed area tour guides, need for effective training program, regular checks of the output of area tour guides, confirm that the area tour guide accommodations and other services are available, code of ethics, creating a fair salary system for area tour guide, give a proper amount of power and authority, environmental protection on their part and increasing women employment. Then, researcher laid the groundwork for such research concepts as role of area tour guides and their impact on sustainable tourism development in Ella.

Keywords: Area tour guide; Challenges; Ella; Sustainability; Tourism

Paper ID: IRCUWU2022-219

Tourism stakeholders' involvement for cultural tourism development in the ancient city of Anuradhapura

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Cultural tourism is considered to be one of the fastest growing sectors in the tourism industry. It has comprised the economic, environment and socio-cultural components and traditions of societies. This cultural tourism sector should be expanded further in order to maximize the social and economic benefits of this sector. Tourism stakeholders are known as the first link in the ladder of development in cultural tourism. Therefore, their involvement is acknowledged as essential for developing cultural tourism. This research aimed to examine the tourism stakeholders' involvement for cultural tourism development in the ancient city of Anuradhapura. Hence, the objectives of this study were to identify factors affecting tourism stakeholders' involvement in cultural tourism development in the ancient city of Anuradhapura and to explore the role of the tourism stakeholders in developing cultural tourism in the ancient city of Anuradhapura. The study's population has included all tourism stakeholders in the ancient city of Anuradhapura, and it was conducted using a qualitative approach. A sample of 15 significant tourism stakeholders was selected via purposeful sampling. The data was collected via a structured direct interview, and the interview transcripts were analyzed using qualitative content analysis. The findings of the study revealed that profession, willingness, power, daily routine and time, family background, religion, myths and beliefs as the major factors that affect tourism stakeholders' involvement in cultural tourism development. Furthermore, the role of tourism stakeholders was defined as preservation of cultural assets, building a good host-guest relationship, promotional efforts, maintenance activities, awareness activities, creating laws and regulations, and achieving an international market. To develop cultural tourism in Anuradhapura, building a proper long-term plann of infrastructure facilities, creating a system of strict legal regulations against illegal activities, implementing awareness campaigns, involving tourism stakeholders in the decision-making process, attracting more travellers through the social media platform, preserving the authenticity of indigenous dance, theater, dress, art, and crafts and promoting traditional products are suggested as recommendations.

Keywords: Anuradhapura; Cultural tourism; Involvement; Tourism stakeholders

Paper ID: IRCUWU2022-238

Potentials to promote sustainable gastronomy tourism in small and medium scale restaurants in Colombo District, Sri Lanka

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The number of small and medium-sized restaurants in popular tourist spots is expanding significantly with the development of the tourism and hospitality industry. Globalization and commercialization have also influenced many establishments. As a result, the restaurant industry is away from following sustainable practices. However, considering the current situation in Sri Lanka, establishing a sustainable gastronomy system is vital for the environment, community, and economy's well-being. Hence, the objectives of the study were to identify restaurant stakeholders' perspectives on promoting sustainable gastronomy tourism in small and medium-scale restaurants in the Colombo district. Primary data were collected from a sample of 15 respondents including tourists, staff members of small and medium-scale restaurants and tourism-related professionals in the government sector. Stratified purposeful sampling was used to select the sample and in-depth interviews were used to collect data. Adopting a qualitative research approach, collected data were transcribed and analyzed using the thematic analysis method. The findings of the study illustrated that promoting sustainable gastronomy tourism is important but people do not have awareness of that. Sri Lankans have inherited unique gastronomy cultures and therapeutically valuable natural food ingredients which are possible to be promoted as unique tourism products. Through that, Sri Lanka has the potential to become a popular gastronomy tourism destination with a unique identity. Therefore, the study suggests creating awareness about sustainable gastronomy tourism through different programmes and media promotions; creating educated and experienced professionals in the sustainable gastronomy tourism sector, and establishing government rules and regulations to set up sustainable gastronomy concepts within restaurants

Keywords: Potentials; Restaurants; SME; Stakeholder perspectives; Sustainable gastronomy tourism

Paper ID: IRCUWU2022-246

A study of domestic tourists' buying behavior on railway tourism in Sri Lanka

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Railway tourism as a niche market in Sri Lanka tourism has a huge potential to promote among both local and foreign tourists. In Sri Lanka, three major railway lines are operating as one of the modes of transportation in the island. Namely, the main line from Colombo to Badulla, the Northern line from Polgahawela to Kankasanthurei and the coastline from Colombo to Beliatta. Along the way of all three railway lines, many tourist attractions can be easily accessed where tourists may gain valuable experience within their budgets. During the Covid-19 pandemic, international tourist arrivals to the country plummeted destroying the entire industry. At present, industry requires resilience from all the possible ways to uplift the industry. Among those, domestic tourism has been prioritized, where railway tourism can be easily promoted. Admitting to this, the present study mainly aimed to identify the factors which shape the domestic tourists' buying behavior on railway tourism in Sri Lanka while discussing promotional strategies that can be used for railway tourism in the future. The study used both quantitative and qualitative approaches. The sample consisted of 200 domestic tourists and 05 station masters to collect primary data. Mainly regression analysis and content analysis methods were used to accomplish the objectives of the study. The findings highlighted that the shaping factors positively related with buying behavior of railway tourism (tourist attractions, railway amenities, reliability of the service, safety and security and other ancillary service). Further, this research recommended some strategies such as development of infrastructure and ancillary services, promoting railway activities and enhancing the awareness about railway tourism to promote railway tourism in Sri Lanka. Moreover, future studies can be carried out on developing the railway tourism industry and promoting the facility among international tourists.

Keywords: Buying behavior; Domestic travelers; Niche market; Railway tourism

Paper ID: IRCUWU2022-258

A study on conflicting behaviors between travel agents and tourist transport providers in Sri Lanka

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Tourism is one of the biggest industries in the world which has a significant impact on the global economy. The Sri Lankan tourism industry has achieved a new milestone with the increased number of arrivals in the past few years before the spread of the Covid-19 pandemic. At the same time, it increased the different types of stakeholders' involvement in the tourism industry. Travel agencies and tourist transport providers can be identified as the two major sectors of it. However, the various conflicts between these two parties had affected the efficiency of the entire tourism industry. Hence, the central focus of the study was to identify factors influencing the conflicts between both parties and then the researcher was examining consequences of those conflicts. The purposive sample methodology was used to derive the sample from the population. Structured interview method was used to collect primary data from 5 travel agents and 10 tourist transport providers who are engaged with each other in the tourism industry to supply service for their clients. In addition, collated data were transcribed and analyzed by using a content analysis method. The findings revealed several key factors influencing the conflicts between the two parties. These include conflicts over payments for tourist transport vehicles, conflicts over delayed payments, conflicts over the staff quality of transport service providers, conflicts over the quality of passenger transport vehicles, conflicts over transport staff facilities, and communication issues between the two parties. These conflicting behaviors had various consequences such as being harmful to the tourist satisfaction, tourist complaints about the service, foreign agent's complaints regarding service, harmful to business relationship and also impact to their profitability. Furthermore, recommendations of the study help to maintain a smoother business operating environment while minimizing conflicts between two parties. In addition, it provides some suggestions for government bodies of the country to minimize the conflicts between travel agents and transport providers. Thus, this research study will help future researchers to find out the kinds of literature, knowledge, and information to develop their literature on tourism and transportation industries related studies.

Keywords: Conflicting behaviors; Stakeholders; Tourist transport providers; Travel agents

Paper ID: IRCUWU2022-308

A study on corporate social responsibility initiatives of the event industry in Sri Lanka

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In recent years, globalization and economic trade have sparked a renewed interest in corporate social responsibility (CSR), resulting in increased business complexity and new expectations for greater transparency and corporate citizenship. Furthermore, while governments have claimed full responsibility for improving people's living conditions for a long time, society's needs have surpassed governments' ability to meet them. Event planning is a large industry with a significant impact on organizations and brands in general. The scope and range of an event determine the number of people involved in organizing it. However, there is a lack of empirical evidence about corporate social responsibility initiatives in the event industry in Sri Lanka. The major objective of the study is to identify the existing corporate social responsibility initiatives in the event industry in Sri Lanka. The purposive sample methodology was used to collect primary data from 15 event managers who are members of the Sri Lanka Association of Professional Conference, Exhibition, and Event Organizers. In addition, the purpose of the study is to elicit responses through structured interviews, and the collected data were transcribed and analyzed by using content analysis. Findings show that social and corporate initiatives have had a significant impact on raising awareness of CSR in the event industry and that there are no effective CSR initiatives in the event industry in Sri Lanka. Findings show that social and corporate initiatives have had a significant impact on raising awareness of CSR in the event industry. This study helps build a good relationship between the society and the event industry. This will give a better understanding of how the high demand, high return and highly competitive event industry can increase its effectiveness through Corporate Social Responsibility Initiatives.

Keywords: Constraints; Corporate social responsibility; Event industry; Initiatives; Opportunities

Paper ID: IRCUWU2022-322

Explore the challenges and change practices towards frontline managers in turnaround management process during Covid-19 in Sri Lanka

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The Covid-19 pandemic has turned into a global health crisis affecting many industries around the world including aviation. As a result of the rapid spread, the government imposed travel restrictions to limit the spread. These government restrictions had a negative impact on the tourism and aviation industry. Furthermore, travel restrictions gain a direct impact on the financial position of aviation sector organizations. This study aimed to emphasize the challenges faced by frontline managers in the turnaround management process during Covid-19, to explore the change practices to improve the turnaround management process and execute current strategies effectively and to identify the role of frontline managers in order to achieve turnaround management objectives during a crisis. Data was collected by the researcher from 15 structured interviews using purposively selected sample with frontline managers working for four major operational departments in Bandaranayake International Airport Sri Lanka and collected data was analyzed using content analysis method. The organization has implemented several turnaround management strategies to overcome financial drop down caused by Covid-19 restrictions. This study demonstrated the significance of understanding the challenges faced by frontline managers during turnaround management process and the effective change practices to overcome those challenges and survive during a crisis. Findings of this study indicated that frontline managers faced five main challenges during implementation of the turnaround management strategies. First health risk, second TAM strategies, third lack of technology, fourth inadequate human resource and last poor decision making. Moreover, the study explored two main change practices to overcome the challenges which are staff training and employee cost cutting. Finally, decision making and new technology was identified as the most important to include in the frontline manager job role during a crisis. Based on these findings, this study recommends building for the future, introducing feedback channels, assigning decision making to the frontline manager's role, improving understanding, and creating a new task force by providing comprehensive training.

Keywords: Aviation sector; Covid-19; Frontline managers; Turnaround management strategy

Paper ID: IRCUWU2022-348

Identifying the importance of food photography on online food delivery in restaurants located in the Colombo city

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During the Covid-19 pandemic, Sri Lankan restaurants lost millions of dollars, and shut down entire operations irrespective of the size. Some of them converted operations into online food ordering platforms with their capabilities. However, it drives benefits for both consumers and the operators because of unique characteristics associated with it. These online food delivery services (OFDS) heavily rely on food photography in order to attract and make a potential customer into a buyer. Therefore, this research aimed to identify the importance of food photography in online food delivery in restaurants located in Colombo city and the types of issues faced by the restaurant operators due to the usage of food photography on OFDS. To achieve the objectives of the study, primary data was collected using the semi-structured interview method. The sample of 12 restaurant operators running OFDS and 10 food consumers who are ordering those OFDS was selected using purposive sampling technique. The collected data were analyzed using thematic analysis. The results revealed that seven importance factors; ease of describing dishes, effective linkage with social media sites, positive effect on sales, convenience of online food ordering, easiness of remembering restaurant's online menu, understand the food and use for food order customization and four major issues and challenges such as issues to comply with consumer's food photography expectations, to engage in professional food photography, lack of support from outsourced partners and OFDS system issues faced by operators because of food photography use in OFDS. Based on the findings, the study recommends enhancing the awareness and knowledge of employees, quality, use of mobile photography, display descriptive food photographs, daily visual aspects on social medias and use of realistic food illustrations. Future researchers could use a mixed research method to broaden the scope of the study. Furthermore, researchers can focus their studies on a different geographic area and a different niche restaurant OFDS service area.

Keywords: Food photography; Online food delivery service; Online food ordering; Restaurants

Paper ID: IRCUWU2022-401

Harmonizing luxury and sustainability: Potential of developing luxury sustainable tourism in Sri Lanka from hoteliers' perspective

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Sustainable tourism emerged to mitigate negative tourism impacts and to ensure equal benefits to everyone engaged in tourism, whereas luxury tourism built on addressing unique, more comfortable and personalized experiences pursued by high-end travelers. The purpose of this study was to examine the managerial perception on sustainability tourism practices in luxury hotels and how they have compromised luxury and sustainability in their hotels. This study was conducted through a qualitative approach. Out of 37 hotels that were awarded National Sustainability Tourism Certification in Sri Lanka, 10 were selected through purposive sampling technique and conducting in-depth interviews with semi-structured questions, with the property naturalists and engineers. The researcher also followed up an observation checklist. Data was analyzed employing content analysis. Results indicated that luxury hotels have been switching onto sustainable tourism, recognizing sustainable tourism trends, increasing guests' awareness and purchasing behavior towards sustainable products, cost effectiveness and green marketing as perceived by managerial level staff. Sustainability policy documents, sustainability officers, environment conservation and tourist information centers and CSR projects are among the key actions that have been executed by the luxury hoteliers in different magnitudes. Results further demonstrated the current sustainability practices of luxury hotels in Sri Lanka under themes; environmental, economical and socio cultural. Findings amalgamated that the luxury hotels have focused on management of air quality, waste, water, environment and biodiversity conservation for enhancing guest satisfaction, chemical pollution control, zero plastic mission. For economic sustainability, they try to ensure cost effectiveness through energy conservation and enhancing self-sufficiency, benefit to the community and the employees from the hotel, guest satisfaction for long term customer relationship management. The analysis evoked that there is a great potential to develop luxury sustainable tourism in Sri Lanka with regards to the hotel sector. More government support, a well- developed sustainability grading system for hotels, more actions for coastal and marine conservation, more renewable energy sources, a green tax for tourists, sustainable tourism fund, introducing and increasing awareness of sustainable tourism products are recommended to further sustainable hospitality and tourism management in Sri Lanka.

Keywords: Harmonizing; Hotels; Luxury; Sri Lanka; Sustainable tourism

Paper ID: IRCUWU2022-404

Perceived potentials of promoting Kandy city as a traditional fashion tourism destination in Sri Lanka

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Fashion industry is a worldwide industry that produces and sells clothing, and it is one of the most influential phenomena in the world. People travel to grasp, experiment with, and use fashion as part of fashion tourism. One of its major segments can be named as traditional fashion tourism. Hence, this study was to identify the potentials to promote Kandy city as a traditional fashion tourism destination in Sri Lanka. Research objectives were to identify the scope of traditional fashion tourism and to study the traditional fashion industry stakeholders' perspective on potentials to promote traditional fashion tourism in Kandy city. Primary data were collected from the 15 selected fashion and tourism industry stakeholders in Kandy city. Snowball sampling was used to formulate the sample and semi-structured interviews were used to collect data. Under the qualitative research approach, collected data were transcribed and analyzed by using the thematic analysis method. The findings of the study illustrated what is traditional fashion tourism, what are the including areas for this sector, supply adequacy, and market segments, opportunities, and challenges to promote Kandy as a traditional fashion tourism destination in Sri Lanka and the future directions of this sector. Further, this study recommends some policy implications such as building a strong manufacturing basis to support the fashion industry and conducting awareness programs, creating a comprehensive national tourism policy plan, and establishing an entirely specialized business segment (designer market) for designers.

Keywords: Designer market; Fashion industry; Fashion tourism destination; Traditional fashion tourism

Paper ID: IRCUWU2022-444

International tourists' perception towards rural tourism in Sri Lanka and its authenticity: Empirical evidence from Hiriwadunna

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Local way of living in Sri Lanka has been changing with the technological advancements, colonization, tourism and globalization. The past life led by the local community strived to maintain in certain rural villages exclusively for tourism development. Offering tourists more real, authentic experiences with greater insights into local ways of life is important and trendy in the modern tourism industry. The aim of this study was to discover the tourists' perspective towards rural tourism in Sri Lanka, importance of authenticity and how it can be developed to ensure authenticity. Applying a qualitative approach, the study was done collecting primary data from 10 international tourists visiting rural tourism site; Hiriwadunna, Sri Lanka through in-depth, semi-structured interviews employing convenient sampling techniques. Collected data was analyzed using content analysis. Findings stated that tourists have noted Sri Lanka rural tourism setting as a context with more attached communities, difficult to access, more nature bound and less developed life, accommodation similar to local communities' and interference for the tourists' privacy due to community behavior . It was further investigated that travellers' interest for a simple, nature bound life, desire for novel experience, hospitality the rural community affords, and seeking originality in rural attractions and desire to learn new ways of doing things emphasized the importance of integrating authenticity and rural tourism. Tourists' aversion to alienation and desire to be treated as part of the social setting, ensuring privacy concerns, maintaining nature bound, less modified setting simultaneously maintaining traditional way of life, more ways to engage for tourists were highlighted as the ways of integrating authentic rural lifestyle into tourism industry from tourists' perspective. Thus, results conclude that authenticity is a must factor in rural tourism and rural tourism sites in Sri Lanka still conceive authentic features with more potential to further authentic rural tourism. Awareness sessions for the local community about the negatives of soliciting, introducing new ways of exposing tourists to rural culture, more cultural events, policies for the way forward of rural tourism and educating the rural community and tourism stakeholders on tourist handling, securing their privacy are recommended for more authentic rural tourism development.

Keywords: Authenticity; Hiriwadunna; Tourists' perception; Rural tourism

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HUMANITIES, SOCIAL & LIBRARY SCIENCES

Paper ID: IRCUWU2022-010

A critical discourse analysis of the English usage in the Tuk-Tuk drivers' community of Southern Province, Sri Lanka

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This study primarily examined the presence of power hierarchies, hegemonies, ideologies and social practices that are connected to English language proficiency and tourism in the *tuk-tuk* drivers' community of Sri Lanka. In this qualitative study, Critical Discourse Analysis (CDA) was used as the main theoretical framework to analyze the data which take the form of semi-structured interviews conducted with ten *tuk-tuk* drivers from ten different locations in the Galle district. These locations indicated a high amount of tourist traffic allowing the researcher to connect with drivers who have more exposure to foreign clients. The findings of the study reflected the status-quo of power relations that have been created through the inequities in English language proficiency among this community.

Keywords: Critical discourse analysis; English proficiency; Galle; Sri Lanka; Tourism; Tuk-tuk drivers

Paper ID: IRCUWU2022-013

The role of reflective journals to understand and develop own teaching practice

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The term 'self-reflection' is developed as merging personal experience, beliefs and thoughts. Reflective practice is a form of mental processing to reflect on one's action. As a professional teacher, it involves a cyclic process as planning, acting, observing and then reflecting. This paper discusses changes in my teaching and seeks to answer how my experience has led to changes in my attitudes, beliefs, and teaching behaviour. Teaching journals and self-reflection and evaluation questionnaires were used to investigate and evaluate change. A personal language teaching methodology profile was adopted for my research. It evaluated the need to conduct a 'baseline study' in order to objectively evaluate change. Johnson's idea of the inevitability of change summarized important lessons for dealing with my reflective journals successfully. Teachers change their perceptions from different experiences. All these experiences lead to a student-centered classroom. The major change was that there is a greater understanding in the consideration of affective factors of students in the classroom. Whenever students struggle with the sentence patterns related to writing ability, the technique of meaningful drilling which in conventional language teaching wisdom has a role to play. Likewise, some changes were anticipated, some were monitored changes and some can be adapted for a change. But all these were influenced by forces outside their immediate control. The changes were towards the self-generating humanistic approaches. They were towards the feasibility of students. In the final analysis, all these can be categorized into change management. The reflective practices acted as catalysts for change. It infused values into a professional identity. This emphasized personal values being integrated into one's professional identity, which in turn will produce a personal code of conduct.

Keywords: Change; Personal; Reflective journals; Self-reflection; Values

Paper ID: IRCUWU2022-017

The effectiveness of using padlet as an interactive tool for practicing grammar in the second language classroom

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Since language educators are constantly exploring creative strategies for teaching and learning, technology has become a popular and effective mode of delivering language content. In this light, the present study examined the benefits of using padlet in the second language classroom. The language component selected for the study was grammar because it has been observed by the teacher that even though grammar is a key component of every classroom lesson, students demonstrate less enthusiasm and little or no progress in the acquisition of grammar. 30 second year undergraduates following the Bachelor of Science degree program at a national university were selected for the study. They were a mixed ability group and padlet was used for practicing their grammar over the period of two months. The students were assigned activities based on the grammar units covered in the curriculum of their compulsory English language module. Prior to using the application, they were given ample instructions on creating and using a padlet account. At the end of each classroom lesson, different grammar activities were prepared and shared on padlet. The performance of the students was monitored throughout the tasks and the effectiveness and impact of padlet as a learning mode was determined via teacher's observations and the students' responses to a questionnaire distributed at the end of activities. It was observed that, although the students are reluctant to engage in grammar activities in the traditional learning setting, practicing through padlet enhanced their engagement and enthusiasm. As per the findings of the questionnaire, the students were motivated to learn via padlet and noticeably, grammar had become an interesting component when it was practiced on padlet. Further, it was understood by the responses that learning via padlet was a refreshing experience for the students and they were comfortable in initiating discussions through padlet rather than in the physical classroom. In consideration of these findings, it can be concluded that padlet can be successfully incorporated as a practicing tool of grammar in the second language classroom. The study recommends the use of padlet for practicing other language components as well.

Keywords: Grammar practice; Learner motivation; Padlet; Second language

Paper ID: IRCUWU2022-023

A comparative analysis of the basic sentence structures with special reference to English and Chinese

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More than 7,000 languages are spoken in today's world. Each language consists of its own set of rules on how they use that particular language. There are similarities between languages while there are dissimilarities among languages. The present study mainly focused on the differences of sentence structures with special reference to English and Chinese languages. Sentence structure is how all the parts of a sentence fit together. If anyone wants to make more advanced and interesting sentences, that person first have to understand how sentence structure works. When learning a new language, sentence structure is one of the topics in which you have to have a solid foundation. The sentence structures in different languages are usually very different. They may have some similarities, but most likely when adding more details in the sentence, those details are put in different places within a sentence. In this study four main sentence structures in English language; simple sentences, compound sentences, complex sentences, and compound-complex sentences, and time based sentences in which they talk about a particular time or time duration and location based sentences were compared with sentences in Chinese language. Examples for the above sentence patterns were first found in English language and the same sentences were converted into Chinese language following the sentence structures of Chinese language. It was noticed that the simple sentence and compound sentence structures acted similar in both languages while in complex sentence and compound-complex sentence there were differences in the place of words used in the sentence. Moreover, there were differences in the word order of sentences which indicate time and location as well. In a time where most of the learners found it hard to acquire a foreign language due to different sentence structures, and also for the learners who try to apply the same sentence structure of the language you have already learnt specially English language, as it is considered as a linking language, to other foreign languages, this study assists to get in the right pathway to clear problems on sentences structures.

Keywords: Chinese language; English language; Foreign languages; Language learning; Sentence structures

Paper ID: IRCUWU2022-061

Divorce as a family affair among newly married couples in Jaffna society: A content analysis

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Divorce is a legal status for an end of marriage life. In the Jaffna district, the number of divorces among newly married couples has increased recently. This study aims to identify the trends and causes of divorce among newly married couples in the Jaffna society. The study considered the matrimonial profiles of the EQ marriage service online platform accessed from January 2022 to May 2022. The online platform offers various easy-to-use and quick facilities to the customers. A mixed method was used for this study. Primary data sources include matrimonial profiles, key informant interviews, and case study methods—the cluster sampling technique employed 99 divorced matrimonial profiles to draw a statistically representative sample. The analysis used for this study was qualitative and quantitative content analysis. Accordingly, quantitative data were analyzed using SPSS version 21. The qualitative data used thematic analysis. The results revealed a link between the trends and causes of divorce among newly married couples in the Jaffna society. Of the 99 divorced profiles, 64% were males, 36% were females, and the majority of the divorced males lives abroad (Europe). The reason was that frequent war and displacements have affected the Jaffna district. Therefore, men and youth (boys) moved abroad and got their partners from Jaffna. On that basis, men are more likely to apply for a divorce based on gender and anticipate remarriage. Nearly three-fourth (90%) of the divorced belong to Hinduism, whereas more than one-fourth (10%) belong to Christianity. Significantly, the divorced cases were high among the Vellalar high caste group (79%) in the caste-based stratified Jaffna society. Further, in this study, 74% of the divorced cases belonged to the category of couples below 35. In contrast, the comparative majority of divorced cases belonged to Jaffna society's government and private sector employment category. This study recommends more awareness-raising programs at family, religious, and community levels to reduce the divorce rate among newly married couples.

Keywords: Diaspora; Divorce; Marriage; Tamil grooms

Paper ID: IRCUWU2022-077

Code switching: the functional usage in the Sri Lankan ESL classroom context

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Sri Lanka is a multilingual country that mainly consists of Sinhala, Tamil and English speakers. Therefore, Sri Lankan ESL classrooms include learners who have the ability to speak and understand one or more of these languages. The undergraduates at the tertiary level are facilitated by ESL courses because English stands as a requirement for academic achievements and numerous employment opportunities. Moreover, code switching is widely used in multilingual and multicultural communities such as Sri Lanka. However, the teachers are reluctant to accept the use of first languages (L1) in the ESL classroom, assuming that it is a barrier to acquire the target language. Furthermore, students face a dilemma whether to use their first languages in the ESL classroom or not, due to the diverse notions in society regarding English. Therefore, the objective of this study was to investigate the functional usage of code-switching used by the teachers and learners in the tertiary level ESL classroom context in Sri Lanka. A random sample of 30 Intermediate-level first-year undergraduates who study at the Faculty of Management and Finance, University of Ruhuna participated in the study. These learners study in the English Language Intensive Course (ELIC) conducted virtually using Zoom Application in their first academic year to cover all four language skills. Moreover, the qualitative research design was implemented in the study. The duration of the session was 3 hours and it was audio recorded using the zoom application. Subsequently, the speech sample was transcribed and analyzed using content analysis. The findings of the present study showed that ESL teachers and learners both use code switching for varying purposes. Hence, building rapport in the classroom, clarification of instructions and addressing complex topics or vocabulary are the functions of code-switching used by teachers in the ESL classroom context. The functional usages of code-switching used by learners in the ESL classroom are clarifying messages, filling gaps in a conversation and compensating for the lack of competence. However, it is recommended to employ code-switching to make students feel motivated and encouraged while setting boundaries to moderate code-switching to create a more productive ESL classroom.

Keywords: Code switching; English learning; ESL; ESL classroom; Multilingual classroom

Paper ID: IRCUWU2022-084

Enhancing oral communication skills in virtual classrooms through cooperative learning

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Cooperative learning, although not a modern approach, provides opportunities for the ESL learners to practise the language that enables them to become more confident in using and producing English when working in groups. Focusing on promoting the oral communication skills of the ESL learners, this study attempts to shed light on the importance of employing cooperative learning strategy in virtual classrooms. The present study was carried out with fifty (50) first year undergraduates from the Faculty of Arts, University of Jaffna for one semester. Pre-test, post-test, classroom observation, learners' feedback report and informal discussions were used as data collecting instruments. The samples were divided into control and experimental groups and taught by regular method and through cooperative learning method respectively for one semester via virtual platforms. Mixed methodology was adopted to analyse the data. At the end of the research, it came to light that engagement and performance of the experimental group drastically improved and they remarkably developed their communication skills after the implementation of cooperative learning than the control group members. In the post-test marks also, the experimental group scored higher than the control group. Thus, the method found to be constructive to our context and it is recommended that cooperative learning can be adopted by ELT practitioners to enhance the oral communication skills of the tertiary level learners.

Keywords: Communication; Cooperative learning; ESL classroom; Speaking skill; Tertiary level

Paper ID: IRCUWU2022-141

Effect of stress and anxiety on decision-making in laboratory employees during Covid-19 pandemic in Sri Lanka

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Challenging circumstances that elevate levels of stress and anxiety affects the physical, mental and social well-being of people. The main aim of this research was to identify the impact of stress and anxiety on decision-making during a pandemic. The study objective was to highlight the effects of high stress and anxiety on decision-making ability among the laboratory employees with the increase in PCR samples for Covid-19 testing in Sri Lankan urban laboratories. For this study, 220 employees from the urban Sri Lankan labs filled a mixed survey circulated widely through social media and other platforms. Data gathered from this survey was analyzed using correlation analysis. The results showed a positive correlation (r= 0.29) between stress and anxiety and between stress and regretful decision (r=0.26) whereas a negative correlation was found with successful decision (r= -0.28). Factors such as age groups, gender and marital status further influenced these parameters. Our study showed that when the number of samples increased in labs, it led to increased levels of stress and anxiety among the employees, which led to poor decision-making. Furthermore, we highlight that laboratory managers and relevant authorities can take necessary actions to provide a supportive environment for the employees that can increase their quality of life.

Keywords: Anxiety; Decision-making; Laboratory; Pandemic; Stress

Paper ID: IRCUWU2022-247

Exploring etymological roots of Covid-19 vaccine hesitancy: A study of young adults in Sri Lanka

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Vaccination has been identified as the most effective and safest method of combating the public health risks associated with the novel Covid-19 pandemic era. However, vaccine hesitancy stands out as the foremost barrier to global vaccination coverage. In order to explore its nature in Sri Lankan context, this study was conducted with the aim of investigating underlying concerns of Covid-19 vaccine hesitancy among young adults in Sri Lanka. This research was carried out as a cross-sectional survey utilizing a mixed method, which is majorly based on five districts in Sri Lanka. An online self-administered questionnaire was used to collect data from 601 Sri Lankan young adults aged 15 to 35 years, who were selected via crowdsourcing followed by simple random sampling. The data were analyzed using descriptive statistics and thematic analysis. As indicated by findings from quantitative analysis, Covid-19 vaccine hesitancy has gradually increased over three phases of hesitancy: initial doses (37%), booster doses (59%), and response to future vaccination (60%). The female population, married respondents, and Sinopharm receivers showed a higher hesitancy towards the Covid-19 vaccine. Moreover, most cited concerns with vaccines reported as side effects and allergy issues. In terms of vaccine awareness, the majority show less awareness, owing to their increased exposure to social media information (60%). Furthermore, while 80% of respondents had a positive attitude toward vaccination, they were becoming increasingly hesitant to receive the vaccine. According to 34% of respondents, the vaccine was prescribed because it was mandated by a third party. The findings of an in-depth interview with 30 respondents revealed that there were several novel concerns with special reference to the Sri Lankan context. After receiving initial dosages, the majority of respondents were concerned about "exhaustion and body pain," "impaired eyesight," and "menstrual cycle disorders" which caused them to be hesitant on receiving the subsequent vaccine doses. This research provides valuable insights to address uncertainty about Covid-19 vaccines by increasing confidence in vaccine safety and efficiency, which can help guide future efforts to increase Covid or any other vaccination program acceptance in Sri Lanka.

Keywords: Concerns; Covid-19; Hesitancy; Vaccine; Young adults

Paper ID: IRCUWU2022-276

Journey of medical education at the Faculty of Health-Care Sciences, Eastern University, Sri Lanka

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Academic atmosphere has a significant role in every institute in determining the success and effectiveness of the programmes. It has a strong impact on students' learning experience. Moreover, it affects students' level of enthusiasm and degree of learning. It is everyone's responsibility to enhance the standard of the programmes with students' satisfaction and achievement. Therefore, it is important to study the academic atmosphere through getting feedback from the students. This study aimed to assess the undergraduates' perception of the academic atmosphere at the Faculty of Health Care Sciences (FHCS), Eastern University, Sri Lanka. A case study was conducted with a qualitative method at FHCS in 2022. The study population included final year medical undergraduates. A self-administered questionnaire with open-ended questions was used to collect data using google forms. On their perceptions from the first year to the final year, data analysis was done using a thematic analysis approach and emerging themes were categorised. Three core themes which emerged across data sets were indented. The themes are Transition, Relationship with the staff, and Challenges. The study revealed mixed perceptions with more positive insights towards coping with the Transition and Relationship with the staff. Students have more concerns about available resources in the clinical environment. Accordingly, the Medical Undergraduates successfully handled the transition status with the support of the staff while they highlighted the challenges in the clinical setting.

Keywords: Academic atmosphere; Challenges; Medical undergraduates; Relationship with the staff; Transition

Paper ID: IRCUWU2022-299

Enhancing ESL learning process by accommodating autonomous learning of the students at the tertiary level

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In ESL classrooms, autonomous learning has become a challenge because the learners have a lack of interest and enthusiasm to learn ESL. On the other hand, though some learners have interest in learning, they have shyness and fear to speak in English, lack of vocabulary to convey the message and so on. Therefore, this experimental study was conducted to identify how to enhance the ESL learning process through accommodating autonomous learning of the students. The samples for this study were chosen from the ESL first year students from the Faculty of Management studies and Commerce, University of Jaffna. The data were collected through pre-test, post-test and classroom observation. The students were divided into two groups: a control group and experimental group. SPSS statistical package and paired-sample t-test were used. The duration was for three months. The experimental group was taught through the teaching strategies which promote learner autonomy whereas the control group was taught through traditional teacher chalk and talk methods. The teacher observed significant changes in the learning behaviour of the two groups. A post- test was conducted to know the consequences of the study. Finally, the expected outcomes were to provide appropriate scaffolding for the ESL learners to become autonomous and to create the classroom culture where learner autonomy is accepted and applicable. Moreover, the findings showed the learners of the experimental group have become independent learners with self-confidence. This study also embodies the gradual improvements of the learners of the experimental group in their meta-linguistic awareness and multi literal knowledge flow.

Keywords: English as a second language; Learner autonomy; Scaffolding; Teaching and learning

Paper ID: IRCUWU2022-340

The impact of parental separation on empathy and coping amongst young adults in Sri Lanka

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In Sri Lanka, the divorce/separation rate was 1.2 percent in 2009/10, but it jumped to 1.7 percent in 2016. It has been estimated that the prevalence of divorce/separation within homes is growing, which affects all members of the family unit. Many detrimental consequences on children's well-being have been connected by research on parental separation, which can last into adulthood. This cross-sectional study aimed to assess various aspects of psychological effect such as coping levels and whether coping predicts the level of empathy owned by young adults who live with Two Parent (TP), married families as opposed to Single Parent (SP) families as a result of parental separation or divorce. Young people who have had such an influence for more than two years were classified as susceptible, whereas young adults who have just been subjected to such a condition may be at risk. N=101 young individuals aged 18 to 24 participated in this study. Purposive sampling was utilized to recruit participants via social media in the form of an online survey. Participants were given a demographic form, a coping scale, and the Toronto empathy questionnaire in order to assess their empathy and coping levels. A t-test revealed a significant degree of coping (p=0.017) among persons from TP households as compared to individuals from SP families, but no significance (p=0.705) of empathy. A larger significance (p=0.017) was discovered between coping and household type, whereas no significance was found when gender was included (p=0.058). The variance between coping and household type was 4.7 percent, with an increase of 3.7 percent when gender was included. Even after gender was included (p=0.513), there was no significance (p=0.587) between empathy and household type, whereas the variation between empathy and household type was -0.07 percent, which remained consistent when gender was included. This leads to the conclusion that people from TP households deal better than those from SP families, even if coping does not predict empathy.

Keywords: Coping; Divorce; Empathy; Parental separation; Young adults

Paper ID: IRCUWU2022-346

Dostoevsky, shipman and criminal guilt: A criminological examination of guilt in neurosis and psychosis

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This study examined the feeling of guilt within the structures of neurosis and psychosis through two case studies. The first is the highly contested study by Sigmund Freud titled 'Dostoevsky and Parricide' which maps the pathology of guilt in a neurotic, using psycho-analysis on parricide as the primal crime. The second case study was Darian Leader's psycho-analysis of the prolific serial killer Harold Shipman and his hypothesis of transgression/crime of the psychotic. Though the essay will utilize the aforementioned case studies as the base sources, it will also interpolate the analysis with arguments of other theorists. Furthermore, in both these examinations, this essay will identify the role of guilt in characterizing an individual's relationship with the internal (superego) and external (social law) normative orders. The public policy standing of the study is that to truly understand guilt, the capacity to feel guilt and its impact on crime, both psycho-analysis and the criminal justice system must synthesize to investigate the origin of guilt and its implication on an individual's propensity for transgression/crime.

Keywords: Guilt; Neurosis; Psychology and crime; Psychosis

Paper ID: IRCUWU2022-352

An exploration of trends in unpaid care work in Sri Lanka

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Although the critical role played by unpaid care work (UCW) in sustaining societies has been increasingly recognized, few studies are available on the subject due to issues such as difficulties in data collection. More recently however, time use surveys have been used to analyse UCW and the factors influencing its gendered nature. The current study employs descriptive statistics and a multiple regression estimation to analyse data available in the first nationally representative time use survey in Sri Lanka. The findings suggested that similar to global trends, UCW was highly feminized in Sri Lanka and was affected by a range of demographic, social and economic factors. Age, residence in the urban sector and higher education levels tend to be positively associated with the time spent on UCW, whereas the time spent on paid work and being unmarried were negatively associated. This study therefore highlights the need to mitigate the undue burden of UCW by improving access to labour-saving devices and services and promoting more flexible gender norms.

Keywords: Gender; Time use survey; Unpaid care work; Women

Paper ID: IRCUWU2022-359

Academic achievement and home school partnership: Parents' views on home learning environment

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Based on a set of collateral observations done in a study that investigated the impact of the home learning environment on the academic performance of primary students in three schools in the Western Province of Sri Lanka, this paper presents the parental views on the impact of the home learning environment on students' academic achievement. The research investigated the applicability of the concept 'Home Learning Environment' in relation to a child's level of learning. A mixed method was used and a purposive sample of fifty parents from three schools in the Western Province and respective subject teachers contributed to the study as participants where data was collected through a questionnaire with forty questions under four distinguished categories and semi-structured interviews for parents. Out of the 50 participants who returned the questionnaire, 76% were mothers while 24% were fathers, suggesting that mothers may be more involved in primary students' academic work. The findings of the study revealed that the majority of parents in the sample agreed upon the significance of parents' involvement in school and community for student development. 82% of the participants understood the value of taking their child's contribution while making decisions related to education whereas 76% realized that they have a significant role in shaping the overall development of the child. Parents were generally happy with the support they get from the school in assisting with the student's homework and were positive about participating in parents' meetings. However, the study found that 72% of the parents did not know how to handle their children during misbehaviour and most of the parents did not have adequate knowledge of child psychology and its implications. Parents generally believe that academic performance is a priority and the school should take it as a major responsibility and assist parents in relation to it. The findings of the study suggest that although parents are aware of the importance of parental contribution to child development, there are gaps to be filled by the authorities by broadening the parental awareness programmes and providing more opportunities for strengthening the parent-teacher relationships.

Keywords: Home learning environment; Home-school partnership; Parental contribution; Student performance

Paper ID: IRCUWU2022-363

Conceptualizing inquiry-based language learning in English language teaching classrooms

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Inquiry-based learning is a form of active learning that centralizes students' questions, ideas and observations in the learning experience. According to ELT practitioners, inquiry-based learning assists the teachers to play an active role throughout the process by establishing a culture where ideas are respectfully challenged, tested, redefined and viewed as improvable. It enables students to move from a position of wondering to a position of enacted understanding and further questioning. Generally, in ESL (English as a Second Language) classrooms, the students tend to deliver their presentations on rote memorization and pattern drilling, especially for speaking skills. They memorize the vocabulary, phrases, and grammar rules and they could not deliver them in a desirable way. This makes the learners become passive and assists low-level thinking skills as they were encouraged to memorize speeches and deliver. To explore inquiry-based language learning as a strategy to solve the issue, the researcher attempted to find out the practicality of this learning theory in the classroom. In a mixed-method approach the researcher employed an intervention with the undergraduates of the University of Jaffna who offer political science as their core subject. The participants of the research were administered open-ended pre-questionnaire and post-questionnaire before and after their intervention. A pre-test and post-test were also conducted. The data collected from the questionnaire and pre and post-test marks were used and questionnaires were decoded and analyzed. In the analysis, it is found that the students diffuse, produce and transform their knowledge through inquiry. The final results showed that this type of learning espouses investigation, exploration, search, quest, research, pursuit, and study. Based on a constructivist point of view this learning facilitated the teachers to limit their talk and assign group works and pair works to make the students talk. This kind of learning motivates the learners and by reflecting upon their own questions the learners' metacognitive skills are also developed.

Keywords: Inquiry-based; Learning; Memorization; Metacognitive skills; Questioning

Paper ID: IRCUWU2022-405

Developed succession law related to state lands accomplish the actual inheritable land rights? A critical analysis

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Matrimonial Rights and Inheritance Ordinance No.15 of 1876 provides that when any person dies intestate as to any of his private land, leaving spouse and children (male/female); surviving spouse and children inherit the property and entitled for the land rights under succession law. However, the law related to the state lands is differed from the general law. According to the Land Development Ordinance No.19 of 1935; when any person dies intestate as to any of his state land, leaving wife and children (male/female); the elder son of the family inherits the property. The spouse has only a life interest in his or her lifetime and he or she is not entitled to the rights of the lands. However, Sri Lankan government introduced a new amendment to the existing Land Development Ordinance and amended the succession part. Accordingly, it has been amended as the word "elder son" as children (both male/female) giving priority to the elder child consistently. Further, the inherent right of the spouse has not been changed and it is only a life interest. Therefore, it is observed that the effort of the government to amend the law to sustain the land rights of inherent people does not still satisfy the requirement of establishing the inheritance rights of heirs of the deceased person reasonably. The objectives of this study were to critically examine the practical impact and the discrimination occurred to the heirs of a deceased person governed by the laws related to state lands before the fundamental rights of the constitution and the sub legislations. This study followed the doctrinal research methodology and a qualitative research approach. The study revealed the challenges that affect the land rights of the people governed under the law related to state land in Sri Lanka. Accordingly, it concluded and recommended that, firstly, to establish a strong succession law related to the state lands, very similar to the general law including new provisions and, secondly, to ascertain the existing law according to the effective use of the current state legal theories in the world and the developed legal theories based on judicial precedents.

Keywords: Deceased person; Inheritance; Land rights; State lands

Paper ID: IRCUWU2022-421

Socio economic problems faced during the Covid-19 pandemic by the people in Colombo district, Sri Lanka in 2021

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The Covid-19 pandemic has probably threatened the entire humanity of the Sri Lankan community from social and economic perspectives. This research was done to investigate the impact, not only on the economy but also on social affairs where people shared their thoughts and experiences about the current situation while comparing socioeconomic status before and after the pandemic. Methods and materials included a qualitative, descriptive study followed with the aid of in-depth interviews based on a question guide to collect data through a virtual platform and analyzed according to thematic analysis. Participants who are self-employed, from the Colombo district, within the age category of 30- 50 were selected using purposive sampling techniques until the saturation point was reached. In the exclusive review of the socio-economic problems faced by the people during the Covid-19 pandemic, the results were analyzed under three major themes. The first theme was 'economic aspect with regards to their self-employment businesses'. The second theme was, 'opinions on the current economic crisis within the country'. The third theme was 'the social aspect', which was assessed to see what their opinions were with regards to the new way of life that they had never been accustomed to before. Under this, participants were assessed for certain subthemes to see if they were psychologically affected due to any other coexisting factors. The other subthemes were to explore how it affected the overall family and how technology has affected their lifestyle. Covid-19 has definitely impacted the lives of self-employed people in economic and social aspects. However, it is recommended for people to get familiar with the new lifestyle while introducing new approaches to their businesses amid the pandemic to reduce both economic and psychological issues. Moreover, these people should be provided with opportunities to overcome their current status and normalize with the pandemic.

Keywords: Covid-19; Economic; Impact; Problems; Social

Paper ID: IRCUWU2021-571

Strategies employed in translating religious poetry from Sinhala to English: With special reference to Yashodarawatha and its English translation

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Translation is generally pronounced as a process of replacing textual material in one language by equivalent textual material in another language. Among other types of translation, religious translation stands out as it requires one of the most challenging tasks of smooth intercultural transfer. Poetry is considered more challenging as the translator, while carrying the culture capital of the source text has to respect the poetic techniques that generate aesthetic flavour. The main aim of the present study was to identify the strategies employed by the translator of Sinhala elegy *Yashodarawatha* when translating it to English. *Yashodarawatha* is considered as a literary peace with rich cultural identity which encourages the researcher to select it for the present study. As far as the methodology is concerned, the research is a descriptive qualitative study and the data is collected through observation. The primary data of the research was the original text *Yashodarawatha* and the English translation The Story of Yasodara done by Prof. Ranjani Obeysekara. The related books, journals and previous studies were used as the secondary data. When analyzing the results, the researcher has identified three key translation strategies used by the translator; Borrowing as introduced by Hockett which includes loanword, loan blend and loan translation, Addition by Davies and Descriptive Equivalent by Peter Newmark. As far as the frequency of using those strategies is concerned, the study identified borrowing as the most frequently used strategy with a percentage of 86% where addition and descriptive equivalent has shared the rest. It was clear that rather than using the target reader friendly strategies such as addition and descriptive equivalent, the translator has heavily trusted the strategy of borrowing, a source text friendly strategy to facilitate the intercultural transfer. In conclusion, the study suggests that the translator of *Yashodarawatha*, rather than entertaining the target English audience, has taken much effort to deliver the message given in the source text directly and accurately. Future researchers are encouraged to investigate the effectiveness of these strategies in translating cultural concepts embedded in religious translation.

Keywords: Culture capital; Poetry; Religious translation; Strategies

MATERIALS & MINERAL SCIENCES

Paper ID: IRCUWU2022-40

Montmorillonite intercalated *Centella asiatica* essential oil (CEO) for controlled release of active compound/s responsible for antimicrobial activity

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Centella asiatica essential oil (CEO) is used in Chinese, Indian, and Sri Lankan traditional medicine. Although CEO has promising health benefits; its low solubility, low stability, and delicate nature have limited its applications. Intercalation of oils has emerged as a feasible and efficient solution to overcome this. Only a few published information is available on the use of nanomaterials in intercalating essential oils. Moreover, there is no information available on the CEO intercalation yet. Clevenger-type apparatus was used to extract bright yellow CEO from the shoots collected from Wijerama, Sri Lanka. It had a strong odour, 0.04% (v/w) yield, and 830 kg/m^3 density. Gas chromatography-mass spectrometry (GC-MS) profile of CEO contained 43 compounds with matching percentages equal to or higher than 80% accounting for 95.06% of the total components present. Molecular weights of each compound were lower than 300 g/mol. The most prominent compounds were α-humulene (23.74%), caryophyllene (18.64%), and β-farnesene (11.16%). Oil was featured with sesquiterpenes and chromenes. Intercalation of CEO into montmorillonite nanoclay (MMT) was performed by liquid assisted grinding. The introduction of CEO has increased the interlayer spacing of MMT from 11.9 Å to 14.2 Å confirming successful intercalation. FT-IR spectrum of intercalated CEO (MMT+CEO) showed additional peaks due to chemical species present in CEO. However, the plate-like appearance of MMT had been slightly disturbed during the intercalation process. The bioactivity of intercalated CEO was assessed by its antimicrobial activity, and it was moderate against Gram-positive *Staphylococcus aureus*, low against *Candida tropicalis*, and negligible against Gram-negative *Escherichia coli* according to the Kirby Bauer assay. The minimum inhibitory concentrations of CEO and MMT+CEO against *S. aureus* were 25 and 100 (µL/mL), respectively. Colony counts obtained from the poison food technique showed an increase in antimicrobial activity of MMT+CEO with time. The qualitative *in vitro* antimicrobial activity was unchanged, but the quantitative activity was higher in non-intercalated form. Intercalated CEO has exhibited a slow releasing property with time.

Keywords: Antimicrobial activity; *Centella asiatica*; Essential oil; Montmorillonite; Nanoencapsulation;

Paper ID: IRCUWU2022-86

Comparison of Murunkan clay deposit (Sri Lanka) with commercial standard

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Among the several groups of clay minerals, smectites exhibit attractive properties. Montmorillonite (MMT) is the most abundant clay mineral out of smectites and is required for various advanced applications. In this ongoing study, we previously published the spatial and temporal variations of the Murunkan clay as prospective for MMT clay. Therefore, this study aimed to characterize clay minerals present in the Murunkan area and demarcate the boundary of the deposit. Two core samples were collected from inside and one core sample from outside the Giant's Tank reservoir at Murunkan. Both of these cores reached over 1.2 m of clay deposit thickness. Each core was cut into 0.125 m intervals for geochemical characterization of clay minerals present. X-ray diffraction (XRD), Fourier transform infrared (FT-IR), and X-ray fluorescence (XRF) techniques were used to characterize the clay samples. The results obtained were compared with a Sigma-Aldrich commercial standard. XRD analysis indicated almost similar diffraction patterns in each clay sample, dominated by MMT peaks in comparison with the Sigma-Aldrich commercial standard. This evidence of the presence of MMT in Murunkan samples was further supported by FT-IR results showing transmittance bands aligned with Sigma-Aldrich commercial standard. The XRF results showed the presence of ~57% SiO_2, ~19% Na_2O, ~10% Al_2O_3, ~5% Fe_2O_3, ~2% CaO, ~2% MgO, and ~1.5% K_2O as major oxides in Murunkan clay samples. These compositions were almost similar to the commercial standard. The third core drilled outside of the Giant's Tank reservoir was only composed of a clay layer ~0.1 m of thickness. This indicated that the MMT deposition is restricted to a narrow area and is mostly concentrated within the Giant's Tank reservoir. According to the geological setting, the Murunkan area is underlain by alluvium and Red Beds. Therefore, weathering of regional bedrocks, and transportation and deposition of weathered products can be identified as the most important processes for the deposition of MMT in the washbasins/depressions of the Murunkan area. Exploring the area for commercial viability and value addition are future works of this study.

Keywords: Advanced applications; Commercial viability; Montmorillonite; Murunkan washbasin; Value addition

Paper ID: IRCUWU2022-121

Development of a titanium dioxide-incorporated zinc phosphate pre-treatment method for corrosion prevention on mild steel

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Metal corrosion is a common problem in many industries that use metals. To prevent corrosion, coatings such as paint or enamel are typically applied in liquid or powder form. Surface pre-treatment processes are sometimes used prior to paint finishing to reduce corrosion, increase surface area, and modify surface chemistry. Zinc and iron phosphate conversion coatings are a type of surface pre-treatment processes commonly used on steel, aluminium, and other metals. Recent studies have shown that nanotechnology-based pre-treatments outperform traditional phosphate coatings, and there is still room for advancement. Furthermore, the required knowledge for advanced pre-treatment techniques is not currently available in the local metal processing industries, and they import pre-prepared chemicals at a high cost. The goal of this research was to develop a nano-Titanium dioxide-incorporated zinc phosphate coating method for use in the local industrial sector as an advanced surface pre-treatment technique for mild steel. In this case, we used nano-titanium dioxide particles as a constituent that can be deposited on mild steel using a simple electrodeposition method with zinc phosphate. A variety of characterization techniques were used to investigate critical properties such as coating thickness, morphology, crystalline phases (XRD), functional groups (FT-IR), chemical, thermal, and corrosion stability, and porosity. The XRD data showed two phases: hopeite, $Zn_3(PO_4)_2.4H_2O$, and phosphophyllite, $Zn_2Fe(PO_4)_2.4H_2O$, with TiO_2 nano particles successfully incorporated. Furthermore, mild steel corrosion studies showed that phosphate-layered areas have high corrosion resistance. This research discovered a viable surface pre-treatment method based on nanotechnology. As a result, with further research, nano TiO_2-incorporated zinc phosphate coating could be introduced as a viable method for use in the local industrial sector.

Key words: Corrosion; Mild steel; Nano-titanium dioxide; Phosphating; Pre-coating

Paper ID: IRCUWU2022-125

Investigation of the possibility of *Neolitsea cassia* extract to be used as an alternative electrolyte for lithium-ion batteries

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To meet the demand for green and sustainable energy sources, gel polymer electrolytes are gaining popularity as the potential electrolyte for solar cells, batteries, fuel cells, and sensors. Liquid electrolytes in lithium-ion batteries have disadvantages like flammability, evaporation, degradation, leakage, and poor electrochemical stability. As a novel alternative, biopolymer gel electrolytes are projected to overcome the limitations stated above. Plant seeds, tubers, and roots of cassava, potato, rice, tapioca, and arrowroot have been used for polymer electrolyte designing with other polymers such as chitosan, methyl cellulose, polyethylene oxide (PEO), and polyvinyl alcohol (PVA). However, the polymer electrolytes based on food crops may generate significant competition with food and feed products. Hence, this study focused on the development of conducting gel polymer electrolytes based on *Neolitsea cassia*, a local plant species that does not compete directly with food and feed crops and mucilaginous extract of leaves used in preparation of local sweet in Sri Lanka. In this regard, cleaned and air-dried *N. cassia* leaves were boiled in 70% ethanol, steam blanched for 10 min in 1% sodium metasulphite solution, followed by washing with cold distilled water. Treated leaves were then chopped with 1% citric acid solution at a leaves: citric acid ratio of 1:8. Filtered extract was centrifuged at 3,000 rpm for 10 min, precipitated with 70% ethanol, and dried at 45°C for 10 h. Dried mucilage was ground, sieved with 80 µm mesh, and stored in an airtight container at ambient conditions. The fundamental properties such as solubility (insoluble in organic solvents, soluble in water at 50°C), gelling properties, pH (6.04 at 25.7°C), swelling index (53.69%), bulk density (0.52 g/cm^3), tapped density (0.63 g/cm^3), bulkiness (1.93 cm^3/g), powder compressibility (17.28%), Hausner's ratio (1.21) and conductivity (610 µs/cm at 25.7°C) were determined. In this ongoing study, gelling properties, conductivity, electrical stability, thermal stability, and their compatibility with the lithium-ion battery performance (capacity, cyclability and durability) will be studied to further investigate the applicability of *Neolitsea cassia* extract as an electrolyte.

Keywords: Gel polymer electrolyte; Lithium-ion batteries; *Neolitsea cassia*; Plant derived

Paper ID: IRCUWU2022-137

Characterization of few-layer graphene synthesized via microwave assisted exfoliation

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Microwave-assisted graphene synthesis methods have recently emerged as a novel graphene synthesis method with a shorter processing time than chemical methods and the ability to prepare graphene with some unique properties. This study aimed to characterize Few-layer graphene (FLG) synthesized from natural vein graphite in Sri Lanka using environmentally friendly chemicals and microwave-assisted techniques. In this technique, the H_2O_2 and liquid hand wash treated natural vein graphite powder in an aqueous medium was microwave irradiated at 800 W for 10 min in a domestic microwave oven. In the present study, FLG was fabricated sequentially by H_2O_2 treatment, soap intercalation, and microwave irradiation which is facile and energy-saving. X-ray diffraction (XRD), scanning electron microscopy (SEM), and Fourier transformed infrared (FT-IR) spectroscopy characterizations were performed on raw graphite, treated samples, and FLG samples. When compared to raw graphite, the SEM data showed that microwave-treated graphite has rough, fracture-like, or irregularly shaped structures with partially opened edges. In addition, SEM results agreed with the XRD results of the samples, implying that the microwave-treated graphite has a more irregular and expanded structure than the raw graphite structures. Furthermore, SEM data revealed that the prepared graphene has only a few layers (5 layers). Moreover, FLG was composed with lateral sizes ranging from several micrometers to nanometers. Newly formed peaks in graphene FT-IR graphs confirmed the presence of oxygen functional groups and saturated sp3 carbon atoms that were greater than raw graphite; however, XRD data indicated that the oxygen functional groups in graphene specimens were less than graphene oxide. The findings of this study contribute to a better understanding of the crystal structure, morphology, and chemical functionality of FLG, as well as the rapid synthesis of graphene from Sri Lankan vein graphite using a microwave-assisted technique.

Keywords: FT-IR; Graphene; Microwave irradiation; SEM; Sri Lankan vein graphite; XRD

Paper ID: IRCUWU2022-203

Investigating calcium carbonate nanostructures as an efficient light reflective coating

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Self-reflective surfaces are one of the key approaches to sustainable development because these surfaces reflect the radiation which causes heating without consuming additional energy. $CaCO_3$ which is widely used in construction industries shows minimum light absorbance, a modified light reflectance property at the nanoscale. However, the simplified synthesis approach and shape and size-dependent light-reflective properties of $CaCO_3$ can further illustrate the applicability of the nanoscale material in real-world applications. In this study, we focused on modifying the synthesis approach and the structure-property relationship of $CaCO_3$ nanostructures with their light reflectance properties. The modified synthesis approach focused on controlling the solvent viscosity by controlling the temperature which can reduce the rate of collisions of respective reactants. Therefore, different temperatures were applied in the synthesis to obtain nanostructures with varied sizes. The SEM images showed aggregated structures with different morphologies and different size distributions. FT-IR spectra of the samples were used to confirm the $CaCO_3$ regardless of the different synthesis parameters used. However, when the synthesis temperature is above 60°C, the morphology has changed from cube-like calcite structures to needle-like structures. The XRD spectra demonstrated that at elevated temperature, the $CaCO_3$ formed its polymorphic vaterite and aragonite structure. The light reflectance studies revealed that the $CaCO_3$ cubic morphology with an average size of 276 nm has the highest reflectance ability among other smaller sizes and needle-like morphologies. Since there was no absorbance in the UV, visible and near-IR regions (200–1,000 nm) suggested by the UV-visible absorbance spectra, $CaCO_3$ nanostructures have no potential to be heated up under the sunlight. As reflectance and absorption are inversely interrelated, a complete reverse trend was observed in absorption studies. In that, the 276 nm sample showed the lowest light absorption among the other sizes and morphologies. Therefore, this study concludes that $CaCO_3$ with 276 nm size and cubic morphology shows improved light reflectance properties with minimized light absorption for efficient sunlight reflecting applications.

Keywords: Calcium carbonate; Nanoparticle synthesis; Nanostructures; Self-light reflective coating; Sustainable development

Paper ID: IRCUWU2022-206

Development of an eco-friendly packaging material from waste materials

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Polymers are the most commonly used packaging materials to protect the products or contents from external sources. It is popular in worldwide due to its unique properties and compatibility with the market preferences but, the environmental impact of the synthetic polymers is yet a severe problem. It takes a long time to degrade and the time required to degrade cannot be predicted exactly. Because biodegradation process can differ due to material and structure, whether, soil structure, microorganisms, etc. However, it is predicted that synthetic polymers take approximately 500 to 1000 years to degrade completely. Synthetic polymers are causing considerable harm to nature. Therefore, this research work aimed on providing a reliable solution to minimize this undesirable effect via introducing an eco-friendly packaging material which meets the current market and environmental requirements. The major raw materials were extracted from natural and synthetic waste materials heading a path to the value addition of waste problem. Polylactic acid (PLA) which is a bioactive and biodegradable polymer, carboxymethyl cellulose (CMC) which was extracted from natural monomers and Dextrin which was extracted from almost any starch source like corns, cassava, or potatoes were used by incorporating with rice husk, coconut fiber, sawdust, and nylon fabric to make four major types of packaging materials under different compositions. Thin sheets were prepared first by mixing the materials using a laboratory scale internal mixer and then pressed with a compressive testing machine under desired conditions. The sheets were tested for biodegradability and tensile strength and the results were compared with existing commercially available packaging materials. Based on the results, the optimum composition of the prepared eco-friendly packaging material was identified as PLA with saw dust (SD80 P20 - saw dust 80% and PLA 20% according to the weight of 10 g) and Dextrin with saw dust (SD50 D50 - saw dust 50% and Dextrin 50% according to the weight of 10 g).

Keywords: Biodegradability; CMC; Dextrin; Eco-friendly; PLA

Paper ID: IRCUWU2022-242

Ultrasonication mediated green synthesis of silver nanoparticles using *Commiphora wightii* gum

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The development of silver nanoparticles (AgNPs) has received tremendous attention owing to their myriad biological and physicochemical properties. However, there is an increased emphasis on the green synthesis of AgNPs due to the demerits of the conventional physical and chemical synthetic approaches. Therefore, plant-mediated nanofabrication is exploited due to accessibility, relaxed laboratory setups, low cost, and less toxicity. However, AgNP synthesis with plant gums is less common. *Commiphora wightii*, a medicinal plant, has various biomedical properties owing to the high abundance of phytochemicals. Ultrasound radiation has been proved to be highly beneficial as it produces a greater yield of smaller non-aggregated NPs at low temperatures. The objective of this study was to synthesize AgNPs with *C. wightii* gum via the ultrasound-mediated method in a rapid, cost-effective, and efficient procedure. Herein, *C. wightii* gum extract was used as the reducing and capping agent and the precursor was $AgNO_3$. Sonication temperature was maintained at 50 ˚C while changing the time to 15 (sample B) and 60 min (sample A). The colour transformed from cream to brownish-maroon within less than 5 min upon sonication revealing the rapid and effective synthesis. This was further confirmed by surface plasmon resonance bands at 424 nm. Sample A showed higher absorbance than the latter revealing the higher formation of AgNPs. X-ray diffraction revealed that the NPs were in Face Centred Cubic structure. Moreover, according to Transmission Electron Microscope, both samples contained spherical AgNPs less than 20 nm in size. In addition, sample B had a smaller quantity of polyhedral-like, prism-like, and rod-like AgNPs about 20–50 nm. Furthermore, comparatively uniform and dispersed particles were observed in sample A. Several stronger Fourier Transform Infrared bands corresponding to O-H, N-H, C=O, etc. were detected for the vibration of functional groups corresponding to alcohols, amines, aromatic compounds, ethers, etc. Moreover, this method can be considered a cost-effective approach as no chemical requirement except $AgNO_3$ and no high energy requirement. The effect of temperature, percentage synthesis of AgNPs and percentage of AgNPs with specific morphologies are to be determined in the tertiary experiments. Hence, this method can be utilized to effectively synthesize AgNPs in an environmentally benign and cost-effective approach. Furthermore, these AgNPs could be used in various therapeutics and further studies are to be conducted to evaluate their antimicrobial activity.

Keywords: *Commiphora wightii*; Green synthesis; Plant gum; Silver nanoparticles; Ultrasonication

Paper ID: IRCUWU2022-243

Development of a novel lithium montmorillonite cathode suitable for rechargeable battery applications

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Montmorillonite (MMT) is naturally found as a clay mineral in Sri Lanka. It is an aluminosilicate crystalline compound with a layered structure. In this structure an octahedral sheet of aluminium-oxygen (Al-O) is sandwiched between two tetrahedral sheets of silicon-oxygen (Si-O). The MMT structure can accommodate various monovalent and divalent cations such as Li^+, Na^+ and Mg^{2+} within interlayer spacings. The loosely bound interlayer cations in the MMT structure can be exchanged by various other cations. Rechargeable Li batteries are still very expensive. Our goal is to invent a suitable Li intercalation cathode using low cost natural montmorillonite. Previous studies have been reported that MMT with interlayer alkali cations has appreciable ionic conductivity. The natural montmorillonite was modified as a cathode material for Li-ion batteries. For the present work commercially available Li-MMT was purchased from Sigma-Aldrich Chemie. To increase the ionic conductivity of Li-MMT, the structure was further saturated with Li^+ ions by using a LiCl solution. The concentration of Li^+ ion in saturated Li-MMT was measured by Inductively Coupled Plasma Mass Spectroscopy. The structural and electrical properties of Li rich MMT were investigated using XRD, SEM and Complex Impedance Spectroscopy. The layer spacings of Li-MMT confirmed that lithium ions are present within the interlayer. The conductivity of saturated Li-MMT was 4.69×10^{-6} S cm^{-1} at 30°C. Saturated Li-MMT shows negligible electronic conductivity which is less than 0.004%. Therefore, saturated Li-MMT can be used in many solid electrolyte applications. For using Li-MMT as cathode materials in rechargeable batteries the electronic conductivity must be increased. To obtain electronic conductivity in Li-MMT 1, 5, 10, 15, 20 and 25% of carbon black were added. The electronic transference number of saturated Li-MMT with graphite electrodes was determined by the DC polarization method. The electronic transference numbers of Li-MMT with 20 and 25% carbon black were 0.21 and 0.26, respectively. Overall, the bulk conductivity and electronic conductivity of Li-MMT were enhanced by modification of Li-MMT structure.

Keywords: Cation exchange; Ionic conductivity; Lithium cathode; Lithium montmorillonite

Paper ID: IRCUWU2022-294

Treatment of waste engine oil by solvent extraction and adsorption processes using water spinach (*Ipomoea aquatica*) and rice husk (*Oryza sativa)*

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Used engine oil is a high pollutant substance that requires responsible management as it may cause damage to the ecosystem. Thus recycling such contaminated materials will be beneficial in reducing environmental pollution and engine oil costs. Here the used engine oils were treated by solvent extraction to extract impurities and obtain heavy metal free engine oil using adsorption process. Two samples of Used Petrol Engine Oil (UPEO) which is Petra (SAE10W-30) and used diesel engine oil (UDEO) as Dtron (SAE15W-40) were selected, and physico-chemical properties were analyzed before the treatment to measure the degradation level of chosen oils. The adsorbance capacities of dried Water Spinach (WS) and Rice Husk (RH) to accumulate Cu and Zn metals in waste engine oils have been evaluated using Atomic Absorption Spectrophotometer (AAS). Methyl ethyl ketone (MEK; 45 mL) and 15 g of used oil were utilized for each sample and then agitated separately with 1, 2, and 4 g of dried WS and RH to identify the optimum amount of adsorbents required. According to the results, UPEO (8.9738 mg/L) and UDEO (7.1597 mg/L) had contaminated by Zn more than three times compare to fresh oil as 1.3881 mg/L and 2.1790 mg/L, respectively. After the treatments, 4 g of WS in UPEO and 1 g of WS in UDEO specified the maximum removal rate up to 81.3% and 96.2%. Cu concentration of UPEO (0.0499 mg/L) and UDEO (0.0446 mg/L) were nearly close to the fresh oil amounts which are 0.0412 mg/L and 0.0352 mg/L sequentially. However the optimum treatment results disclosed, 2 g RH treated UPEO and 2 g of WS contained UDEO had adsorbed Cu around 36.7% and 29.8%. Both treatment methods were statistically analyzed using CRD and Dunnett's methods and all the *p*-values were under the 0.05. Hence, the results revealed that WS is more efficient but both WS and RH have the capability to remove heavy metals from waste engine oil.

Keywords: Adsorption; Heavy metals; Recycle; Solvent extraction; Used engine oil

Paper ID: IRCUWU2022-305

Phytogenic silver nanoparticles from pineapple peel waste extract of Murusi and Kew varieties for antioxidant activity

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In the field of green nanotechnology, phytogenic synthesis of metallic nanoparticles using various biomasses has proven to be an eco-friendly, cost-effective, and safe scientific approach with numerous potential applications in diverse fields. The utilization of agro-waste as a source of renewable biomass in the synthesis of nanoparticles is underexplored. Hence, the present research work reports the green synthesis of silver nanoparticles from pineapple peel waste extracts that are obtained from two varieties; Murusi and Kew which are commonly consumed in the Sri Lankan community. $AgNO_3$ was used as a substrate ion, with the peel extract, where the phytochemicals act as a reducing, capping, and stabilizing agent in the synthesis process of nanoparticles. The effect of various parameters on green nanoparticle synthesis was studied, including $AgNO_3$ concentration, irradiation methods (solar, microwave, UV), peel extract to $AgNO_3$ ion solution ratio, and incubation time. Accordingly, 0.1M $AgNO_3$, 1:1 metal ion solution to peel extract ratio, microwave irradiation, and 24-h incubation time were identified as the optimal conditions for synthesizing smaller nanoparticles in both peel extracts. The synthesized silver nanoparticles were characterized by UV-Vis spectroscopy, FT-IR, SEM, TEM, and XRD analysis. DPPH and FRAP assays were applied to determine the antioxidant potentials of silver nanoparticles synthesized under optimal conditions. The absorption of surface plasmon resonance peaks appeared in the range of 425 to 435 nm for both peel extracts. The interactions between the bioactive compounds of the plants and the produced silver nanoparticles were evident in the FT-IR spectra. Under the optimal conditions, SEM analysis exhibited that particles were spherical with a size distribution of 116±5 nm and 115±15 nm for Murusi and Kew respectively. TEM analysis revealed that the Murusi and Kew peel-mediated nanoparticles are spherical under optimal conditions, with average diameters of 12.58 nm and 11.48 nm respectively. The XRD spectra confirmed that the silver nanoparticles synthesized under optimal conditions from Murusi and Kew peel extracts were pure crystalline in nature, with an average crystallite size of 15.21 nm and 11.33 nm, respectively. The DPPH radical scavenging capacity demonstrated that Kew peel-mediated silver nanoparticles have a higher antioxidant capacity than Murusi peel-mediated silver nanoparticles. Similarly, Murusi and Kew peel-mediated silver nanoparticles showed high FRAP scavenging power than the respective peel extract. The ability of biosynthesized silver nanoparticles to scavenge free radicals revealed a strong antioxidant activity.

Keywords: Antioxidant activity; Green synthesis; Kew and Murusi; Peel waste; Silver nanoparticles; Value addition

Paper ID: IRCUWU2022-309

Establishment of guidelines for an appropriate quantity of explosives to be used for effective and safe blasting in large scaled aggregate mining in Sri Lanka

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Industrial rock aggregate mining plays vital role in construction sector in Sri Lanka. In connection with the blast operations assimilated in the mining, it is to be highlighted, that majority of rock aggregate miners are anxiously seeking practical solution for the problem of optimization of fragmentation and yield of the rock, subjected to the usage of optimal quantity of explosives. According to this analysis, it was able to establish explosive as ammonium nitrate 409.46 kg, water gel 45.14 kg and 342 electric detonators in order to obtain production rock volume of 1000 cubes. These values could be effectively utilized for determining the said explosives by a mining regulator of the country for any permited mining volume. In this case, it is also be able to establish 0.264 kg/m^3 as powder factor which makes the bridging relationship between adoptable explosive quantity and the resulting fragmented volume of rock. The most important points of this establishment are acceptability of the proposing values irrespective to the location of the quarry site, possibility of giving guaranty for the hassle freeness from adverse blast outcomes, with the usage of said recommended quantities. The establishment of the respective values are refer to averaging based data processing whereas the data (84 Nos.) refer to the metal quarry sites scatted within four different lithotechtonic rock groups of the country. Each and every data is referring to an approved blast tests conducted by Geological Survey & Mines Bureau as mining regulator of the country. In this case, the generated blast out comes such as air blast overpressure (<120 dB), ground vibration (<5 mm/s), fly rock generation (<25 m) and fragmentations (<40% of over size – 30 mm × 450 mm) are found well within the acceptable ranges compliance with the interim standards of regulating authorities. This establishment is referring to multi hole blasting with blast hole depth of 3 m and hole diameter of 38 mm. The most important aspect of the determination is the adoptability of this methodology by mining regulator of the country for the determination of royalty to be charged against the used total explosive quantity. The royalty calculation is based on the extracted production rock volume whereas it could be calculated with 0.264 kg/m^3 powder factor.

Keywords: Air blast overpressure; Fragmentation; Ground vibration; Powder factor

Paper ID: IRCUWU2022-317

Incorporation of Guinea grass ash as a grout additive in cement-based grouting

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Cement-based grout (CBG) is a fluid composite of cement and water admixture that is widely used in construction and geotechnical applications. The effective performance of the CBG greatly depends on the bleeding, setting time, strength, and viscosity. Hence, grout additives (GA) are used to control those properties. Mostly, GAs are based on silica. Previous research studies have introduced sugarcane bagasse ash and rice husk ash as effective silica additives for CBG. Guinea grass ash (GGA) belongs to the "Poaceae" plant family as same as sugarcane and paddy. Therefore, the objective of the present study is to introduce GGA as an effective GA for CBG. The GGA was collected from the agricultural waste disposal site, and 63–150 µm size fraction was obtained. Six grout sample series were prepared by varying the GGA content from 0 to 5.0 g, respectively. Each sample series contained 1,000 g of Portland cement with 420 mL of water according to the BS 1881 standard. Mineral phase identification was conducted by X-ray diffraction analysis and confirmed the presence of both crystalline and amorphous phases of SiO_2. However, crystalline silica in GGA facilitated the pozzolanic reaction in CBG. The compressive strength (CS) analysis was conducted at different curing ages such as after 7th, 28th, and 45th days. BS-EN 12390-3:2002 standard explained the CS should be greater than 20 MPa. Each sample had a CS greater than 20 MPa, and the highest CS was recorded for the sample with 5.0 g of GGA. The flow ability was tested by the flow cone test based on the ASTM C939 standard, and the flow cone efflux time should be less than 15 sec. All the tested samples were in the range of 14.7–14.8 sec. Hence, each grout mixture had a favorable flow ability that had not been affected by the addition of GGA. Therefore, GGA can be used as an effective grout additive for cement-based gouts.

Keywords: Cement-based grout; Compression strength; Flow cone test; Guinea grass ash

Paper ID: IRCUWU2022-391

Development of fiber reinforced concrete paver blocks in road transportation with reduced rehabilitation

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Rapid urbanization and population growth have resulted in the development of a wide range of infrastructure including buildings, highways and urban common areas. The purpose of this study is to figure out the suitability of using fiber to reinforced concrete paver blocks for road transportation, to provide a sustainable way for natural and artificial waste management. As major fiber types, one natural fiber and one synthetic fiber was selected as coconut and polyethylene terephthalate (PET), respectively. Coconut fiber and PET were obtained from waste plastic water bottles and a broom factory. Samples were made by using the mixing ratio: fiber-0.2%, cement-5.26%, quarry dust-2.16%, and stone chips-92.38%. After 28 days of curing, the testing was started to assess the compressive strength and water absorption under the BS EN 1338:2003 and SLS 1425 (2011) standards. Findings were compared with the properties of commercially available paver blocks for any significant deviation. The average compressive strengths of coconut fiber and PET fiber paver's blocks are 14.80 MPa and 15.20 MPa, respectively, which are close to that of plain blocks 16.58 MPa. PET fiber reinforced concrete paver block has 10.90% water absorption percentage. Coconut fiber reinforced concrete paver block has the highest water absorption percentage (13.43%) while normal paver block has the lowest (8.37%). Considering the research findings, it is recommended that, PET fiber reinforced concrete paver blocks and coconut fiber reinforced concrete paver blocks are more suitable for pedestrians and jogging paths than heavy traffic roads. By using these concrete paver blocks in places where people and vehicles are less crowded, rehabilitation can be reduced. Also, fiber reinforced concrete paver blocks provide a sustainable solution for natural and artificial waste.

Keywords: Coconut fiber; Compressive strength; Fiber reinforced concrete; PET fiber; Waste management; Water absorption

Paper ID: IRCUWU2022-403

Efficiency of graphene-based water desalination system developed from vein graphite

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Despite the fact that Sri Lanka is a water self-sufficient country, both rural and urban communities are facing difficulties finding pure water for household, agricultural, and industrial use. The Extensive environmental pollution, urbanization, worldwide industrialization, and population caused by growth have decreased the water quality. Stomach cramps, kidney diseases, liver damage, vomiting, and bladder stones have all been listed as the most frequent diseases in Sri Lanka and all of them are caused by poor water quality. This study was aimed at overcoming the issue on the uncertainty of the water quality of filtered by the ordinary water filters, using high purity Ceylon vein graphite with unique properties like high density, ability to withstand under high pressure and temperature and being totally non-hazardous. Graphene oxide-based water filter membrane designed by Improved Hummer's method as this method was used to prepare graphene oxide (GO) membrane as an effective and reliable way within the less time and include the lowest possible expense for the chemicals. Though an X-ray diffraction analysis (XRD) spectroscopy the prepared graphene oxide were tested for the characteristics and then, focused on the parameters such as pH, total dissolved solids (TDS), salinity, and conductivity that lead to water quality. These parameters were measured for the water samples obtained from eight different areas in Sri Lanka and gathered data after filtration through the designed membrane. Resulted data were analyzed and made a comparison with the commercially available bottled water. According to the findings, designed vein graphene filter could be commercialized as a high-quality water filtering system that stabilizes the pH value in the range of neutral and reduces salinity, TDS, and conductivity of the water. The outcome of a water desalination system is a great solution to be successful in residential filtering, especially for those living in rural areas of Sri Lanka that have water quality problems.

Keywords: Conductivity; Graphene oxide; Nano filtration; Salinity; TDS; Water filter

Paper ID: IRCUWU2022-411

Optimization of the process of non-edible castor oil based bio lubricant production using random surface methodology

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The concept goes green is driving the world toward environmental safety by replacing synthetic lubricants with biodegradable lubricants. The production of estolide bio lubricant from non-edible Castor oil [ricinoleic acid (RA)] through a transesterification reaction is an emerging field of study. The presence of eco-friendly free *Candida rugosa* lipase (CRL) catalyses the transesterification. The maximum yield of the estolide (bio lubricant) depends on many process parameters. However, identifying values for process parameters for the maximum percentage yield of estolide is challenging due to the multiple dependencies of process parameters. However, statistical modelling is one of the solutions for process optimization. In this study, the Box Behnken design derived random values for three process parameters (reaction time, temperature and CRL percentage) for 15 trials. The actual percentage of the yield of estolide was obtained by laboratory experiments. The process parameter values (temperature, time, catalyst) fed into the random surface methodology (RSM) optimized function to predict the highest conversion yield of estolide. The model predicted a temperature of 42.31℃, time of 72 h and catalyst of 10.46% for the highest conversion of estolide is 65.49%. However, the actual maximum yield was 65%. Under the condition of a minimum catalyst of 4 %, the percentage yield was 60.31%. The minimum reaction period of 24 h estolide turnover is 58.56%. The results showed agreement with the predicted value with the experimental values. Further, findings proved the feasibility of using the RSM model for process optimization of bio lubricant production. Moreover, it could conclude that bio lubricant production using free CRL as a catalyst and Castor oil as a substrate in a non-aqueous medium is a promising sustainable alternative to petroleum-based lubricants.

Keywords: Box Behnken design; *Candida rugosa*; Estolide; Response surface methodology; Ricinoleic acid

Paper ID: IRCUWU2022-464

Suitability of sesame oil as an alternative processing aid for aromatic oil in carbon black filled natural rubber composites

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The tyre is one of the most ingeniously designed rubber products for the benefit of mankind. Aromatic oils containing polycyclic aromatic hydrocarbons (PAHs) are used as processing aids in tyre compounds and have been recognized as potential carcinogens. Hence, it is important to find processing aids having low PAH content. Use of natural oils as alternatives for aromatic oils is one such approach in the tyre industry. The main objective of this study was to develop carbon black filled natural rubber (NR) composites with environmental and user-friendly sesame oil for tyre treads. Initially, sesame oil was characterized using fourier-transform infrared spectroscopy. Thereafter, a series of NR composites was prepared by varying the sesame oil loading from 3-9 phr at 2 phr intervals. A control was prepared with 5 phr aromatic processing oil, Dutrex-R. Dispersibility of carbon black in all the above composites was assessed using a dispergrader. Cure characteristics and physico-mechanical properties of the above composites were evaluated and compared with those of the control. Physico-mechanical properties were analysed using the Minitab 19 statistical software. Viscosity, processing safety and cure rate of the composite produced with 5 phr sesame oil were 32, 6 and 56 higher, respectively compared to the control. The latter results indicate that sesame oil could behave as a co-activator in rubber compounds. According to Tukey's mean comparison, it was identified that, for physico-mechanical properties, each of the sesame oil quantities shared the same grouping frequency when compared with the control. However, 5 phr was selected as the most suitable treatment since the control was also prepared by Dutrex-R with 5 phr. Furthermore, the former vulcanizate showed a lower (0.8±0.16%) swelling index in water compared to the control (1.9±0.63%). There was a statistically significant difference (p<0.05) identified between each of the treatments, when tested on physico-mechanical properties. Hence, it is concluded that the composite produced with 5 phr sesame oil could be a suitable alternative to the composite produced with Dutrex-R in tyre treads.

Keywords: Cure characteristics; Physico-mechanical properties; Polycyclic aromatic compounds; Sesame oil; Swelling index; Thermal ageing resistance

Paper ID: IRCUWU2022-465

Effect of ammonia preservative systems on phosphate levels in centrifuged latex and its impact on latex film properties

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The phospholipid layer around the rubber particle is presumed to be hydrolyzed rapidly in ammonia preserved latex, releasing a significant amount of phosphate ions to the aqueous phase during storage. Concentrated latex processing plants are confronted with issues related to latex characteristics due to the high phosphate in latex. This study was conducted to determine the effects of ammonia preservative systems on phosphate levels in centrifuged natural rubber latex (CNRL). Two grades of CNRL, the high-ammonia CNRL–0.7% ammonia (HACL) and the low-ammonia CNRL–0.2% ammonia (LACL), were used here. Both LACL and HACL samples were characterized for initial total phosphate and other basic latex properties. At the initial stage, the LACL had the highest mean total phosphate level of 434.20±2.20 ppm, while the HACL had the lowest of 412.02±1.42 ppm. Changes in latex properties such as total phosphate and soluble magnesium content were monitored once a week throughout a month using ISO 19043:2015 and ISO 17403:2014 standard procedures, respectively. Moreover, it was discovered that the maximum phosphate level in both LACL (576.94±2.80 ppm) and HACL (490.42±4.66 ppm) samples was reached in the second week of storage and gradually declined up to the fourth week. However, it was observed that the LACL sample contained the highest phosphate concentration throughout the storage period. A statistically significant interaction between the storage time and the ammonia concentration (p<0.05) on phosphate content was observed. The mechanical properties of latex films were studied, and the impact of ammonia concentration on the latex film properties was observed to be statistically significant (p<0.05). The LACL (2.49±0.03 MPa) had the lowest mean for tensile strength, while the HACL (2.73±0.08 MPa) had the highest. And for tear strength also, the LACL (8.41±0.01 MPa) showed a lower mean than the HACL (8.78±0.05 MPa). Even though both samples showed elongation at break (EB) values greater than 750%, the HACL recorded the highest EB (886±9.31%). Hence, this study reveals that high phosphate levels impair the quality of latex.

Keywords: Ammonia preservative system; Centrifuged natural rubber latex; Storage time; Total phosphate content

Paper ID: IRCUWU2022-466

Effects of added ammonium laureate soap on physicomechanical properties of natural rubber latex

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Addition of ammonium laureate helps to enhance the ion concentration in the latex colloid. Due to the increment of electrostatic repulsions on the surface of the rubber particles, soap has potential to stabilize the latex. Nevertheless, excessive usage of ammonium laureate may adversely affect on the physico-mechanical properties of natural rubber latex. This study was carried out to investigate the effects of added ammonium laureate on physico-mechanical properties of natural rubber latex with respect to the glove formulation. Concentrated latex samples (without adding tetra methyl thiuram disulphide/zinc oxide) were treated with varying amounts of 10% (w/v) ammonium laureate solution. Changes in film properties such as tensile strength with elongation at break and tear strength were monitored in accordance with the ISO 37:2011 and ISO 34-1:2015 after 21 days. The interaction between added ammonium laureate on latex and storage time was investigated using the physicochemical properties including mechanical stability time, volatile fatty acid number and potassium hydroxide number for four weeks. Maximum tensile strength and elongation at break were observed at the ammonium laureate concentration of 1.5×10^{-4} moles per 100 g of latex. However, tear strength showed continuous increment with added ammonium laureate concentrations. The plotted graph for added ammonium laureate versus KOH number showed 1.63×10^{-4} moles/100 g of latex as the best soap concentration for the latex ($p<0.05$). Both mechanical stability time and volatile fatty acid number of latex was significant with storage time at the 0.05 level of significance. It can be concluded that physico-mechanical properties of natural rubber latex can be improved by using ammonium laureate at the concentration of 1.5×10^{-4} moles/100 g of latex.

Keywords: Ammonium laureate; Elongation at break; Potassium hydroxide number; Tear; Tensile

Paper ID: IRCUWU2022-513

Fabrication and characterization of low-cost flooring material based on Sri Lankan red clay and sewage sludge

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The production of tiles as an industrial category has increased significantly globally. The accessibility of red clay, a native raw material, is one of the leading ceramic industrial focuses in Sri Lanka. The current research explores developing ceramic floor tiles made of red clay and sewage sludge. Red clay is a very malleable soil created by carbonatite laterization, which has frequently been employed as a natural subgrade or foundation material. Wastewater treatment leaves behind sewage sludge. The study intends to investigate the possibility of producing low-cost flooring tiles incorporating red clay and sewage sludge with higher chemical, physical and mechanical properties as value addition. First, the different types of floor tiles were processed by mixing red clay with 0, 10, 20, 30, 40, 50, 60, 70, 80 up to 90% of sewage sludge. Tiles with 0% sewage sludge were taken as the control. Then uniaxially pressed green tiles were vitrified at 900℃ in a kiln for 39 h. The processed tiles were tested for linear shrinkage, water absorption, weight loss on firing, apparent porosity, chemical resistance, and compressive strength. The chemical and mineralogical analyses were also investigated by X-ray fluorescence (XRF) and X-ray diffraction (XRD). Results have exhibited SiO_2, Al_2O_3, Fe_2O_3, K_2O, MgO, TiO_2, CaO, MnO, and P_2O_5 as the dominant composition of products. Among all products, control exhibited the best properties after firing, including; 15.40% for weight loss on firing, 1.681% of linear shrinkage, 0.080 g/cm^2 for water suction, 1.729 g/cm^3 bulk density, 15.679 for apparent porosity, 18.594% water absorption, and 8.37 MPa for the compressive strength. Also, it was chemically inert. The study concludes that the tiles developed using only red clay or control carried better properties than those developed with sewage sludge. Furthermore, the study will be continued to investigate the moisture absorption properties of sewage sludge added tiles.

Key words: Ceramic floor tile; Red clay; Sewage sludge; Wastewater treatment

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