

**FACULTY OF APPLIED SCIENCES**  
**SABARAGAMUWA UNIVERSITY OF SRI LANKA**

# **OUT OF THE PRESS**

**OUR PUBLICATIONS – DECEMBER**  
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# **PEER-REVIEWED JOURNAL ARTICLES**

## LGAttNet: Automatic micro-expression detection using dual-stream local and global attentions

Madhumita Takalkar, Selvarajah Thuseethan, Sutharshan Rajasegarar, Zenon Chaczko, Min Xu and John Yearwood

### ABSTRACT

Research in the field of micro-expressions has gained significance in recent years. Many researchers have concentrated on classifying micro-expressions in different discrete emotion classes, while detecting the presence of micro-expression in the video frames is considered as a pre-requisite step in the recognition process. Hence, there is a need to introduce more advanced detection models for micro-expressions. In order to address this, we propose a dual attention network based micro-expression detection architecture called LGAttNet. LGAttNet is one of the first to utilize a dual attention network grouped with 2-dimensional convolutional neural network to perform frame-wise automatic micro-expression detection. This method divides the feature extraction and enhancement task into two different convolutional neural network modules; sparse module and feature enhancement module. One of the key modules in our approach is the attention network which extracts local and global facial features, namely local attention module and global attention module. The attention mechanism adopts the human characteristic of focusing on the specific regions of micro-movements, which enables the LGAttNet to concentrate on particular facial regions along with the full facial features to identify the micro-expressions in the frames. Experiments performed on widely used publicly available databases demonstrate the robustness and superiority of our LGAttNet when compared to state-of-the-art approaches.

#### ABOUT THE JOURNAL

KNOWLEDGE-BASED SYSTEMS

IMPACT FACTOR – 8.038

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## Hydroxyapatite incorporated bacterial cellulose hydrogels as a cost-effective 3D cell culture platform

Sandya Shiranthi Athukorala, Chathudina J. Liyanage & Anil C. A. Jayasundera

### ABSTRACT

For cell and tissue physiology research, drug discovery, and growing replacement tissues for regenerative medicine, accurate and cost-efficient in vitro techniques are increasingly demanded. The conventional model for in vitro cell culture is the two-dimensional (2D) culture. Yet, cells have been found to be more native when they are grown in 3D conditions. We present here the development and evaluation of biological properties of bacterial cellulose/hydroxyapatite (BC/HA) nanocomposite hydrogel as a potential 3D cell-culture platform. The synthesized composites were characterized using Scanning Electron Microscopy (SEM), Atomic Force Microscopy (AFM), Swelling measurements and Celltiter 96® Aqueous One Solution Cell Proliferation Assay (MTS) using mouse fibroblast cell line (L – 929). The arrangement of composites shown in SEM and AFM images closely resembles the native extracellular matrices (ECM) showing the potential to act as a viable substrate for cell culture. The composites exhibited high swelling ratio (5.31–5.81), indicating enhanced moisture absorption and potential for nutrient exchange. The in vitro biocompatibility results indicated significantly high percentage cell proliferation (85.20% - 88.30%). These findings indicate that the BC/HA composites are potential candidates for 3D cell-culture applications.

#### ABOUT THE JOURNAL

SOFT MATERIALS

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## Effect of Fungicide Chlorothalonil on Leaf Litter Decomposition in Tropical streams

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### ABSTRACT

Streams draining through agricultural catchments are subjected to multiple stressors including pollution with nutrients and pesticides. Pesticides, in interaction with other agricultural stressors, can impact microbial diversity and key ecosystem processes underlying the delivery of ecosystem services from streams. The understanding of how such stressors interact to alter ecosystem structure and function and how responses of biota reflect their longer-term disturbance history remains limited. Effects of the fungicide chlorothalonil on litter breakdown rates of riparian tree leaves of *Ficus racemosa* and sedge *Panicum maximum* were assessed in 40-day indoor microcosm systems. Litter breakdown rates were analysed in microcosms treated with chlorothalonil concentrations of 0.01, 0.025, 0.10, 0.25 and 1.0 mg/L and in control tanks without pesticides using the ANCOVA test. The results of the study indicated a significant reduction ( $P < 0.05$ ) of litter breakdown rate in chlorothalonil-treated tanks compared to the control tanks in terms of reduction percentage of dry weight and organic matter, microbial community sporulation and nutrient content. These alterations were modulated by the litter quality and microbial colonisations on leaf materials. Findings of the study emphasise the importance of considering indirect effects of pesticides on ecological processes. Stressing the need for deeper insight into how multiple stressors can affect the functioning of aquatic ecosystems and associated services.

### ABOUT THE JOURNAL

AQUATIC SCIENCES

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## Impacts of soil erosion and forest quality on water quality in Samanalawewa watershed, Sri Lanka

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### ABSTRACT

Soil erosion is one of the serious environmental concerns in Sri Lanka which affects on water quality of watersheds. Forest quality is an important indicator of the healthiness of forests which often contribute to mitigate the adverse impacts resulting from watershed disturbances and to improve water quality in river watersheds. Thus, the prime aim of this study is to evaluate and map the rate of soil erosion and forest quality of the Samanalawewa watershed and to establish their relationship with water quality of the watershed. Soil erosion and forest quality of 12 sub-watersheds of Samanalawewa watershed were evaluated using the Integrated Valuation of Ecosystem Services and Trade-offs (InVEST), InVEST Sediment Delivery Ratio (SDR) and Carbon models developed by the NatCap-Project, Sanford University-USA and also using the Normalized Difference Vegetation Index (NDVI), respectively. Water quality parameters viz. temperature, pH, electrical conductivity, total dissolved solids, dissolved oxygen, biochemical oxygen demand, alkalinity, hardness, nitrate-N, phosphate-P were analyzed in monthly basis for water samples collected from 12 sampling locations ( $n = 12$ ) in the sub-watersheds within month of May–July 2019. Pearson correlation was conducted to establish the relationships between water quality parameters and soil erosion and forest quality/NDVI of each sub-watershed. The results of the study indicated that the soil erosion of the watersheds ranges from 0 to 3555.7 t/ha/yr with an annual average of 139.9 t/ha/yr, which is  $\sim 28$  times greater than the soil loss tolerance (T) in Sri Lanka. The average NDVI values (forest quality) of the sub-watersheds varied between  $-0.2907$  and  $0.4628$ . All the water quality parameters in the study area were within the standards limits of SLS (614:2013). Estimation of vegetation cover of the study area using the InVEST Carbon model revealed that the above ground biomass is the dominant carbon storage among the other carbon pools. No significant correlation ( $p < 0.05$ ) was found between the water quality parameters and the soil erosion rates in the watershed possibly attributed to the mitigation effects of the healthy forest cover within the study catchment. This was further confirmed by the significant negative correlation ( $r^2 = 0.521$ ,  $p = 0.008$ ) established between the average NDVI values and nitrate-N levels of the river water of the catchment. The findings of the study provided the empirical evidence of the contribution of the healthy forest cover on the improvement of watershed water quality. The outcome of the research is useful for formulating watershed management policies and planning for watershed management.

### ABOUT THE JOURNAL

MODELING EARTH SYSTEMS AND  
ENVIRONMENT

IMPACT FACTOR – 2.84

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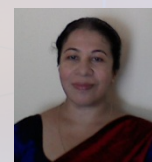
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## Cryptic species diversity and molecular diagnosis of *Channa orientalis*; an endemic freshwater fish of Sri Lanka

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Walpita , Suranga P. Kodithuwakku & Sandun J. Perera

### ABSTRACT

Fish genetic resources and diversity are very important aspects of environmental management and fisheries and are vital for making decisions on their commercial exploitation as well as conservation. The snakehead fishes in the world have significant economic importance as food and ornamental fish. A clear understanding of species' taxonomic status and genetic diversity is important for the utilization and implementation of conservation and management practices. *Channa orientalis* is a snakehead endemic to Sri Lanka that is heavily utilized in the ornamental fish export trade. Its genetic diversity has not yet been fully understood and it is difficult to distinguish it from closely resembling species. Therefore, we examined the genetic diversity of *C. orientalis* and developed a DNA-based marker that permits accurate, low cost, and reliable identification of *C. orientalis*. Determination of genetic diversity was mainly carried out through genetic analysis of the mitochondrial cytochrome c oxidase subunit I (MT-COI) gene. The development of the DNA-based marker for the identification of *C. orientalis* was done through Polymerase Chain Reaction and Restriction Fragment Length Polymorphism (PCR-RFLP) analysis. Our analyses confirmed the presence of two distinct genetically divergent and geographically separated lineages of *C. orientalis* in Sri Lanka. The fast cost-effective gel-based PCR-RFLP marker method developed by us was successful in diagnosing *C. orientalis* from its closely resembling species. Thus, we believe our findings on the cryptic diversity and diagnostic methods will have important implications for the conservation and management of this endemic species.

#### ABOUT THE JOURNAL

MITOCHONDRIAL DNA PART A

IMPACT FACTOR – 1.514

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## Land snail biogeography and endemism in south-eastern Africa: Implications for the Maputaland-Pondoland-Albany biodiversity hotspot

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### ABSTRACT

Invertebrates in general have long been underrepresented in studies on biodiversity, biogeography and conservation. Boundaries of biodiversity hotspots are often delimited intuitively based on floristic endemism and have seldom been empirically tested using actual species distributions, and especially invertebrates. Here we analyse the zoogeography of terrestrial malacofauna from south-eastern Africa (SEA), proposing the first mollusc-based numerical regionalisation for the area. We also discuss patterns and centres of land snail endemism, thence assessing the importance and the delimitation of the Maputaland-Pondoland-Albany (MPA) biodiversity hotspot for their conservation. An incidence matrix compiled for relatively well-collected lineages of land snails and slugs (73 taxa in twelve genera) in 40 a priori operational geographic units was subjected to (a) phenetic agglomerative hierarchical clustering using unweighted pair-group method with arithmetic means (UPGMA), (b) parsimony analysis of endemism (PAE) and biotic element analysis (BEA). Fulfilling the primary objective of our study, the UPGMA dendrogram provided a hierarchical regionalisation and identified five centres of molluscan endemism for SEA, while the PAE confirmed six areas of endemism, also supported by the BEA. The regionalisation recovers a zoogeographic province similar to the MPA hotspot, but with a conspicuous westward extension into Knysna (towards the Cape). The MPA province, centres and areas of endemism, biotic elements as well as the spatial patterns of species richness and endemism, support the MPA hotspot, but suggest further extensions resulting in a greater MPA region of land snail endemism (also with a northward extension into sky islands—Soutpansberg and Wolkberg), similar to that noted for vertebrates. The greater MPA region provides a more robustly defined region of conservation concern, with centres of endemism serving as local conservation priorities.

#### ABOUT THE JOURNAL

PLOS ONE

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## Monitoring of Reproduction and Influence of Fecal Progesterone on Reproductive Cyclicity in Captive Sri Lankan Sambar Deer (*Rusa Unicolor Unicolor*)

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### ABSTRACT

This study examines the length of the estrous cycle in 16 Sambar deer hinds in National zoological gardens in Dehiwala and Kegalle, Sri Lanka (NZGDK) assessed with the use of changes in progesterone concentrations, along with the changes in the profile of this hormone and by the visual estrus manifestations. The objectives of the present study were to characterize ovarian activity throughout the estrous cycle and the non-pregnant luteal phase of captive sambar deer in Sri Lanka. These objectives were achieved with the use of radioimmunoassay (RIA) to measure fecal concentrations of progesterone and visual estrus manifestation. Fecal samples were collected from non-pregnant sambar deer hinds (aged 2–4 years) over the period of six months on daily basis, both during breeding and non-breeding seasons. Estrous cycles were recorded in non-pregnant females, based on fecal progesterone concentrations. The average estrous cycle length was  $26.1 \pm 2.08$  days (mean  $\pm$  SEM) and  $2.10 \pm 0.51$  days in the inter-luteal phase. The average fecal progesterone concentrations attained the peak mid-luteal values of  $2.74 \text{ ng mL}^{-1}$ . There appeared to be variation in fecal progesterone amplitude between animals and between dates, but the low frequency of sampling prohibited confirmation of trends. Behavioral estrus was detected only when the average progesterone concentrations were less than  $0.07 \text{ ng mL}^{-1}$ . However, not all periods of depressed progesterone secretion were associated with the observed estrus. Behavioral estrus was detected in hinds when progesterone concentrations were less than  $0.07 \text{ ng mL}^{-1}$ ; a subsequent rise in progesterone indicated ovulation taking place at this time. Keywords: Sambar deer hinds; estrus, progesterone; estrous cycle, Sri Lanka.

#### ABOUT THE JOURNAL

SCIENTIFIC NOTES OF THE UO VGAVM

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140

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## Records of the lichen genus, *Collema* (Collemataceae, Ascomycota), in South Korea

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### ABSTRACT

*Collema* Weber ex F.H. Wigg is scarcely scattered throughout South Korea. However, a detailed taxonomic or revisionary study has not been carried out for almost two decades. The present study was based on specimens deposited in the lichen herbarium at Korean Lichen Research Institute, which were identified using recent literature. In this revisionary study, a total of sixteen species of *Collema*, including five new records, *C. furfuraceum* var. *luzonense*, *C. pulchellum* var. *subnigrescens*, *C. rugosum*, *C. subconveniens*, *C. tenax*, and one variety *C. leptaleum* var. *leptaleum* were documented. Further, detailed descriptions of each species and their morphological, anatomical and chemical characteristics and a key to all known *Collema* species of South Korea were reported.

#### ABOUT THE JOURNAL

THE KOREAN JOURNAL OF MYCOLOGY

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## Chemical Composition and Antimicrobial Activity of Two Sri Lankan Lichens, *Parmotrema rampoddense*, and *Parmotrema tinctorum* against Methicillin-Sensitive and Methicillin-Resistant *Staphylococcus aureus*

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### ABSTRACT

Medicinal utility of lichens is ascribed to the presence of various secondary metabolites of low molecular weight and they have been used in traditional medicine including Ayurveda in the treatment of wounds and skin disorders. Despite the urgent need to effectively address the antibiotic resistance worldwide, the discovery of new antibacterial drugs has declined in the recent past. This emphasizes the increasing importance of investigating and developing new classes of antibiotics that can withstand antibiotic resistance. The present study was conducted to investigate the chemical composition and the antibacterial activity of hexane, ethanol, and aqueous extracts of *Parmotrema rampoddense* and *Parmotrema tinctorum*, two lichens collected from Belihuloya, Sri Lanka, against Gram-negative and Gram-positive bacteria including twenty clinical isolates of methicillin-resistant *Staphylococcus aureus* (MRSA). Phytochemical analysis, thin layer chromatography (TLC), and Gas Chromatography Mass Spectrometry (GC-MS) were performed to determine the chemical composition of the two lichens. Hexane, ethanol, and aqueous extracts of both lichens were tested against clinical isolate of Gram-negative and Gram-positive bacteria including twenty clinical isolates of MRSA. Bacterial susceptibility was tested using a disc diffusion assay. Minimum inhibitory concentration (MIC) was determined by a broth microdilution method. Vancomycin was used as the positive control. Aleochemical acid, atranorin, atraric acid, orcinol, and O-orsellinaldehyde were among the secondary metabolites identified by the TLC and GC-MS analysis. None of the lichen extracts were active against Gram-negative bacteria but both lichens showed a concentration-dependent activity against methicillin-sensitive *Staphylococcus aureus* (MSSA) and MRSA. Ethanol extract of *P. rampoddense* showed the highest activity against MSSA with the MIC, 0.0192 mg/ml, but all MRSA isolates investigated showed MIC between 0.096 and 2.4 mg/ml for the same extract. Both lichens, *P. rampoddense* and *P. tinctorum*, represent potentially important sources of future antimicrobial drugs. Further investigation on the ethanol extract of *P. rampoddense* will enable us to determine the most active phytoconstituents responsible for the activity, their mechanism of action against bacterial pathogens, and also their cytotoxicity against normal cells.

#### ABOUT THE JOURNAL

EVIDENCE-BASED COMPLEMENTARY AND  
ALTERNATIVE MEDICINE

IMPACT FACTOR – 2.629

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## A systematic review on adsorptive removal of hexavalent chromium from aqueous solutions: Recent advances

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### ABSTRACT

The contamination of natural resources by hexavalent chromium (Cr(VI)) originating from natural and anthropogenic activities is a serious environmental concern. Although many articles on chromium remediation have been published, a comprehensive understanding of the mechanisms involved in remediation with different sorbents is not yet available. In this systematic review, the performance and applicability of several adsorptive materials for Cr(VI) removal from aqueous media are discussed, along with a detailed analysis of the mechanisms involved. Statistical analysis is applied to compare the efficacies of different adsorbents, while a similar approach is used to determine the effects of sorbent properties and experimental conditions on the adsorption capacity. A detailed analysis of the factors involved in fixed-bed column studies is also presented. A suitable desorption approach to the regeneration of the spent adsorbent and its adsorption performance in reuse is also examined. Among the different sorbents, nanoparticles and mineral-doped biochar were found to be the most effective sorbents, while the adsorption was higher at low pH (~4.0) than that at intermediate pH (6–8). Contrary to our expectation, adsorption was high for sorbents with low specific surface areas, suggesting that the adsorption of Cr(VI) is largely influenced by the chemical properties of the sorbents. The optimum adsorption in fixed-bed column systems is obtained at a lower Cr(VI) ion concentration, a lower influent flow rate, and a higher bed height. Since most of the studies reviewed herein were merely experimental and utilized ideal conditions with the presence of a single contaminant, i.e. Cr(VI) in water, further studies on adsorption dynamics with the presence of other interfering ions are suggested. This review is promising for the further development of Cr(VI) removal strategies and closes the research gaps pertaining to their challenges.

#### ABOUT THE JOURNAL

SCIENCE OF THE TOTAL ENVIRONMENT

IMPACT FACTOR – 7.963

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## Effect of enhanced $\text{CaCl}_2$ , $\text{MgSO}_4$ , and $\text{KH}_2\text{PO}_4$ on improved in vitro growth of potato

Deepchandi Lekamge, Tomoki Sasahara, Shin-ichi Yamamoto, Masashi Hatamoto, Takashi Yamaguchi, Shinya Maki

### ABSTRACT

Potato (*Solanum tuberosum* L.) is a major global food crop. Contemporary potato production largely utilizes micropropagation to produce healthy seed potatoes. The micropropagation of potatoes is widely achieved through nodal explants using the conventional Murashige and Skoog (MS) medium. Currently, effective culture media that can facilitate rapid propagation are increasingly required for new cultivars that have been developed to possess improved traits. In this study, we evaluated the effect of enhanced meso nutrients ( $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$ ,  $\text{MgSO}_4$ , and  $\text{KH}_2\text{PO}_4$ ) in MS medium on the growth of *S. tuberosum*. The cultivars used in this study were representative of Japanese, European, and Peruvian lines. Enhanced meso nutrients improved the overall quality of all cultivars, as indicated by longer shoots and larger leaves with dark color, compared with MS medium only. Shoots grown on enhanced mesos were approximately 1.5 times longer than on MS medium. Quantitative ion analysis revealed that plantlets with improved shoot length and leaf quality in most cultivars had increased calcium, magnesium, potassium, and phosphorus uptake than plantlets on MS medium. The results suggest that the reduced iron uptake on  $3.0 \times \text{MS}$ , compared with  $2.0 \times$  or  $2.5 \times \text{MS}$  mesos, reduced plant growth. This study revealed for the first time that mesos concentrations higher than MS medium concentrations, complemented by enhanced calcium, magnesium, potassium, phosphorus, and iron uptake, play a significant role in improving the in vitro growth of potato.

#### ABOUT THE JOURNAL

PLANT BIOTECHNOLOGY

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OGY.21.0830A

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# **BOOK CHAPTERS**

## Biogeography and endemism of the birds of Sri Lanka

Sandun J. Perera

### ABSTRACT

The avifauna of Sri Lanka, although with a lesser percentage endemism compared to the island's herpetofauna or ichthyofauna, still comprise a unique assemblage of species that paved way for mapping of the Ceylonese subregion (peninsular India south of the Godavari basin and Sri Lanka) of the Oriental region in Wallace's (1876) global map of zoogeography, following global avifaunal regionalisations by Sclater (1858, 1891). Subsequent avifaunal delimitations such as the Singhalese subregion of Blyth (1871; the hill range along the western coast of India south of Tapi basin and southern Sri Lanka) as well as the Malabar province of Blanford (1876, 1901; Western Ghats and southern Sri Lanka) has supported the recognition of the Western Ghats and Sri Lanka biodiversity hotspot (Mittermeier et al. 2004; Myers et al. 2000) as a true biogeographical entity. However, both Blyth and Blanford identified northern Sri Lanka to harbor an Indian avifaunal element. Recent molecular phylogenetic evidence suggests Sri Lanka as a local avian endemism centre, within the hotspot (Wickramasinghe et al. 2017; Jha et al. 2021), especially with some 70 or so specific being near-endemic to the island. It is also notable that at least 22 among the 34 bird species endemic to the island are found in further restricted ranges, mostly in the perhumid south-western wet zone and the south-central highlands characterized by a uniquely high habitat heterogeneity. Furthermore, members of the families Timaliidae, Pellorneidae and Leiothrichidae representing seven species of the 'Asian babblers' in Sri Lanka show remarkably high endemism with four species being endemic to the island, while the other three are also endemic at subspecies level. Such high degrees of endemism have inevitably made Sri Lanka to be recognized as an Endemic Bird Areas by the BirdLife International (Stattersfield et al. 1998), also been strongly supported by similar studies for other taxa especially herpetofauna with insular endemic speciations (Schulte et al. 2002; Bossuyt et al. 2004). Further, identifying the Global 200 priority ecoregions for the conservation of a representative sample of the global biodiversity Olson and Dinerstein (1998, 2002) recognized Sri Lankan moist forests as a spatial conservation priority representing the Tropical and Subtropical Moist Broadleaf Forests Biome of the Indomalayan Realm (Olson et al. 2001). With such conservation biogeographical analyses Sri Lanka has recently been repeatedly highlighted as a landmass with high bird conservation value that have preserved a considerably important evolutionary history.

### ABOUT THE BOOK

THE NATIONAL RED LIST 2021 -

CONSERVATION STATUS OF THE BIRDS OF SRI LANKA.

PUBLISHER: BIODIVERSITY SECRETARIAT,  
MINISTRY OF ENVIRONMENT SRI LANKA.

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# CONFERENCE PROCEEDINGS



## Boosting Emotion Recognition in Context using Non-target Subject Information

Selvarajah Thuseethan, Sutharshan Rajasegarar and John Yearwood

### ABSTRACT

Recognizing emotions in context from an image has become an emerging topic in the recent past due to its high practical demand in various domains. Performance of the existing works is limited as they predominantly utilized the entire image and the primary human subject as major cues to recognize the emotions from images. However, in addition to the primary human subject, other human subjects in a scene also play a vital role in determining the images overall emotional state. In this work, a novel visual feature type is introduced based on the features extracted from other human subjects in order to enhance emotion recognition performance. A novel deep learning based hybrid framework is also proposed to effectively integrate the proposed feature with the visual cues from the entire image and primary human subject. The extensive experiments carried out on a subset of the Emotic dataset reveal that the newly introduced visual feature type contributes to the overall emotional state of the scene. Furthermore, the proposed framework achieved 45.11% average accuracy for discrete emotion categories, which is a significant improvement in the emotion recognition performance compared to existing techniques that use emotion information from the entire image and primary human subject.

#### ABOUT THE CONFERENCE

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NETWORKS (IJCNN) 2021  
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## Deep COVID-19 Recognition Using Chest X-ray Images: A Comparative Analysis

Selvarajah Thuseethan, Chathrie Wimalasooriya and Shanmuganathan Vasanthapriyan

### ABSTRACT

The novel coronavirus variant, which is also widely known as COVID-19, is currently a common threat to all humans across the world. Effective recognition of COVID-19 using advanced machine learning methods is a timely need. Although many sophisticated approaches have been proposed in the recent past, they still struggle to achieve expected performances in recognizing COVID-19 using chest X-ray images. In addition, the majority of them are involved with the complex pre-processing task, which is often challenging and time-consuming. Meanwhile, deep networks are end-to-end and have shown promising results in image-based recognition tasks during the last decade. Hence, in this work, some widely used state-of-the-art deep networks are evaluated for COVID-19 recognition with chest X-ray images. All the deep networks are evaluated on a publicly available chest X-ray image datasets. The evaluation results show that the deep networks can effectively recognize COVID-19 from chest X-ray images. Further, the comparison results reveal that the EfficientNetB7 network outperformed other existing state-of-the-art techniques.

#### ABOUT THE CONFERENCE

4TH SLAAI-INTERNATIONAL CONFERENCE ON  
ARTIFICIAL INTELLIGENCE

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## Optimization of the recovery of pectin from fruit peel waste using response surface methodology

Sanoli L. Perera, Chathudina J. Liyanage

### ABSTRACT

Fruit processing industries generate a significant quantity of residual material. Fruit peel waste, usually discarded, is a very useful natural resource as it contains many reusable substances of high commercial value such as pectin, which is widely used as a thickener, texturizer, stabilizer and gelling agent in the food industry. Therefore, extraction of pectin can be considered as a good valorization method for the otherwise discarded fruit peel residues. The objective of the present study was to develop a viable methodology for a high yield pectin recovery from a blend of fruit peels by optimizing the extraction conditions and to compare the quality characteristics of the extracted pectin to commercial pectin. A blend of fruit peel residues (banana, mango, pineapple, citrus, watermelon, avocado, papaya, soursop and passion fruit) was collected from a local fruit juice manufacturer. Citric acid and hydrochloric were used as extracting solvents and pectin precipitation was done according to the alcohol precipitation method. Response surface methodology (RSM) was used to determine the optimum conditions for pectin extraction. The central composite design (CCD) was employed and the effects of temperature (60, 70 and 80 °C), pH (1.5, 2.5 and 3.5) and extraction time (30, 45 and 60 minutes) were studied. The optimum conditions for extraction were identified as 80 °C for 60 minutes at pH 1.5 according to the response surface analysis. A higher pectin yield (~ two times) was obtained by the extraction with the citric acid. The extracted pectin was analysed for the physicochemical characteristics of equivalent weight, methoxyl content, degree of esterification and total anhydrouronic acid content. The obtained values were 411.11, 3.12%, 29.04% and 60.78% respectively. A texture profile analysis was performed (Brookfield CT3 texture analyser) to compare the gel strength of extracted pectin incorporated, commercial low methoxy (LM) pectin incorporated and a market sample of gelatin incorporated set yoghurt. The extracted pectin can be categorized as LM pectin which would be ideal to use in low-calorie products and to make stirred type yogurt.

### ABOUT THE CONFERENCE

6TH INTERNATIONAL ISEKI-FOOD CONFERENCE  
23-25 JUNE 2021  
VIRTUAL EVENT

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## Development and Evaluation of the Effectiveness of a *Kappaphycus alvarezii* Seaweedbased Coating Solution for the Shelf-life Extension of Banana (Variety: Cavendish)

H.A.S.U. Hettiarachchi, A.L.C.J. Liyanage and A.C.A. Jayasundera

### ABSTRACT

Application of biodegradable coating solutions is a novel approach to extend the shelf life of fresh fruits and vegetables. A variety of raw materials are used to develop cost effective coating materials. Studies focusing on the development of seaweed-based coatings are still scarce in Sri Lanka. Therefore, the aims of the present study are to formulate fruit coating material from *Kappaphycus alvarezii* seaweed using glycerol as the plasticizer and to determine the applicability of formulated coating for the shelf life extension of Cavendish bananas. Seaweed extract (obtained by hot water extraction) and 10%, 15% and 20% (V/W) glycerol concentrations were used to produce three different types of coating solutions (glycerol concentrations were selected based on potential bioplastic strength). Cavendish bananas (ripening index 5) were coated with the prepared coating solutions and percentage weight loss, change in firmness (fruit hardness tester), total soluble solid (TSS) content (refractometer) and the peel browning (visual observation) were evaluated for six days. Percentage weight loss was highest for non-coated bananas compared to coated bananas and the least weight loss was observed in the bananas coated with 20% glycerol added coating solution ( $p < 0.05$ ). After six days of storage, total percentage weight loss of non-coated bananas was 23.97% and 11.54% for bananas coated with 20% glycerol added coating solution. A continuous loss in fruit firmness was observed in all the four types of samples. The rate of firmness reduction was highest (32%) in non-coated bananas than coated bananas ( $p < 0.05$ ). There was a significant difference in TSS content of non-coated bananas compared to coated bananas during storage ( $p < 0.05$ ). The rate of TSS increment was higher (8%) in non-coated bananas than coated bananas. Lowest degree of peel browning was observed in the banana coated with 20% glycerol added film forming solution while peel browning was greatest in control samples. Accordingly, percentage weight loss, loss of firmness and peel browning can be effectively reduced by applying seaweedbased coating solutions. Effectiveness of coating solution increases with the increasing glycerol content. It can be concluded that the 20% glycerol incorporated coating solution is a viable coating material for the shelf life extension of Cavendish bananas.

#### ABOUT THE CONFERENCE

5TH INTERNATIONAL RESEARCH CONFERENCE  
UVA WELLESSA UNIVERSITY, SRI LANKA  
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## IoT-Blockchain Enabled Food Safety decision Support System for the Manufactures and the Regulatory Authorities in the Dairy Sector in Sri Lanka

Uditha Karunathilaka and Chathudina J. Liyanage

### ABSTRACT

While there is a global trend to convert functionalities into industry 4.0 infrastructure which incorporates blockchain technology, artificial intelligence, and the internet of things (IoT) for tracking, tracing, and ensuring the safety of food, Sri Lanka still practices a system that is regulated by a manual process and that has features of industry 2.0. The existing system is incapable to address the widespread food fraud reported and a proper traceability system and risk management system based on the recommended risk-based inspection approach is required. The objective of the present work is to introduce an IoT-Blockchain enabled digital food safety decision support system to the dairy industry in Sri Lanka. The suitability of using blockchain technology for tracing and certifying the food origin and claim will be assessed. The study will be conducted in three phases: identification of the software specifications and development of a software requirement specification document; development of the physical system focusing on business process reengineering; introduction of the system to the industry and generating a risk profile. The first phase would be accomplished via three stages: data collection, data analysis and data reporting. The output of the first phase will be the proposal for the second stage. The system developed in phase two will be implemented and validated in the third phase. A dynamic querying system and data models have been introduced via a NoSQL database system, comprising five modules: human resource management module, quality assurance module, tracking and tracing module, facility management module, process and unit operation management module. Data are transferred inter-system as JSON data. The process and unit operation management module acts as the smart-contract module. When fully implemented, the proposed system will be a robust surveillance system for the food authorities, an administrative decision supporting system for the food manufacturers and support services, and an information sharing and complaining system for the consumers.

### ABOUT THE CONFERENCE

IAFP ANNUAL MEETING, PHOENIX, ARIZONA

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(HYBRID EVENT)

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## Regional Food Systems Dashboard with a dairy Industry perspective: a tool to guide policy towards sustainable and equitable food systems

Uditha Karunathilaka and Chathudina J. Liyanage

### ABSTRACT

Dairy foods play an important role in sustainable food systems. The dairy industry of Sri Lanka has been significantly affected by the current COVID-19 pandemic. The conventional dairy supply chain was disrupted since many dairy farmers found it difficult to channel their daily production of milk to the manufacturers thereby leading to a shortage of certain consumer products. This unprecedented situation occurred mainly due to a lack of coordination among the stakeholders in the dairy supply chain. A Food System Dashboard (FSD)-based approach is proposed to overcome the above problem by providing real-time insights to all stakeholders in the dairy industry to ensure food security focusing on dairy foods. A model regional FSD with a dairy industry focus was designed by adopting an agile software development framework. Structured interviews, questionnaires, and observations were used to identify the main functionalities of the system. They were modeled using a unified modeling language. The environmental indicators of the system were developed with reference to the ISO 14000 family of standards. Artificial intelligence modules (evolutionary algorithm-based) were incorporated for predicting the supply and demand and to optimize the supply chain of dairy products. A centralized database for storing food data, a distributed supply chain management system, an online regional FSD for providing real-time overview and supply chain insights to authorities and industries, a native mobile application for communicating with the public are the principal elements of the developed system. The food database can store food composition data, environmental details regarding products, techno-functional properties of dairy foods, and market/sales data. The online regional FSD can provide real-time food security-related data in the form of an infographic. With the native mobile application, customers can find the location of the dairy food of their choice and specifications. The native application also opens a direct communication channel between food authorities and the dairy industry to address dairy supply chain-related issues. Local governing bodies can access the information in the FSD to identify any surplus of production and take measures to distribute such products in an equitable manner in the region. The proposed system can be used to enable a perfect competition scenario for each player in the dairy food economy of Sri Lanka. Resources can be perfectly mobilized in the market and buyers will have complete information for purchasing and selecting dairy products. This will lead to the elimination of monopolies and ultimately contribute to the establishment of sustainable and equitable food systems benefiting all stakeholders. Keywords: food systems dashboard, sustainability, equitability, dairy foods

#### ABOUT THE CONFERENCE

LIVESTOCK, ENVIRONMENT AND PEOPLE  
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## Human Health Risks Associated with High Fluoride Intake in Walawe River Basin, Sri Lanka

S. Senarathne, J.M.C.K. Jayawardana and R. Chandrajith

### ABSTRACT

Health risks associated with excessive intake of fluoride through drinking water in the Dry Zone of Sri Lanka have become a nationally important environmental health problem. Lower Walawe River basin has been identified as a region with higher incidence of fluoride related health issues. In this study, spatial and temporal variations in groundwater fluoride content and potential health risks for residents in the Walawe River basin were investigated. One hundred and twenty-six groundwater samples were collected from 38 deep and 25 shallow wells covering the entire basin during pre-and post-monsoon periods. The potential health risks associated with elevated fluoride intake through drinking water in adults and school-aged children in the study region were calculated by the hazard quotient ( $HQ_{\text{fluoride}}$ ) using the model recommended by the United States Environmental Protection Agency. Elevated levels of fluoride ( $> 1.5 \text{ mg L}^{-1}$ ) were detected in deep groundwater during the pre- and post-monsoon periods ( $1.45$  and  $1.96 \text{ mg L}^{-1}$ , respectively) in the Dry Zone area of the basin. High fluoride in groundwater was primarily of geogenic in origin, mainly due to dissolution of fluoride-bearing minerals and evapotranspiration. Based on the results obtained from  $HQ_{\text{fluoride}}$ , 45% pre- and 55% post-monsoon groundwater samples in the Dry Zone area were unsuitable for drinking purposes for school-aged children, as it causes dental fluorosis. The results of this study also indicated that school-aged children are more vulnerable to non-carcinogenic risks induced by fluoride than adults. The findings further emphasized the need for continuous water quality monitoring and development of mitigation systems in the Dry Zone to ensure the health of residents.

#### ABOUT THE CONFERENCE

8<sup>TH</sup> INTERNATIONAL SYMPOSIUM ON WATER  
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## Effects of fungicide Chlorothalonil on leaf litter decomposition rate and Plankton communities

R.G.I. Sumudumali, I.D.U.H. Piyathilake, J.L.P.C. Randika, J.M.C.K. Jayawardana, E.P.N. Udayakumara, S. Malavipathirana, R.G.U. Jayalal and S.K. Gunatilake

### ABSTRACT

Pesticides applied into agricultural lands can contaminate waterways and affect the different levels of the aquatic food web and key ecosystem processes underlying the provision of ecosystem services from streams. Chlorothalonil is a commonly used fungicide, in agricultural areas in Sri Lanka, but its effect on non-targets such as in-stream ecological processes is less explored. The objectives of the present study were to assess the effects of Chlorothalonil on leaf litter decomposition rate and freshwater plankton communities. The effect of fungicide Chlorothalonil on *Ficus racemosa* and *Panicum maximum* litter breakdown rate and plankton community composition were assessed in indoor microcosm systems with treatment tanks of Chlorothalonil concentrations: 0.01, 0.025, 0.1, 0.25, 1 mg/L and in control tanks with freshwater for 40 days. The leaf breakdown rates in treatment and control tanks for both leaf types were compared using ANCOVA with time as covariate and plankton counts were compared using one-way ANOVA. The results of the study indicated a significant reduction ( $p < 0.05$ ) of litter breakdown rate in terms of % dry weight reduction, % organic matter reduction and % nutrient content reduction in treatment tanks with Chlorothalonil in comparison to control tanks in *Ficus* leaves. Moreover, a significant difference was observed only in the % dry weight reduction and no significant difference was observed in % organic matter reduction and % nutrient content reduction in *Panicum* leaves. The study further revealed that these alterations were further modulated by leaf litter quality and inhibition of microbial colonisations on leaves. Further, a significant reduction ( $p < 0.05$ ) of plankton counts was also observed in Chlorothalonil treated tanks in comparison to control tanks after 20 days. The findings of the study suggests that the fungicide Chlorothalonil can have multiple impacts on non-target organisms of litter decomposing organisms and plankton communities and thus affecting the ecosystem processes of aquatic systems.

### ABOUT THE CONFERENCE

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## In-vitro Antioxidant and Phytotoxic Properties of the Lichen Species *Parmotrema stuppeum* from Sri Lanka

Lasith V. Perera, R.G.U. Jayalal, Sandun J. Perera

### ABSTRACT

Acute usage of synthetic antioxidants and weedicides are causing different adverse impacts on the environment and the human body, promoting the use of natural antioxidants and weedicides in order to minimize such impacts. Lichens are a promising source of natural bioactive compounds. However, a very few investigations have been carried out to identify the bioactivity of lichen substances in Sri Lanka. Hence, the present study investigated the antioxidant and phytotoxic properties in the lichen species *Parmotrema stuppeum*, also reported here as a new record for Sri Lanka from the Belihuloya area. We prepared acetone, methanol, and hexane extracts of the air-dried lichen *Parmotrema stuppeum*, and tested them for bioactivity as given below. Free radical scavenging antioxidant ability of extracts was measured using 2,2-diphenyl-1-picryl hydrazyl (DPPH), while the reducing ability was evaluated using ferric reducing antioxidant potential (FRAP) test. The total phenolic content (TPC) of the extracts was evaluated using the Folin–Ciocalteu reagent assay. Further, to evaluate the phytotoxicity of the lichen extracts, a seed germination inhibition assay and a root length inhibition assay were performed by using reddish seeds (*Raphanus sativus* L.). Methanol extract of the lichen showed the highest free radical scavenging antioxidant activity against DPPH assay ( $IC_{50} = 300.3$  ppm,  $R^2 = 0.923$ ,  $p \leq 0.05$ ) and the highest absorbance against FRAP assay ( $0.1633 \pm 0.0211$ ). TPC of the same extract was significantly higher ( $9.6709 \pm 3.8018$ ) compared to all other extracts ( $p \leq 0.05$ ). Reddish seeds germination was significantly inhibited by the acetone extract of the lichen *Parmotrema stuppeum* after 24hr and 72hr ( $p \leq 0.05$ ). Similarly, the methanol extract of the lichen had the highest root inhibition activity against Reddish seeds after exposure for five days. Hexane extracts of the lichen did not show any bioactivity. Hence, we propose the methanol extract of the *Parmotrema stuppeum* for further studies on applications of its bioactivity.

### ABOUT THE CONFERENCE

9TH INTERNATIONAL ASSOCIATION FOR  
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INTERNATIONAL ASSOCIATION FOR  
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## Nutritive Value of Grass Species Palatable to Sambar Deer (*Rusa unicolor*) in Horton Plains National Park

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### ABSTRACT

Sambar deer (*Rusa unicolor*) is classified as a browser since it secretes viscous saliva and consists of the relatively less stratified rumen. However, they often gathered in herds for communal grazing in Horton Plains National Park (HPNP) grasslands dominated by native *Chrysopogon zeylanicus* and introduced *Pennisetum cladeustum* and *Pennisetum glabrum* species. The present study investigated the nutritional value of more palatable grass species for sambar in HPNP grasslands. Grazing sambar was observed along a transect from Pattipola entrance to Ohiya in HPNP at three observation circles (100 m radius) from 6:00 to 8:00 hours and 15:00 to 18:00 hours on three consecutive days of every month during 2020. The grass patches where sambar grazed in higher numbers were assumed to contain more palatable grass species. In each observation circle, those grass patches were marked, and the species composition was recorded using a quadrat ( $n = 6$ ). The most common grass species was *P. cladeustum* followed by *P. glabrum*, *C. zeylanicus*, *Garnotia exaristata*, and *Andropogon lividus*. Edible plant matter of the most common five grass species was collected ( $n = 6$ ), and proximate composition, organic matter digestibility (OMD), and metabolizable energy content (ME) were estimated. The most palatable *P. cladeustum* had the highest ( $p < 0.05$ ) crude protein (CP) percentage ( $10.46 \pm 0.37$ ), followed by *P. glabrum* ( $8.27 \pm 0.57$ ). The CP percentages of less palatable *C. zeylanicus*, *G. exaristata*, and *A. lividus* ( $7.46 \pm 0.23$ ,  $6.60 \pm 0.15$ , and  $6.73 \pm 0.14$ , respectively) were lower than *P. cladeustum* ( $p < 0.05$ ). The native grass species in HPNP, *C. zeylanicus* had the lowest ( $p < 0.05$ ) OMD ( $33.51 \pm 1.43\%$ ) and ME ( $4.9 \pm 0.21$  MJ/kg). The results suggested that high CP percentage in *P. cladeustum* caused sambar in HPNP to shift from browsing to grazing, and further studies are needed for confirmation.

#### ABOUT THE CONFERENCE

RESCON, POSTGRADUATE INSTITUTE OF  
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## The First Ever Induced Breeding and Larval Rearing of Critically Endangered, Endemic Freshwater Fish *Labeo lankae*

AR Mudalige, CN Walpita, SJ Perera, HMUKPB Herath and ARSB Athauda

### ABSTRACT

Many freshwater endemic fish species in Sri Lanka are listed as either endangered or critically endangered, showing the dire need of human intervention in their conservation. Captive breeding of these fish species may play a pivotal role as the first step of stock enhancement. Captive breeding efforts for critically endangered freshwater fish species in Sri Lanka are scanty and protocols are yet to be developed for many species. Present study was conducted to develop a protocol for induced breeding and nursing of hatchlings of critically endangered fish species Thambalaya (*Labeo lankae*). As the first-ever study, rearing *L. lankae* in captive conditions and breeding were conducted successfully. Induced breeding was performed by hormonal treatment for ovulation and spawning (sGNRHa + Domperidone) at the rate of 0.5 ml per kg for females and 0.2ml per kg for males. Breeding was performed in a hatchery jar and found that the latency period was 10 hrs. Selected females produced approximately 48000 eggs and they were spherical, non-sticky, and kept in hatchery jar and embryonic growth completed within 18-22 hrs. Eggs hatched at the water temperature of 27.40C, dissolved oxygen 8.1 mg/l, and pH at 7.4. Free swimming Post larvae were first fed with blended whole chicken egg and then with artemia nauplii, followed by daphnia and formulated powdered feed with 42% crude protein. In conclusion, this study records the first ever evidence of successful captive breeding and larval rearing of *L. lankae*.

#### ABOUT THE CONFERENCE

8TH INTERNATIONAL CONFERENCE OF  
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## Population Dynamics of Sambar Deer (*Rusa unicolor unicolor*) in Horton Plains National Park, Sri Lanka

DS Weerasekera, SJ Perera and KB Ranawana

### ABSTRACT

We investigated the social organization of Sambar deer (*Rusa unicolor unicolor*) in Horton Plains National Park, Sri Lanka (HPNP). We used the antler stage of males and the behavior of individuals to describe the population's reproductive stages. Distance sampling protocols were conducted along road strip transects within the grassland area of HPNP (9.4 Km<sup>2</sup>), each month over three years from 2018 to 2020. Population estimates varied over the seasons but the peak numbers were consistent from year to year with the highest number of individuals recorded in November-December (2002 ± 238.6 SE in 2018, 1766 ± 267.98 SE in 2019, and 1690 ± 299.42 SE in 2020), while the lowest numbers of individuals were recorded in May- June (513 ± 61.702 SE in 2018, 407 ± 49.68 SE in 2019, and 347 ± 51.76 SE in 2020). The percent- age of antler- cast males peaked in March-April of each year, while the highest percentage of males in hard antler was observed in November through January. Females were observed with newborn calves throughout the year but the highest number of newborn calves was recorded in July- August of the year (a range of 210-267 calves observed at peak). Mean group size was variable throughout each year with the largest groups recorded from September to December, a period accompanied by the most observations of mating and sparing behavior. Sambar deer in HPNP, inhabiting highland plains of a tropical island, exhibited a reproductive seasonality for both males and females, comparable to temperate cervid species.

#### ABOUT THE CONFERENCE

8TH INTERNATIONAL CONFERENCE OF  
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## Characterization and Authentication of Isolated Rhizobia from Some Selected Host Plants

G.G.C.G. Thennakoon, R.G.U. Jayalal and S.A. Kulasooriya

### ABSTRACT

Rhizobia are naturally occurring soil bacteria, of them plant growth - promoting Rhizobacteria (PGPR) have an ability to fix atmospheric inert nitrogen into plant utilizable forms like ammonia and amino acids. Rhizobia are either specific or promiscuous for nodulating certain legumes under different environmental conditions. In the present study, Rhizobia strains isolated from soybean (*Glycine max*), groundnut (*Arachis hypogaea*), mung bean (*Vigna radiata*), cowpea (*Vigna unguiculata*), common bean (*Phaseolus vulgaris*), and white clover (*Trifolium repens*) were purified using selective culture media and characterized morphologically, biochemically and physiologically. According to morphological characterizations, Rhizobia were found to be gram - negative and rod - shaped / roughly rounded bacteria. The colony appearance was gummy, white, opaque, or immersed. Biochemical characteristics were tested against five different antibiotics (Tetracycline, Cloxacillin, Ampicillin, Ciprofloxacin, Doxycycline, and Metronidazole), five different amino acids (L - tryptophan, Urea, Glycine, Cysteine, and L - tyrosine) and six different carbohydrates (D - glucose, Galactose, Fructose, Lactose, Mannitol, and Sucrose). Tetracycline was given solitary observation for the resistance of selected strains. Sucrose and dextrose were optimally utilized by Rhizobia besides mannitol. Utilization of amino acids by many strains was restricted to Cysteine and L - tyrosine. Green gram and cowpea strains were fast growers with acid-production in BTB and BRYMA, while soybean and common bean Rhizobia were detected as slow growers. Similar results were obtained in UV absorbance of Rhizobial culture densities at 254 nm wavelength for their growth rate. Following the physiological characteristics, many strains were restricted to the 6.5-9.5 pH range and 0.5 % - 1 % salinity levels. There was optimized growth of all strains at 32°C and 35°C temperatures incubation. Authentication gave a respectively high performance with a particular host plant. Groundnut, cowpea, and green gram obtained excellent potential to nodulation out of other Rhizobia inoculated legumes. Anyhow, this study implies the importance of selecting the most effective and efficient Rhizobial strain for a particular physical and biochemical conditions of the host plant and rhizosphere. The recorded properties of isolated Rhizobia confirmed their potential to implement sustainable agriculture by promoting them as biofertilizers to replace chemical N fertilizer.

#### ABOUT THE CONFERENCE

11TH ANNUAL RESEARCH SESSION OF  
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## Determination of the Spectrophotometric Properties of Low-Quality Gems in Sri Lanka: A Case Study from Marapana

Sandaruwan P.D, Jayalath R.D.M.G, Udawatte C.P, Wanniarachchi D.N.S, Wijesekara H, Gunasekara I, Diyabalanage R.S and Zoysa G

### ABSTRACT

Geuda, the most common low-quality gemstones found in Sri Lanka is frequently subjected to different treatments in order to enhance their color and transparency, thereby increasing their trade value. This study was conducted to investigate the applicability of Fourier-transform infrared spectroscopy (FTIR) and Raman spectroscopic techniques to distinguish different Geuda varieties. Low-quality gems were collected from a gem pit in Marapana, Sri Lanka. Based on the morphological and optical properties, the collected gems were identified in three families: corundum, spinal, and garnet. The corundum consisted of twelve gemstones belong to seven major groups including; Pita ottu, kalu ottu, Silky, and Young Geuda. The FTIR results of Geuda (i.e., Pita ottu) showed OH stretching infrared absorption peak at  $3160\text{ cm}^{-1}$ , thereby suggesting their natural origin and presence of goethite in the inclusion. The Raman vibrations at  $242\text{ cm}^{-1}$  and  $547\text{ cm}^{-1}$  confirmed the presence of goethite. This study provides evidence for the application of FTIR and Raman spectrophotometry for the identification of functional groups and characterization of low-quality gemstones.

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## A PRELIMINARY STUDY TO DETERMINE THE GEOGRAPHIC ORIGIN OF LOW-GEM QUALITY CORUNDUM IN SRI LANKA

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### ABSTRACT

The value of a gemstone largely depends on its rarity, size, clarity, and durability. At present, the geographic origin of a gemstone is also an important factor that affects its value. In heat treatment, the geographic origin is highly important as the physical and chemical properties of gemstone could be vary among different gem-bearing localities. Therefore, the present study aimed to determine the origin of low-gem quality corundum in Sri Lanka based on spectrophotometric data and trace element concentrations. Thirty five gem samples were directly purchased from mines located at Marapana and Horana. The physical properties of samples such as weight, refractive index, and fluorescence were measured. Inclusions were observed using the optical microscope. Spectrophotometric properties were determined using Raman spectrophotometer and Fourier-transform infrared spectrophotometer (FTIR). Initial observations made by magnification lenses suggested that most of the samples contained mineral inclusions, cracks and had a translucent appearance. The Raman spectroscopic observations revealed peaks at  $417\text{ cm}^{-1}$ ,  $644\text{ cm}^{-1}$ , and  $750\text{ cm}^{-1}$  corresponding to corundum. The observed inclusions and FTIR results confirmed that the samples are natural, and have not been subjected to any heat treatment. However, none of the FTIR spectra of samples revealed characteristic peaks that could be successfully used to distinguish the geographic origin of the samples. The X-ray fluorescence and laser ablation-inductively coupled plasma-mass spectrometry based investigations should be performed in a wide range of gem samples from the two localities in order to compare the geographic origin.

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