34TH KERALA SCIENCE CONGRESS

10-12 February 2022
Mar Ivanios College
Thiruvananthapuram

ABSTRACTS

Focal Theme

Science, Technology & Innovation for Transition to a Knowledge Economy

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Science, Technology & Innovation for Transition to A Knowledge Economy

Abstracts

KERALA STATE COUNCIL FOR SCIENCE, TECHNOLOGY AND ENVIRONMENT
Sasthra Bhavan, Pattom, Thiruvananthapuram
2022

34th Kerala Science Congress - Abstracts

Focal Theme

Science, Technology & Innovation for
Transition to a Knowledge Economy

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Pinarayi Vijayan

Chief Minister of Kerala

MESSAGE

I am delighted to note that Kerala State Council for Science, Technology and Environment (KSCSTE) is organizing its 34th Kerala Science Congress. As our State is transforming in to a knowledge economy in the post pandemic scenario, science & technology innovation come out from R&D activities will play a crucial role in the development of the State. To emerge successfully, it is important to address the opportunities & challenges and explore the research & innovation outcomes while transitioning to a knowledge society. In this circumstance, the selection of this year's Focal theme "Science, Technology & Innovation for Transition to a Knowledge Economy" is quite appropriate and I congratulate the organizers for choosing the relevant theme for this year's Science congress.

I sincerely hope that the 34th KSC will serve as a platform for the budding scientists, young researchers and scientists in Kerala to present their scientific research outcomes and to their effective interactions. The results of these exercises will hopefully support the State's efforts to emerge into a knowledge economy. I take this opportunity to congratulate the young researchers and budding scientists of the state who are participating and showcasing their research in the 34th KSC. I look forward to have fruitful deliberations and recommendations from this year's Kerala Science Congress, which could be made use of in the development of the State.

Pinarayi Vijayan

Kerala State Council
for Science, Technology and Environment

FOREWORD

Kerala State Council for Science, Technology and Environment (KSCSTE) is organizing the 34th Kerala Science Congress -an annual event of the Council- which provides a platform for scientists, researchers, budding researchers and students to share, discuss and disseminate their research results.

This year's focal theme of Kerala Science Congress is "Science, Technology & Innovation for Transition to a Knowledge Economy". The theme is quite relevant as the State leaps forward to embrace the knowledge economy with the help of science, technology and innovation. I hope the outcome of the discussions and interactions among scholars in the meet will help the State in building up a Knowledge Economy unique to our State.

The researchers present their findings in 12 different subject areas viz. Agriculture & Food Sciences; Biotechnology; Chemical Sciences; Earth & Planetary Sciences; Engineering & Technology; Environmental Sciences, Forestry & Wildlife; Fisheries & Veterinary Sciences; Health Sciences; Life Sciences; Mathematical Sciences; Physical Sciences & Scientific Social Responsibility. Kerala Science Congress has several highlights compared to any other Science Congress. An important highlight of Kerala Science Congress is the Memorial Lectures, named after great scientists and

visionaries of Kerala by eminent scientists. A new Memorial Lecture is included commemorating Prof. Thanu Padmanabhan, the great theoretical astrophysicist, from this year. An important component of the Congress is the PG Students' Interactive Session in which upcoming researchers interact with eminent Scientists in various fields. This program motivates and encourages the students to take up their careers in science. The Children Science Congress is another important feature of the Kerala Science Congress where child scientists present their research findings.

This book contains the abstracts of papers that the researchers present during the 34th KSC. I thank all the contributors to their work mentioned in the book. The great efforts of experts who reviewed all the papers and judiciously chose the papers for 34th KSC are commendable. I sincerely thank each and every member of the organizing committee for materializing this year's Kerala Science Congress.

I wish the 34th KSC all success.

Prof. K.P. Sudheer

Executive Vice President, KSCSTE

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Oral Presentation

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Oral Presentation

Focal Theme Session

Science, Technology & Innovation for Transition to a Knowledge Economy

Focal Theme Session Special Lecture

by

Prof. Sir Konstantin Sergeevich Novoselov FRS

Nobel Laureate in Physics 2010

Sir Konstantin Sergeevich Novoselov is a Russian-British physicist, and Tan Chin Tuan Centennial Professor at the Centre for Advanced 2D Materials, National University of Singapore. He is also the Langworthy Professor in the School of Physics and Astronomy at the University of Manchester. His work on graphene with Andre Geim earned them the Nobel Prize in Physics in 2010. Kostya Novoselov's research interests cover a wide range of topics from mesoscopic superconductivity and ferromagnetism to materials science and biophysics. He studied vortex structures in mesoscopic superconductors, observed atomic-scale movements of ferromagnetic walls, monitored heartbeats of individual bacteria and mimicked gecko's adhesion mechanism. His breakthrough moment was the discovery of graphene.

Novoselov is now widely recognised to be one of the pioneers in this field (as a number of international awards prove) and, together with Prof. Geim FRS, leads research on various applications of this new material ranging from electronics, photonics, composite materials, chemistry, etc. Prof. Novoselov is strongly committed to disseminating science through public lectures and media interviews.

Novoselov has published 376 peer-reviewed research papers on several topics including mesoscopic superconductivity, subatomic movements of magnetic domain walls, the discovery of gecko tape and graphene. Novoselov is one of Directors of the National Graphene Institute and sits on the International Scientific Advisory Committee of Australia's ARC Centre of Excellence in Future

Low-Energy Electronics Technologies. Novoselov is also a recipient of a starting grant from the European Research Council. In 2014 Kostya Novoselov was included in the list of the most highly cited researchers. He was also named among the 17 hottest researchers worldwide—'individuals who have published the greatest number of hot papers during 2012–2013'.

Perspectives on Graphene

Focal Theme Session Special Lecture

by

Prof. Sir Konstantin Sergeevich Novoselov FRS

Graphene is considered as one of the most exciting and widely used materials for research and technology. Known as the wonder material, it's a broad name with differences in structure, morphology or even sometimes chemical composition. The path from lab to commercialisation involves the exploration of a range of its properties and uses. In this talk, Nobel prize winning physicist, Prof. Sir Konstantin (Kostya) Novoselov, shares his thoughts and views on the future of this emerging material and its applications.

Focal Theme Session Invited Lecture

by

Prof. V. K. Ramachandran

Vice Chairperson, Kerala State Planning Board

Prof. V.K. Ramachandran

Prof. VK Ramachandran has previously served as the Head and Professor of the Economic Analysis Unit at the Indian Statistical Institute. His areas of interest are research in development economics, agrarian relations, agrarian issues, rural development, labor issues in the Indian economy, class, caste, tribe, gender discrimination and other forms of social oppression in India. He is the editor of the Review of Agrarian Studies.

Focal Theme Session Invited Lecture

by

S. Somanath

Chairman, Indian Space Research Organization

S. Somanath

S. Somanath is Chairman, ISRO and an expert in system engineering of Launch vehicles. Shri. Somanath assumed charge as Secretary, Department of Space and Chairman, Space Commission after a stint of four years as the Director, Vikram Sarabhai Space Centre (VSSC), Thiruvananathapuram. He also served as the Director of Liquid Propulsion Systems Centre (LPSC), Valiamala, for two and half years. He is the recipient of the 'Space Gold Medal' from the Astronautical Society of India. He received the 'Merit Award" and 'Performance Excellence award' from ISRO and a 'Team excellence award' for GSLV Mk-III development. He is a Fellow of the Indian National Academy of Engineering (INAE), a Fellow of the Aeronautical Society of India (AeSI), Astronautical Society of India (ASI), and a Corresponding Member of the International Academy of Astronautics (IAA). He is in the bureau of the International Astronautical Federation (IAF) and a recipient of the National Aeronautics Prize from the Aeronautical Society of India (ASI).

Somanath is known for his contributions to launch vehicle design, particularly in the areas of launch vehicle systems engineering, structural design, structural dynamics, and pyrotechnics. He has published papers in journals & seminars in structural dynamics and control, dynamic analysis of separation mechanisms, vibration & acoustic testing, launch vehicle design, and launch services management.

Memorial Lectures

Dr. Thanu Padmanabhan Memorial Lecture

by

Dr. P. Sreekumar

Former Director, Indian Institute of Astrophysics (IIAP), Bangalore

Dr. P. Sreekumar

Sreekumar is currently the Satish Dhawan Professor at ISRO Headquarters. Dr. Sreekumar had officiated at various capacities as the Div. Head / Group Director, ISRO Satellite Centre, Bangalore; Former Director of the Indian Institute of AstroPhysics (IIAP), Bangalore, Research scientist for 10 years at Goddard Space Flight Center, NASA, USA and Co-PI of India's first dedicated astronomy observatory, ASTROSAT.

Dr. Sreekumar is an expert in Space Science payload design and development; X-ray ML optics; solar coronal abundance, extragalactic gamma-ray background, emission from active galactic nuclei; lunar science. He has been the Principal Investigator of payloads on lunar missions and currently participates as member/Chair of many review committees, linked to Space Science missions of ISRO. He is also part of many senior-level management committees of international programs with Indian collaborations, including the LIGO-India program, the SKA-India and the India-TMT programs. Dr. Sreekumar has many awards and accolades to his credit including NASA Group Achievement award, Universities Space Research Association Scientific Excellence award and International Academy of Astronautics. Laurels for Team Achievement: Chandrayaan-1 2013.

Theory and Experiment : The tale of two space missions

Dr P. Sreekumar

Abstract of the lecture

Fundamental research in physics and astrophysics lays the foundation for conceptualizing challenging experiments to test predictions of theoretical models. Experimental results have in turn spurred new ideas and challenges for theorists. These experiments are sometimes best done from a space platform. Here we examine two independent research areas where this symbiosis is very relevant : measuring the temperature of the Universe and testing Einstein's grand prediction on the existence of gravitational waves. We will discuss the experimental validation of one of these by the COBE mission and the anticipated contribution to the second from the future space mission LISA. These will be used to highlight the rich rewards that can emerge from well conceived space experiments.

Dr. P. K. Gopalakrishnan Memorial Lecture

by

Dr. K.N. Harilal

Former Member, Kerala State Planning Board

Dr. K.N. Harilal

From 1990 to 2001, Dr. K.N. Harilal worked at the School of International Relations of the Mahatma Gandhi University, Kottayam initially as lecturer and later as Reader. In 2001, he joined the Centre for Development Studies (CDS) as Associate Fellow. Dr. Harilal also served as the Member, Kerala State Planning Board during 2006-2011, 2016-2021. Trade policy is one of his areas of specialization. He is interested in understanding the developments in the world trading system at multilateral and regional levels to see how global and regional developments affected the state's economy. Dr. Harilal completed his Masters in Economics from University of Kerala, M.Phil in Applied Economics from Centre for Development Studies, Thiruvananthapuram and PhD in Economics from Jawaharlal Nehru University, New Delhi.

Knowledge Economy and Development Planning

K.N.Harilal

Abstract of the lecture

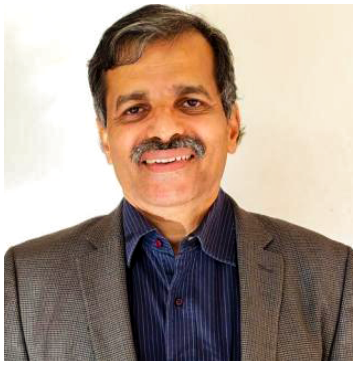
The focus of the lecture is on two distinguishable but related dimensions of the subject chosen for the memorial lecture. The first dimension is that of the policy framework required to nurture an ecosystem appropriate for production and dissemination of knowledge; pure and applied. The second dimension is that of promoting knowledge content of activities of everyday life of the people. The lecture will emphasise the need to give adequate importance to both the dimensions of the knowledge economy. Development planning can play a very important role in ensuring the goals delineated here. The lecture will illustrate the arguments drawing from the experience of Kerala.

P.T. Bhaskara Panicker Memorial Lecture

by

Prof. Sabu Thomas Ph.D., FRSC

Vice Chancellor, Mahatma Gandhi University



Prof. Sabu Thomas

Prof. Sabu Thomas is currently the Vice Chancellor of Mahatma Gandhi University, Kottayam, Kerala, India. He is also the Director of School of Energy Materials and the Founder Director and Professor of the International and Inter-university Centre for Nanoscience and Nanotechnology and former Director of School of Chemical Sciences. Prof. Sabu Thomas is one of India's most renowned scientists known for his contributions in polymer science and nanotechnology. After a short stint in a multinational company, Bayer India Ltd, Prof. Thomas joined Mahatma Gandhi University as a Lecturer in 1987. Later he became the Reader in the same University and a full Professor in 1997. Prof. Thomas is an outstanding leader with sustained international acclaim for his work in polymer science, polymer nanocomposites, elastomers, polymer blends, inter-penetrating polymer networks, polymer membranes, nanoscience, nanomedicine and green nanotechnology.

Prof. Thomas received a number of national and international awards which include Fellowship of the Royal Society of Chemistry, London FRSC, Distinguished Professorship from Josef Stefan Institute, Slovenia, MRSI medal, Nano Tech Medal, CRSI medal, Distinguished Faculty Award and Dr. APJ Abdul Kalam Award for Scientific Excellence. Recently, he was selected for the Kairali Global Lifetime Achievement Award and received the National Researcher Award -DST Nanomission-2020. Prof. Sabu Thomas was also one among the world's top 2% scientists listed by Elsevier Publishers and Stanford University (USA).

Circular Economy: New Opportunities in Sustainable Bio Materials—A Need of the Hour

Prof. Sabu Thomas Ph.D., FRSC

Abstract of the lecture

Green chemistry started for the search of benign methods for the development of nanoparticles from nature and their use in the field of antibacterial, antioxidant, and antitumor applications. Bio wastes are eco-friendly starting materials to produce typical nanoparticles with well-defined chemical composition, size, and morphology. Cellulose, starch, chitin and chitosan are the most abundant biopolymers around the world. All are under the polysaccharides family in which cellulosis one of the important structural components of the primary cell wall of green plants.Cellulose nanoparticles (*fibers, crystals and whiskers*) can be extracted from agro waste resources such as jute, coir, bamboo, pineapple leafs, coir etc. Chitin is the second most abundant biopolymer after cellulose, it is a characteristic component of thecell walls of fungi, the exoskeletons of arthropodsand nanoparticles of chitin (*fibers, whiskers*) can be extracted from shrimp and crab shells. Chitosan is the derivative of chitin, prepared by the removal of acetyl group from chitin (*Deacetylation*). Starch nano particles can be extracted from tapioca and potato wastes. These nanoparticles can be converted into smart and functional biomaterials by functionalization through chemical modifications (*esterification, etherification, TEMPO oxidation, carboxylation*

and hydroxylation etc) due to presence of large amount of hydroxyl group on the surface. The preparation of these nanoparticles includes both a series of chemical as well as mechanical treatments; crushing, grinding, alkali, bleaching and acid treatments. Transmission electron microscopy (*TEM*), scanning electron microscopy (*SEM*) and atomic force microscopy (*AFM*) are used to investigate the morphology of nanoscale biopolymers. Fourier transform infra-red spectroscopy (*FTIR*) and x-ray diffraction (*XRD*) are being used to study the functional group changes, crystallographic texture of nanoscale biopolymers respectively. Since large quantities of bio wastes are produced annually, further utilization of cellulose, starch and chitins as functionalized materials is very much desired. The cellulose, starch and chitin nanoparticles are currently obtained as aqueous suspensions which are used as reinforcing additives for high performance environment-friendly biodegradable polymer materials. These nanocomposites are being used as biomedical composites for drug/gene delivery, nano scaffolds in tissue engineering and cosmetic orthodontics. The reinforcing effect of these nanoparticles results from the formation of a percolating network based on hydrogen bonding forces. The incorporation of these nano particles in several bio-based polymers have been discussed. The role of nano particle dispersion, distribution, interfacial adhesion and orientation on the properties of the ecofriendly bio nanocomposites have been carefully evaluated.

Dr. E.K. Janaki Ammal Memorial Lecture

by

Dr. M. Sanjappa

Former Director, Botanical Survey of India

Dr. M. Sanjappa

Dr. Sanjappa has over 40 years research experience in Taxonomy and Conservation of angiosperms with particular reference to Taxonomic revisions and floristics, cytotaxonomy. Dr. Sanjappa did BSc(Hons.) and MSc from Central College, Bangalore and completed PhD from M.S. University of Baroda(1977). Later, he worked at Central Sericultural Research and Training Institute, Mysore during 1977-78 and Botanical Survey of India, Kolkata from1979 where he held the positions of Systematic Botanist, Scientist C, D, E, F, Joint Director and Head of Central National Herbarium and ultimately as Director, Botanical Survey of India in 2001 and retired in December, 2010. He has conducted general floristic and legume surveys in Western Ghats, Eastern Ghats, Himalayas, Hot Deserts, Cold Deserts, North East India and Andaman & Nicobar Islands. He and his students have worked and enormously contributed to the taxonomy of Leguminosae, Iridaceae, Lamiaceae and Aristalochiaceae. His team of two dedicated students has done an in-depth survey of remote Dihang Dibang Biosphere Reserve in Arunachal Pradesh. He himself has collected Legumes, Primulas, Pedicu-

laris, Rhododendrons, Gaultherias, Vacciniums, Agapetes,etc. in inhospitable areas up to 6500 m in Eastern Himalayas. Besides this he has also collected legumes in Bangladesh, Nepal, Sri Lanka, Australia, Scotland, Panama, etc.

Dr. Sanjappa conducted collaborative research as INSA-Royal Society Visiting Scientist at Royal Botanic Gardens, Kew, Edinburgh, Sydney, Peradenya, Godavari, Cambridge University Garden, Liverpool Museum, British Museum Natural History; Oxford University Herbarium, Linnaean Society, London, Smithsonian Institute, Panama, etc. He had visited and worked in many academic institutions in UK, Australia, Panama, France, Sudan, Singapore, Thailand, Malaysia, Indonesia, etc.

Floristic Diversity in India: An Overview

Dr. M. Sanjappa

Abstract of the lecture

The vast geographical, diverse climate and topographical realms of India have resulted in enormous ecological diversity supporting about 10% of the world's biological diversity on 2.4% of earth's surface making it one of the 18 megadiversity countries in the world. Adding to this there is a very high diversity of human influenced ecosystems including agricultural and pasture lands and impressive range of domestic aided plants and animals. The floral resources of India comprise about 54,733 species representing about 13% of world's known flora. India is one of the 18 megadiverse countries in the world and we share four of the hotspots of plant diversity viz., Himalayan, Indo-Burma, Indo-Sri Lankan and Sundaland with the adjoining countries. The number of recorded species in major groups of plants is about 21,849 in angiosperms, 82 in gymnosperms, 1310 in pteridophytes, 2791 in bryophytes, 8971 in algae, 2961 in lichens, 15,504 in fungi and 1257 bacteria and viruses. About 21.29% of these plant species are endemic to India with 4 mega centers (Himalayas, NE India, Western Ghats and Andaman & Nicobar Islands) and 26 microcenters of endemism. The NE region with about 130 species of primitive flowering plants is considered as cradle of Indian flowering plants.

The natural forest covering about 24.56% of total geographical areas are known repositories of bioresources in the form of food, fodder, fuel, timber, medicines, fibres, resins, tannins, dyes, oils, fruits, vegetables, etc. About 8000 species of flowering plants have recorded medicinal uses but only 150 of them are extensively used in indigenous system of medicine like Ayurveda, Siddha, Unani and Pso-rig-pai (The Tibetan system). About 320 species of wild relative of crop plants are known to have originated in India thus India is considered as one of the 8 Vavilovian centres of origin and diversification of cultivated plants called "Hindusthan Centre of Origin of Crop Plants". The rich diversity includes legumes, sugarcane, paper, citrus, brinjal, banana, mango, jute, ginger, cinamomum, cardamom, sesame, etc. Within each of them the genetic diversity is tremendous for example rice varieties grown in India are estimated to belong to about 60,000 land races.

Dr. G.N. Ramachandran Memorial Lecture

by

Dr. R. Sankarnarayanan

Group Leader, Structural Biology, CCMB, Hyderabad

Dr. R. Sankaranarayanan

Dr. Rajan Sankaranarayanan obtained Bachelors and Masters in Physics from Maduruai Kamaraj University and Ph. D. from the Molecular Biophysics Unit, Indian Institute of Science, Bangalore. He was a postdoctoral research fellow at IGBMC, Strasbourg, France from 1996-2002. Dr. Sankaranarayanan, after returning to India in 2002, established a state-of-the-art macromolecular crystallography laboratory and carried out research in the field of Structural Biology. At CCMB, his group has made outstanding contributions in the area of proofreading during protein biosynthesis. He was awarded the prestigious Wellcome Trust International Senior Research Fellowship, UK in 2003, Swarnajayanthi fellowship of the DST, India in 2005-2006, National Bioscience Award of DBT in 2008, Shanti Swarup Bhatnagar award in 2011, G.N. Ramachandran Gold Medal in 2015 and Infosys Science Prize in 2020. He is an Associate Editor of Journal of Structural Biology and Board of Reviewing Editor of the journal eLife. He is also a fellow of all the three major science academies of the country.

Chiral Proof Reading and its Role in Eukaryotic Evolution

Dr. R. Sankaranarayanan

Abstract of the lecture

A major focus of our laboratory is on understanding 'proofreading' mechanisms responsible for accurate protein biosynthesis. Linus Pauling was the first one to propose that such kind of mechanisms may exist in biological systems based on simple chemical principles. In addition to chemically similar 'amino acids', protein synthesis machinery has to also discriminate against mirror symmetric counterparts of 'L-amino acids' since biomolecules are homochiral. Despite the biological roles and abundance of some D-amino acids, the fundamental issue of how proteins are made only with the correct chiral entities was largely ignored. Over the last two decades, it has become clearer as to how multiple 'Chiral Checkpoints' work in concert to avoid wrong chiral entities from getting incorporated into proteins (1). We earlier elucidated a critical 'Chiral Proofreading' mechanism, completely conserved in all Bacteria and Eukaryotes, through which D-amino acids are prevented from infiltrating the translational machinery. Further structural and functional studies revealed that the major chiral checkpoint can act on 'achiral' glycine, an important ingredient of proteins, thus resulting in a 'misediting' paradox. Efforts to resolve this paradox have led us to identify key evolutionary stages in which these primordial molecules played a critical role in the emergence of eukaryotes. I will discuss some of our recent findings that link such 'Chiral Checkpoints' to evolution of multicellularity, land plants and mitochondria (2, 3, 4). These studies are leading us to propose how molecules that originated very early have been used by nature at critical junctions during the expansion of life forms.

01

Agriculture & Food Sciences

Oral Presentation

Ozone Treatments for Improving the Quality Parameters and Surface Decontamination of Tomato

Ardra C. Babu and Rajesh G.K.

Kelappaji College of Agricultural Engineering and Technology, Kerala Agricultural University, Tavanur, Kerala, India

Background: Minimising pathogenic and spoilage microorganisms in fruits, vegetables and their products are of prime importance in food safety. Conventionally, thermal processing methods *viz*. pasteurisation, sterilisation, frying, cooking etc. are used to inhibit pathogens. Ozone technology is an emerging non-thermal processing method which is highly effective in disinfection of food products with a great potential for enhancing the shelf stability of food products and to reduce all deteriorating micro-organisms present in the food commodity.

Method: The impact of gaseous ozone treatment on various quality characteristics of tomato and its efficacy in removing surface microflora from tomato samples were evaluated. A treatment chamber specifically for treating tomatoes were designed and developed simultaneously. Consequently, response surface methodology was explored to optimise the ozone treatments with three independent variables: concentration (% weight/weight), temperature (°C), treatment time (min) and twelve physio-chemical response variables of tomato.

Results: The optimised treatment conditions were 30 % ozone concentration, 10 °C temperature and a time of 11.7 min. The ozonation treatment retained all the quality parameters of tomato along with a significant reduction in the count of surface microorganisms.

Conclusions: This study demonstrated the microbicidal effectiveness of ozone and the efficacy of ozone molecule in the retention of various physio-chemical and organoleptic attributes of tomatoes.

Keywords: Ozone, tomato, optimisation, response surface methodology.

AGRICULTURE & FOOD SCIENCES-02 REG. No. 15736

Vacuum Impregnation: Process Optimisation

Binuja Thomas[1], Sankalpa K.B.[2] and Sudheer K. P.[2]

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[2]Agri-Business Incubator, Kerala Agricultural University, Vellanikkara, Thrissur, Kerala, India

Background: Intermediate Moisture Foods (IMF) have wide acceptability among the consumers in terms of its high nutritional value and properties close to fresh foods. The conventional methods such as application of water activity lowering agents, osmotic dehydration etc. had several limitations especially in terms of product quality due to the prolonged time and related microbial load. In this paper, the optimisation of process parameters for vacuum impregnation, a non-destructive method, for the development of IMF from highly perishable pineapple is envisaged.

Method: Vacuum impregnation trials were performed based on four factor three level Box-Behnken design of Response surface methodology. The process parameters were impregnation solution temperature (35, 45, 55°C), vacuum pressure (20, 40, 60 kPa), solution concentration (40, 50, 60°Brix) and vacuum process time (8, 16, 24 min). Accordingly, 29 runs of experimental trials under the various treatment combinations were conducted for VI of pineapple rings and the quality attributes of the products were analysed.

Results: The quality parameters of the vacuum impregnated pineapple namely water activity, yellowness index, TSS, firmness, moisture content, solid gain were analysed. Based on the highest desirability value for the product quality parameters, the process parameters for VI of pineapple rings were optimised as: process temperature of 55ºC, vacuum pressure of 23 kPa, solution concentration of 55ºBrix and time of 20 min.

Conclusions: Vacuum impregnation was found to be effective in overcoming the drawbacks of conventional methods such as osmotic dehydration. IMF with improved functional properties and enhanced shelf life were developed within short impregnation time of 20 min.

Keywords: IMF, vacuum impregnation, RSM, optimisation, sensory analysis

AGRICULTURE & FOOD SCIENCES-03 REG. No. 10895

Investigation on the Potential Wild Indian Bananas for Breeding Programmes

Rajeesh E.P.[1] and M. Sabu[2]

[1]Department of Botany, University of Calicut, Thenhipalam, Kerala, India- 673635
[2]Malabar Botanical Garden and IPS, Calicut, Kerala, India-673014

Background: Bananas and plantains are major crop plants belonging to the genus *Musa* (Musaceae, Zingiberales). It is the fourth most important food crop after rice, wheat and maize. The major distribution of this genus ranges from Tropical Asia to northern Australia. It is believed that the vast majority of the cultivated bananas are originated from the inter and intra-specific hybridization of two diploid (2n=2x=22) wild species, *Musa acuminata* (AA genome) and *Musa balbisiana* (BB genome). Northeastern regions of India are considered as one of the major centers of origin of the wild bananas. From the recent study in India, 34 Musaceae members were identified under two genera, *Ensete* and *Musa*, with two and 32 taxa respectively. In this study, these wild bananas are subjected to molecular-level study to understand the interrelationship of Indian Musaceae and suggest the potential wild banana candidates for the future breeding programmes.

Method: The nuclear ITS region of all available Indian wild bananas is sequenced and constructed a phylogenetic tree with the support of the selected nuclear ITS database of *Musa* from NCBI. Both Maximum likelihood and Bayesian analyses were performed for the tree construction. Also, constructed the phenogram of Indian wild bananas based on the 15 morphological characters used by Simmonds & Shepherd (1954) for the genome classification (A & B genome) of cultivars for the comparison.

Results: A well-supported AA genome (*M. acuminata*) cluster and BB genome (*M. balbisiana*) cluster were observed within the clade of section *Musa*. Phenogram based on the morphological data also resulted in the AA genome grouping and BB genome grouping.

Conclusion: Apart from *M. acuminata* and *M. balbisiana* some other potential wild bananas having AA and BB genome constitution may be contributed to the cultivar formation. Also, some other wild bananas within the AA group and BB group can be selected for future breeding programs.

Keywords: Wild banana, Cultivars, AA genome, BB genome

AGRICULTURE & FOOD SCIENCES-04 REG. No. 15855

Impact of Fenugreek Seeds Intake on Type-2 Diabetic Patients

Sreekavya.S.H. and Krishnaja U.

AWC. Neyyattinkara, Thiruvananthapuram, Kerala, India

Background: It is observed that Diabetes Mellitus is a dreadful disease affecting majority of population worldwide. This study was done to identify the effectiveness of soaked fenugreek seed in control of blood sugar level among Type II Diabetes Mellitus (T2DM). 24 hours recall method is used for the dietary survey, and quantification of food intake was taken from all the sample. Simple random sampling technique is used to identify the effectiveness of soaked fenugreek seeds in control of blood sugar level.

Method: The total sample for the study consists of 90 type II Diabetes Mellitus clients in Thiruvananthapuram district in Kerala. Forty five each from experimental group and 45 in control group were selected. 10 gram of soaked Fenugreek Seed was administered in early morning before breakfast and night before dinner for clients in experimental group for 45 days. It is also classified as <5 years (15 control group and 15 experiment group), in between 5 to 10 years (15 control group and 15 experiment group) and more than 10 years (15 control group and 15 experiment group). Data collection was done on the individual basis in interview schedule, the collected data was analyzed by using t-test.

Results: The study revealed that, it was identified that Fenugreek Seed was effective in reducing blood sugar level. Test reveals that BMI, FBS and PPBS were associated. When the BMI increases there was consequent increase in FBS and PPBS. Statistical analysis of data also reveals that significant and positive correlation between two variables t-value -0.263 for FBS, 0.272 for PPBS. it may be noted that 66.7 percent of the respondents in the less than 5 years and between 5 to 10 years experimental group are recovered from the polyuria, symptoms and 6.7% of the greater than 10years experimental group respondents are recovered from the polyuria symptoms after the intake of fenugreek for 45 days. Polyuria and polydipsia significantly deferred after administrating fenugreek in 45th day.

Conclusions: The statistical analysis of the value relieved that there are

significant difference between 0th day and 45th day of less than 5 years of onset of T2DM. The Fasting blood sugar and post-partum blood sugar of T2DM was found to be significantly lower than the 0th day mean in the experimental group. The study proves that the fenugreek seeds is effective in controlling the blood sugar level in Patients with diabetics and prevents them from developing complications.

Keywords: Type II Diabetes Mellitus, Soaked fenugreek seeds Fasting blood sugar, Post-partum blood sugar, polyuria, polydipsia

AGRICULTURE & FOOD SCIENCES-05 REG. No. 15752

Optical and Microwave Satellite Remote Sensing for Mapping Cropland Area (Paddy): A Case Study of Kuttiyadi Command Area, Kozhikode District, Kerala

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Background: In recent past, the Cropland area (Paddy) in the Irrigation command areas is decreasing due to several anthropogenic and natural factors. In this background, the present study is taken up to assess the changes in the cropland area using optical and microwave remote sensing imagery for understanding the long-term and short-term (seasonal) changes by taking Kuttiyadi command area (Kerala) as a case study.

Methods: Long-term changes in the cropland area in Kuttiyadi command area were assessed using time series Optical satellite data pertaining to the years 1991, 2000, 2010 and 2019, which were further classified using Digital Image Processing technique, i.e., 'supervised classification' and the final statistics on the changes during different time-periods were computed in GIS environment. And, the seasonal changes (rain-fed & irrigated) in the cropland area were computed from the Microwave SAR satellite imagery for 2017-2020 time-periods using Random Forest classifier technique and in Google Earth Engine platform.

Results: Results of the analysis

showed decreasing trend in cropland area i.e., from 6,577 ha in 1991 to 5,503 ha in 2000, and then to 4,346 ha by 2010 and thereon to 3,421 ha by 2019 in the Kuttiyadi command area. While, the results on the seasonal changes in the cropland showed that, 1st season was about 3633 ha during 2017-2018, 3633 ha during 2018-2019, and it was 3324 ha during 2019-2020 time-periods, and during the 2nd season it was 3505 ha during 2017-2018, 3267 ha during 2018-2019 and 3271 ha during 2019-2020 time-periods.

Conclusions: The decreasing trend in the cropland area during 1991-2019 in Kuttiyadi command area is due to conversion of cropland to plantation crops, barren land and built-up. The study has also demonstrated the efficacy of Remote Sensing and GIS technology for mapping the cropland area during different seasons of crop.

Keywords: Cropland area, Optical and Microwave Remote Sensing, Supervised classification, Random Forest classifier, Kuttiyadi command area (Kozhikode district, Kerala).

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AGRICULTURE & FOOD SCIENCES-06 REG. No. 15656

Plant Growth Promoting Potential of Ragi Rhizobacteria Isolated from Attappady Hill Tract

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Background: Attappady is a tribal village area where people's livelihood depends on subsistence agricultural farming with minimum use of chemical inputs. Farming activities of Attappady farmers includes millet cultivation with ragi (*Eleusine coracana*) being the major crop cultivated by them. The tribal farmers of Attappady are reluctant in using chemical fertilizers and pesticides in their cultivation and hence the fertility of soil is mainly based on the organic inputs given and microbial population present in these soils. The possibilities of encountering unique prospective biofertilizer

microorganisms is high in these soils. The present study was taken up with the objectives of isolating, characterizing and estimating the plant growth promotion activities of the beneficial microorganisms *viz*. nitrogen fixers and phosphate solubilizers from ragi rhizosphere.

Method: Soil and root samples from ragi rhizosphere of Attappady region was collected and putative nitrogen fixing and phosphate solubilizing bacteria were isolated using different N-free media and tricalcium phosphate amended Pikovaskaya's media. They were further screened based on the *in vitro* plant growth promotion activity such as indole acetic acid, gibberellic acid, extracellular ammonia, nitrogen content and phosphate solubilizing capacity of bacterial isolates.

Results: Forty-four bacterial isolates were obtained from the ragi rhizosphere. Twenty were selected based on colony morphology and assessed for plant growth promotion activity. *Pantoea agglomerans* ATY10 identified by 16s rRNA recorded highest indole acetic acid production and gibberellic acid production. *Burkholderia territorii* PSB1 and *Burkholderia cepacia* PSB3 had higher phosphate solubilizing capacity under both plate assay and broth assay.

Conclusion: This study identified putative nitrogen fixing and phosphate solubilizing bacteria that has the potential to be used as biofertilizers after subjecting to *in vivo* evaluations.

Keywords: Nitrogen Fixing Bacteria, Phosphate Solubilizing Bacteria, Plant Growth Promotion, Ragi Rhizosphere

AGRICULTURE & FOOD SCIENCES-07 REG. No. 15851

Potash Solubilizing Microbes in Flood-Affected Soils of Kerala

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Background: Two consecutive floods severely damaged Kerala's agricultural sector. The hill stations, Attapadi and Nelliyampathy in Palakkad district were severely affected, causing variations in soil organic matter and soil fertility. The influence of floods on the K-solubilising microbes (KSM),

a promising biofertilizer has not been assessed and seems vital for restoring flooded soils.

Methods: The K- solubilizers (KSM) were isolated from rhizosphere soils of five locations each of Attapadi and Nelliyampathy using Aleksandrow's agar. Screening of all the microbial isolates for dehydrogenase, laccase and cellulase activities were carried out using standard protocols

Results: Six locations from both Attapadi and Nelliyampathy in Palakkad recorded a higher number of KSM in the flooded samples, even in low potash soils. The enzyme activities showed 6 microbial isolates with multifunctional activities of dehydrogenase, laccase and cellulase.

Conclusions: The present study indicated that potash solubilizing microbes were higher in flood-affected soils than in non-flood-affected soils. The potash solubilizing microbes showed multifunctional enzyme activities which could be a potential biofertilizer for the rejuvenation of potash and also organic matter in the flood-affected soils.

Keywords: Potash solubilizing microbes, Floods, Soil organic matter, Enzyme activities

AGRICULTURE & FOOD SCIENCES-08 REG.No.: 15676

Potential Actinobacteria for Fruits and Vegetable Waste Management

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Background: Actinobacteria are ubiquitous gram-positive bacteria inhabiting soil with a characteristic filamentous nature. It has been well exploited mainly for secondary metabolite production, but also plays an important role in the decomposition of many organic substances. Actinobacteria decompose organic matter through the production of various enzymes like lipase, cellulase, laccase, chitinase, proteinase etc. They are relatively less explored for biodegradation of lignocellulosic waste. In the present study, native isolates of actinobacteria were i screened and evaluated for biosolid waste management.

Method: Soil samples were collected from different locations of Kerala

and actinobacteria were isolated and purified. The isolates were screened for its ability to degrade cellulose, lignin, starch, protein, chitin, pectin and lipids for qualitatively and quantitatively. After primary screening, promising isolates were selected and tested for its waste degradation and enzyme activities under *in vitro.* The molecular characterization of the isolates was also carried out.

Results: A total of 100 actinobacterial isolates were collected from different ecological regions of Kerala. Based on its ability to degrade various organic substrates, twenty best isolates were selected for primary screening of biosolid waste degradation. The five most promising isolates were again selected and evaluated for biodegradation of waste under *in vitro*. Among the different isolates, WA17 (identified as *Streptomyces spiralis*) showed higher waste degradation and enzyme activities, which could be further exploited for waste management.

Conclusions: The present study revealed that actinobacteria could be potential isolates in waste degradation. However, further studies are needed on pilot scale and large scale to confirm the efficiency of the isolates which could be commercialized in future.

Key words: Actinobacteria, biosolid waste degradation

AGRICULTURE & FOOD SCIENCES-09 REG. No. 15465

Vulnerability of Sesame Accessions to Phyllody at Higher Temperature in Onattukara

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Sesamum is an important oil seed crop in India which contains 38-54% oil in the seeds. Several diseases affect the yield and productivity of this crop among which sesame phyllody causes severe damage. Phyllody is a serious disease of sesamum caused by phytoplasma which dramatically decreases sesamum yields. Different types of disease symptoms are reported to be associated with sesamum phyllody. Use of resistant varieties provides an efficient and sustainable approach to control susceptibility of phytoplasm. The present study was conducted to screen the available germplasm for resistance to sesame

phyllody. The weather parameters namely temperature, rainfall and relative humidity was found to be congenial for the vector population which resulted in higher disease incidence.. Among the 26 genotypes studied, resistance was observed for 10 genotypes, moderate resistance for 8 genotypes, moderate susceptibility for 5 genotypes and susceptibility for 3 genotypes with respect to the disease incidence values. The genotypes Madhukar local, Ayali-2, S2, KYM-1, S1, Thilak, EVCS 13-11, TMV-3, S4 and EVCS 3-11 exhibited resistance and hence can be used as a source of resistance for future breeding programmes

Key words: Sesame, phyllody, vulnerability index, disease incidence

AGRICULTURE & FOOD SCIENCES-10 REG. No. 15712

Characterization and Management of Leaf Fleck Disease in Sugarcane

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Sugarcane (Saccharum officinarum) is a monocotyledonous perennial cash crop cultivated worldwide both under tropical and sub tropical conditions. It is being cultivated in more than 120 countries in the world. Like any other crops, it is also susceptible to biotic stress. Of which, diseases caused by viruses not only pose serious threat to sugarcane cultivation but also result in deterioration and exclusion of elite varieties of the germplasm. One of the major viral disease which affects global exchange of sugarcane germplasm is leaf fleck disease caused by Sugarcane bacilliform virus (SCBV).

The research project entitled 'Characterization and management of *Sugarcane bacilliform virus* causing leaf fleck in sugarcane' was initiated with purposive sampling surveys in selected sugarcane fields in districts of Kerala and Tamil Nadu in order to document the symptoms under natural conditions, to assess the disease incidence, severity and to collect infected samples for further studies. The per cent disease incidence of the leaf fleck disease in Kerala ranged from 12 to 51 per cent whereas severity ranged from 10 to 36.5%. In Tamil Nadu the per cent disease incidence ranged from 28 to 56 per cent while

severity ranged from 28 to 50.41%.

Major symptoms observed on leaves were mottling, chlorotic flecks, chlorotic patches streaks and stripes with general yellowing of the canopy. In the case of severely affected clones, there was reduction in tillering, internodal length, number of internodes and appearance of deep longitudinal cracks. In highly susceptible clones, stunted growth with bunchy top appearance was noticed. On the basis of phenotypic variability of symptom expression, genotypes were classified into five groups. The development of the symptoms was also studied under artificial condition through insect transmission of the virus using pink mealy bug, *Saccharicoccussacchari*. Morphological characterisation of the virus done using electron microscopy revealed the presence of bacilliform virus particles of size 30 X 130–150 nm which indicated that the virus belongs to genus BADNA and family *Caulimoviridae* and the etiology of the disease was confirmed as *Sugarcane bacilliform virus.* The molecular detection of SCBV was also standardized through polymerase chain reaction (PCR). PCR amplification of RNaseH/RT gene was done using BADNA specific and SCBV specific primers. The amplicons were sequenced and *in silco* analysis of sequences showed sequence homology of 99 to 100 percent identity to SCBV.

Widespread occurrence of the disease was observed even in the early generation of varietal development and in newly developed varieties. The transmission of the virus was suspected through true seed (fluff) developed by biparental crossing during sugarcane varietal development programme. Hence, the study was conducted to establish possible transmission of the virus from sugarcane parents to their progenies and the role of maternal and paternal parents in disease transmission through true seeds to the progenies. Samples from eight months old seedlings, three months old seedlings and parental clones were tested positive to the virus in PCR assays. Real time PCR was also standardized to assay these clones. Immunodiagnostic technique was validated using DAC ELISA. The technique of immunocapture PCR was also standardized. Minimal dilution of antisera with which SCBV could be detected was 2:1000 (V/V). Plant extract (antigen) at a dilution of 1:5 was found to be optimal for the detection of SCBV. Molecular detection of SCBV from mealy bug vector was also standardized. Both phenotypic and molecular methods were utilized to identify potential sources of natural resistance against SCBV. Based on the severity of symptom expression and PCR assays these were further classified as highly susceptible (HS), moderately susceptible (MS) moder-

ately resistant (MR) and resistant (R).

For generation of RNAi hair pin construct, initially forward (SF) and reverse primer (SR) were used to amplify 700 bp fragment of RT/RNase H gene to be cloned in sense orientation of the vector, pHANNIBAL. The linearized vector and the insert were ligated, and the ligation mixture was used to transform competent cells of *Escherichia coli* and the transformants were selected. Later antisense forward (AF) and reverse (AR) primer pairswere used to amplify 700 bp fragment of RT/RNase H gene to be cloned in antisense orientation. PCR product ligated into antisense direction of the vector and transformed into competent cells of *E. coli*. The recombinant pHANNIBAL vector was digested with restriction enzymes. The recombinant pHANNIBAL vector harbouring RNase H/RT gene was released from the vector through *Not* I site and subcloned into plant expression binary vector. Thus, cassette for RNA silencing was prepared.

Meristem tip culture was also standardized with antiviral chemical tenofovir. Recovery percentage of meristem varied from 70 to 75 per cent and the viral load was quantified using real time PCR.

The outcome of the study would facilitate early detection and elimination of the source of infection and prevent the spread of the disease in the field. Information generated in the study could be utilized while planning biparental crossing and reduce the spread of the virus in varietal development programmes. The hair pin construct developed in this study could be further utilized to generate transgenic disease resistant plants.

AGRICULTURE & FOOD SCIENCES-11 REG. No. 15826

Technology Capability of Coconut Enterprises in Kerala

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Introduction: Technological Capability (TC) is a measure of the knowledge, information and skills available in an enterprise that allowed productive utilization of available resources. Technology Capability Index (TCI) can be used as an estimate to determine the efficiency and effectiveness of enterprises. The study used TCI to understand the performance of Coconut MSMEs which holds great significance in the economy of Kerala.

Methodology: Analytical Hierarchical Process (AHP) a multi criterion methodology was followed in the study. It was used to get the relative weights between each of the criteria used and the numerical probability of each alternative used. The tool was used for determining the weightage for indicators, mesoindexes and macro indexes used in technology capability index.

Results and Discussions: The TCI score of coconut enterprises in Kerala was 0.56, medium enterprises were having the highest score (0.75) and lowest score was recorded by the micro enterprises (0.35). Enterprises were more depending on the Level technology use (0.75) when compared with other factors. Micro enterprises were lagging in all the indices studied in comparison with other two enterprises viz., Level of Technology (0.47), Resources availability (0.40), Market competency (0.33) and Coordination and accessibility (0.17).

Conclusion: Technology Capability Index of Coconut enterprises in Kerala was 0.56 and all the enterprises were depending upon the Level of technology use for their performance. Micro enterprises were lagging in all the indicators studied, which indicates the ignorance of these enterprises. This warrants the immediate attention for these enterprises in every aspects and particularly on Coordination and accessibility.

AGRICULTURE & FOOD SCIENCES-12 REG. No. 15751

Assessment of Variability in Soil Parameters Under Different Land Use Types of Banana Cultivation: A Case Study in Kozhikode, Kerala

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Background: The majority of the populations in Kerala are directly or indirectly dependent on agriculture for their livelihood. Banana is one of the major agricultural fruit crops cultivating in Kerala. The undulating topography of Kerala forces farmers to cultivate bananas in different regions. This makes differences in soil quality and has a greater impact on banana productivity. Hence it is essential to better understand the potential of soils and their sensitivity to improve banana productivity. In this context, the present study is carried out to understand the relationships between soil properties and banana yield in different land use type (Garden land vs Low land) in Kerala.

Method: The study was undertaken in major banana growing areas of Kozhikode district of Kerala. Primary observations and soil samples were collected from 58 farmers' fields by applying stratified random sampling. Soil parameters namely N, P, K (Macro-nutrients); Ca, Mg, S (Secondary-nutrient); B (Micronutrients); and pH, EC, TDS, OC (Physicochemical parameters) were analyzed in the laboratory using standard procedures. Statistical models like Descriptive statistics, independent t-test, Principal component analysis (PCA) were used to analyze variability in soil properties.

Results: The results of t test indicate different type of lands like garden and low land making significant changes in the soil properties for banana cultivation. PCA results clearly indicates the soil parameters like TDS, Ca, K, Ph, OC, N and B having grater variation in low land of banana cultivation and the soil parameters like pH, S, N, OC, Mg, EC, TDS, P, and K having grater variation in garden land of banana cultivation. **Conclusion:** From this information's, farmers can arrange the amount of which fertilizers and nutrients are needed to the soil in different land types to increase the percentage of banana yield and also

help in devising suitable strategies for farmers to increase the productivity in different cultivation practices.

Keywords: Banana, Land Use Type, Soil Parametrs, Principal Component Analysis

AGRICULTURE & FOOD SCIENCES-13 REG. No. 15666

Managing Leaf Blight of Amaranthus (*Amaranthus tricolor* L.) from above and below Ground: Use of Phylloplane Antagonistic Bacteria and the Root Endophytic Fungus *Piriformospora indica*

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Background: Amaranthus is the most popular leafy vegetable of Kerala and is considered as a superfood with high nutraceutical values. Leaf blight of amaranthus (*Rhizoctonia solani*) is the most devastating disease that causes heavy yield loss and is a major constraint in production of amaranthus. In the present study, the potential of a combination of bacterial isolates from amaranthus (var. Arun) phyllosphere and the root colonizing fungus *Piriformospora indica* in suppressing the foliar blight disease was evaluated.

Method: The work involved isolation of phylloplane bacteria, screening for *in vitro* antagonism, evaluation of colonization and antagonistic potential of the fungus *P. indica* and *in vivo* greenhouse experiments to confirm the efficacy of selected phylloplane bacteria and *P indica* in suppression of foliar blight as well as plant growth promotion in amaranthus. Changes in levels of defense enzyme like phenyl alanine ammonia lyase, peroxidase and poly phenol oxidase during the interaction were also carried out.

Results: Two of the phylloplane isolates (*Bacillus velezensis* and *Roseomonas gillardi*) showed considerable inhibition in the mycelial growth of *R. solani.* In detached leaf assay, both the phylloplane isolates could

delay the incidence of the disease symptoms by 48 hours. Colonization potential of *P. indica* in amaranthus was established and confirmed by microscopy and molecular detection. *P. indica* colonisation significantly increased the various plant biomass and growth parameters during the *in vivo* test. Moreover, application of *P. indica* as well as a combination of the fungus along with the phylloplane isolate *Bacillus velezensis* could reduce the disease incidence by 84.13% and 63.84% respectively compared to the control. *P. indica* colonization also increased defense enzyme levels in treated plants.

Conclusion: Biological control of amaranthus leaf blight with phylloplane bacterial isolates and combined application of phyllosphere bacteria and *P. indica* could effectively manage the foliar blight in amaranthus.

Keywords: *Piriformospora indica,* foliar blight, amaranthus, *Rhizoctonia solani*, phylloplane bacteria

AGRICULTURE & FOOD SCIENCES-14 REG. No. 15478

Bacterial Endophytes for Hardening and Establishment of Tissue Culture Banana

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Background: Endophytic bacteria are found in healthy plants and are an attractive choice as plant growth promoters and biological control agents. Aseptic tissue culture explants are cultured in low-light circumstances, on artificial media, and in tiny containers and they are susceptible to biotic and abiotic stress. Following transplanting into the natural habitat, they are encountered with extreme environmental stress which many times result in poor survival and establishment. Biotization of *in vitro* grown plantlets with endophytic bacteria during hardening can help them recover and boost their performance in stressful situations.

Method: The effects of inoculation with three endophytic bacterial iso-

lates individually and as a consortium on growth and establishment of tissue culture banana var. Nanjangudu rasabale at primary hardening and secondary hardening stages were investigated. The growth parameters like root length, shoot length, number of leaves, leaf area index and the plant biomass were assessed.

Results: Biotization with the endophytes significantly increased the growth parameters of tissue culture plantlets compared to the uninoculated control. *Pseudomonas* sp LEE18 was identified as the best bioagent for hardening.

Conclusion: Application of promising bacterial endophytes can be recommended for better establishment and plant growth promotion at the hardening stage on tissue-cultured banana. It also ensures the establishment of beneficial endophytes in plants prior to transplanting to the field. Bacterized plantlets grow faster, and are sturdier, with a better developed root mass and can withstand low-level disease pressure than non-bacterized plantlets.

Key words: Endophytes, biotisation, tissue culture banana var. Nanjangudu rasabale, hardening

AGRICULTURE & FOOD SCIENCES-15 REG. No. 15898

Isolation of Silicate Bacteria from Paddy Rhizosphere and its Screening Under *in vitro* Conditions

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Background: Intensive crop cultivation practices have led to the depletion of plant available silicon in the soil which has become one of the possible limiting factors that contribute to yield decline in several crops. Even though silicon is present abundantly on the earth's crust, it is unavailable to plants. So, their increasing demands for plants are met by external fertilizers application. Inorganic materials such as quartz, clay, mica and feldspars are rich in silicon but acts as poor silicon fertilizer because of the low solubility of the silicon. However, the indiscriminate use of chemical fertilizers has several negative effects like environmental pollution, destruction of soil microorganisms, soil nutrient balance and often leads to poor soil quality.

A suitable biological substitute that helps to solubilize insoluble silicate and thereby enhance plant growth without affecting the environment has become essential. The importance of silicate solubilizing bacteria in solubilizing insoluble silicate minerals and thereby promoting plant growth are gaining attention nowadays.

Method: Soil samples were collected from different upland and lowland paddy fields of Kerala and efficient silicate solubilizing bacteria were isolated using Bunt and Rovira medium supplemented with 0.25 per cent insoluble magnesium trisilicate. They were further tested for their phosphorus and potassium solubilization potential in Pikovskaya's medium and in Aleksandrov medium respectively. The five superior SSB isolates selected based on the plate as well as broth assays of silicate in Bunt and Rovira agar medium, were characterized based on morphological and biochemical characters.

Results: Twenty-seven bacterial isolates were obtained from the paddy rhizosphere which could effectively produce clearance zone in Bunt and Rovira medium supplemented with 0.25 per cent insoluble magnesium trisilicate. Among the twenty-seven isolates obtained, fourteen SSB isolates were found to solubilize the insoluble phosphorus compound, tricalcium phosphate in Pikovskaya's agar plates and twelve isolates could solubilize the insoluble potassium compound, potassium aluminosilicate in Aleksandrov agar plates. Morphological studies of the superior SSB isolates revealed that they show variation in colony characters such as colour, shape, margin, elevation, tecture and optic.

Conclusion: This study identified efficient silicate solubilizing bacterial isolates that has the potential to solubilize insoluble silicate compounds under *in vitro* conditions.

Keywords: Clearance zone, Silicate solubilizing bacteria, Silicon, Solubilization, Paddy.

AGRICULTURE & FOOD SCIENCES-16 REG. No. 15778

Paenibacillus sp.—A Potential Novel Nitrogen Fixing Bacteria for an Enhancement of Growth and Yield of Ginger (*Zingiber officinale*)

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Background: The growing interest in environmental sustainability has led to a considerable efforts to minimize the use of chemical fertilizers and pesticides and replacing these conventional approaches with more eco-friendly methods, such as the application of beneficial soil microorganisms. The growth of the plant can be promoted due to consequence of nitrogen fixation or the production of phytohormones or biocontrol of phytopathogens in the root zone. Ginger has been under cultivation by many farmers in Wayanad district for their livelihood. Wayanad is a district where more area of low lands and such lands are suitable for ginger cultivation. The application of various biofertilizers will help in better growth and thereby increase the production of ginger.

Materials and Methods: The novel nitrogen fixing bacteria such as *Microbacterium, Paenibacillus*, *Cellulosimicrbium* and *Azospirillum* were used from the repository maintained in the Department of Agricultural Microbiology and screened for indole acetic acid production and antagonistic activities against major pathogen of ginger. The experiment was conducted at Kolagappara in Wayanad district for the evaluation of the novel nitrogen fixing bacteria under field condition. The biofertilizers were applied as soil application, mixed with farm yard manure in 1:25 ratio and applied in the field(20 g/bed of 3x1 m^2) at two times viz., at the time of planting and 3 month after planting.

Results: Among the novel different nitrogen fixing bacteria , *Microbacterium* strain recorded the maximum IAA production (2.5 µg/ml) followed by *Paenibacillus.* The *Azospirillum zeae* exhibited 28.8% inhibition against *Rhizoctonia* and 30% inhibition against *Ralstonia* . A significantly higher number of tillers per plant (16.37) and number of leaves were observed in *Paenibacillus* treated plants(16.87). Plant treated with *Paeenibacillus* sp also recorded the highest yield of fresh rhizome.(16.57 ton/ha).

Conclusion: The present study revealed that the nitrogen fixing bacteria *Paenibacillus* sp recorded highest number of tillers, the highest number of leaves and the highest yield compared to the uninoculated control plants. The *Paenibacillus* sp could be used as a potential biofertilizer for growth enhancement and yield in ginger.

Key-words: Biofertilizer, Phytohormones, *Penibacillus, Azospirillum*

AGRICULTURE & FOOD SCIENCES-17 REG. No. 15494

Parapoynx diminutalis: A Pest of Submerged Aquatic Weed *Hydrilla verticillata*

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Background: *Hydrilla verticillata* (L.f.) Royle, commonly known as water thyme is a troublesome submerged aquatic weed. Hydrilla is usually controlled by mechanical removal which is not easy and recurrence can occur even in short interval of 4- 6 months. Though some herbicides recommended for aquatic systems are effective, use of chemicals for control of aquatic vegetation may have adverse impact on the ecology and hence not preferred.

Method: Hydrilla samples (1 kg.) collected from pond was grown in cylindrical concrete tanks of height 40 cm and inner diameter of 38 cm. The weed was allowed to establish in the tank under open condition and observed for the infestation by natural enemies.

Results: Infestation by a lepidopteran pest, *Parapoynx diminutalis* was reported for the first time in Kerala. The egg mass of a moth (*Parapoynx diminutalis*) was observed, under the leaves of hydrilla. The hatched out larvae were very active and started feeding voraciously. The caterpillar constructed case out of hydrilla plant part and moved around by remaining within the case. The extent of damage was 95 per cent.

Conclusion: Since the biological control through the natural enemies of weeds do not cause any harmful effect on aquatic organisms, the moth, *Parapoynx diminutalis* can be effectively utilized in the management of Hydrilla based on the further studies.

Key words: *Parapoynx diminutalis*, Hydrilla

AGRICULTURE & FOOD SCIENCES-18 REG. No. 15697

Evaluation of Numerical Response of *Amblyseius largoensis* (Acari: Phytoseiidae) Two Species of Tetranychus (Acari: Tetranychidae)—A Comparative Study

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Tetranychid mites, the popularly called spider mites, forms one of the major phytophagous pests that have been accepted as a constant threat to the economy of agriculture. Chemical control of spider mites seems quite expensive and ineffective as in most cases these mites develop resistance to pesticides. Hence, there is an increasing trend recently to devise specific control measures against mite pests, using biocontrol agents like predatory mites (especially phytoseiid mites), predatory insects, fungi and bacteria etc. Biocontrol efficacy of one of the most common phytoseiid predator mite viz; *Amblyseius largoensis* against two species of potential pest mite under the genus *Tetranychus* viz; *T. neocaledonicus and T. cinnabarinus* is evaluated through the numerical response of the predator on the pest mites. The experiment was initiated by adopting Leaf flotation technique. Results of feeding studies revealed that, all life stages of *A. largoensis* showed preference to the immature stages of the prey irrespective of the difference in prey species. However, the rate of consumption of the different stages of the predator showed variation with respect to change in prey. The adult female was the most voracious life stage with maximum predatory potential. The adult female of *A. largoensis* showed a maximum rate of consumption on *T. cinnabarinus* and a minimum on *T. neocaledonicus*. The feeding potential of the different life stages of the predators generally increased in the order of larva < protonymph = adult male < deutonymph < adult female. The data obtained on the consumption rate of male predators when analysed statistically were found significant. This clearly proved that *A. largoensis* could be an effective biocontrol agent in suppressing the populations of all species of pest mites provided.

Key words: *A. largoensis,* biocontrol, phytoseiid mite, pest mites

01

Agriculture & Food Sciences

Poster Presentation

Piriformospora indica Protects Black Pepper *(Piper nigrum L.)* Plants from Piper Yellow Mottle Virus Infection

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Background: *Piper yellow mottle disease* (PYMoD) is a serious disease in black pepper caused by a DNA virus, *Piper yellow mottle virus* (PYMoV) against which no resistant variety has been reported so far. As most of the high yielding black pepper varieties lack the ability to resist this virus infection naturally, use of beneficial endophytes can be a probable solution to this problem. In this study, *Piriformospora indica,* a beneficial fungal root endophyte was evaluated for the management of PYMoV in black pepper.

Method: A pot culture experiment was conducted to evaluate the efficiency of prophylactic as well as curative application of *P. indica* in controlling PYMoV infection in rooted cuttings of black pepper (var. Panniyur 1).

Results: *P. indica*-colonization resulted in significant increase in various growth parameters of black pepper plants compared to the control plants. Prophylactic as well as curative application of *P. indica* on rooted cuttings of black pepper could significantly reduce the incidence and severity of PYMoV, as well as the loss in biomass caused by the virus infection compared to the control plants upon challenge inoculation with the virus. Titer value of the virus titer was also less in the colonized plants.

Conclusion: Co-cultivation of rooted cuttings of black pepper (obtained from disease-free mother plants) with the beneficial fungal root endophyte *P. indica* and keeping them under insect-proof conditions for around 30 days (for successful establishment of the fungus inside the root cortex) and then planting them in the main field is a reliable and chemical-free method to control PYMoV infection in black pepper.

Keywords: *Piper yellow mottle virus*, *Piriformospora indica*, beneficial endophytes

Acknowledgement: Kerala Agricultural University and KSCSTE for facilities and funding.

AGRICULTURE & FOOD SCIENCES-20 REG. No. 15706

Beneficial Effects of the Fungal Root Endophytes *Piriformospora indica* and *Glomus fasciculatum* on Vegetative Growth and Fusarium Rot Management in Small Cardamom

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Background: Cardamom is known as the "Queen of spices" with highest export value. Occurrence of Fusarium rot caused by *Fusarium oxysporum* Scheldt is a major challenge faced by farmers in Cardamom Hill Reserves. Hence, in order to open up an opportunity for management of Fusarium rot of cardamom with minimal risk to environment and low pesticide residue, the response of cardamom to fungal root endophyte *P. indica* and *G. fasciculatum* was studied using cardamom suckers which is the commercial method of propagation in cardamom.

Method: The work involves evaluation of the colonisation and interaction of two beneficial fungi, *Piriformospora indica* and *Glomus fasciculatum* in cardamom suckers's biometric characters, and their potential to manage Fusarium rot disease of cardamom. Their role in plant nutrient uptake (P, K) and hormone production was also assessed in order to deduce the part of nutrients and auxin in plant growth promotion.

Results: Endophyte-colonised suckers showed improved vegetative characters like plant height, number of tillers, number of leaves, leaf length, root parameters and biomass compared to the uninoculated plants where combinatorial treatment recorded the highest values in all the parameters followed by *P. indica* (which was more or less in par with combinatorial treatment for many characters) and then to *G. fasciculatum*. The well established root systems in the endophytes-colonized plants could be substantiated by the higher amount of auxin observed

in the roots of the endophytes-treated plants. The nutrient analysis also revealed a higher uptake of P and K in the endophytes-colonized plants in root and its content in the shoot and leaf compared to the control plants. Further in disease management, the endophytic bioagents-treated plants significantly reduced the disease severity and lesion size over the control where the disease management aspects were higher in *P. indica*-colonised plants where it reduced the disease severity by 58 per cent over control. The higher uptake of P and K by the plant observed in our study contributes disease tolerance. As per the previous studies *P. indica* is reported to have higher amount of defense related enzymes like peroxidase, superoxide dismutases and ascorbate peroxidase, and this may be a possible reason for the disease tolerance observed here.

Conclusion: Endophytes-colonisation especially *P. indica*-colonisation could effectively improve the plant growth and manage Fusarium rot disease in small cardamom. Similar trend could be observed in cardamom seedlings along with a reduction of nursery period by one month each in both primary and polybag nursery by the combinatorial treatment. These findings are an important milestone in eco-friendly management of the Fusarium rot disease with no pesticide residue which remains as a major concern and reason for the diminishing export quality of cardamom.

Keywords: Cardamom, *Piriformospora indica, Glomus fasciculatum*, Endophytes, Fusarium rot

Acknowledgement: Kerala Agricultural University for facilities and funding.

AGRICULTURE & FOOD SCIENCES-21 REG. No. 15641

Piriformospora indica Enhances Yield Production in Tomato and Decreases Severity of Tomato Leaf Curl Virus in The Field

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Background: Tomato leaf c*url virus* (ToLCV) is a ssDNA Begomovirus with wide host range, posing a threat in the stable production of tomato worldwide. ToLCV infection at early stage of crop development causes complete loss to the farmers. *Piriformospora indica* is an endophytic root colonizing fungus that promotes plant growth, increases resistance of plants against biotic and abiotic stress and bio-regulator for plant growth parameters that includes early flowering and enhanced seed production.

Methods: The tomato seedlings var. Vellayani Vijay were co-cultivated in *P. indica* grown portray mixture. The biometric parameters and yield were analysed for the fungus-colonized plants against the control. ToLCV severity was assessed by artificially inoculating the virus to colonized and non-colonized plants through wedge grafting. The effect of *P. indica* colonisation in total protein contents of leaves were spectrophotometrically analysed by Bradford method.

Results: *P. indica* colonization in tomato plants enhanced the biometric parameters such as plant height, shoot and root biomass, number of leaves, leaf area; and secondary and tertiary root architecture. Further, colonization decreased the days taken for fruit set and enhanced the yield per plant. The fungus-colonized plants remarkably decreased the severity of ToLCV and increased the days taken for viral symptoms development compared to the control on artificial inoculation of the virus. The total protein content in the colonized-plants were higher against the control; also highest in *P. indica*-colonized plants and artificially inoculated with virus.

Conclusion: *P. indica* can be used as a novel and safe strategy for enhancing the productivity of tomato plants and efficient management of ToLCV under the field condition.

Key words: *Tomato leaf curl virus*, *Piriformospora indica*, Vulnerability Index, Total soluble proteins

Acknowledgement: Kerala Agricultural University and KSCSTE for facilities and funding.

AGRICULTURE & FOOD SCIENCES-22 REG. No. 15451

Investigating the Complex Microbial Symbiotic Associations Within the Gut and Fungus Comb of Higher Termite *Odontotermes longignathus,* Holmgren

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Termites are ecologically important arthropods that mediate carbon turnover and maintaining soil fertility in terrestrial ecosystems. They degrade complex lignocellulose matter and release nutrients into the surrounding soil enhancing soil quality greatly. Higher termites belonging to Family Termitidae contribute significantly to nutrient recycling, aerating the soil and thereby supporting plant growth. The microorganisms present in the gut and fungus comb of higher termites play an important role in their lignocellulose digestion. Higher termites have robust prokaryotic gut populations but do not possess eukaryotic gut protists. Higher termites belonging to Subfamily Macrotermitinae depend on fungal symbionts cultured on special structures of termite-faecal origin known as fungus combs. The microbial communities harbored in the gut and fungus comb of the fungus- cultivating termite *Odontotermes longignathus* were isolated and identified. The isolated microbes were analysed for several enzyme activities such as cellulase, ligninase, laccase etc. to identify their role in termite digestion. Termite gut bacterial isolates comprised mainly of three species of bacteria, lacking cellulase activity. The predominant bacterial species isolated from the termite fungus comb belonged to the genus *Bacillus* and the fungal isolates from the fungus comb belonged to Division Ascomycota. The bacterial and fungal isolates from the fungus comb exhibited cellulase activity suggesting their role in degrading cellulose, the major constituent of the termite diet. Yeast strains were also isolated from the fungus comb. The present study asserts the importance of the fungal symbionts in cellulose degradation within the fungus comb and the role of yeast and bacterial species in the fungus comb aiding the fungal potential. This work throws light on how the fungal symbiont took over the function of lignocellulose degradation from termite gut bacterial communities.

Keywords: *Odontotermes longignathus*, termite gut microbiota, fungus comb, yeast, bacteria, fungus

AGRICULTURE & FOOD SCIENCES-23 REG. No. 15596

Application of Yeast-Lactic Acid Bacteria Consortium from 'Dahi' for the Development of A Novel Cereal Based Fermented Milk Product

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Background: Fermentation is an oldest method of preservation of foods. Cereal based milk products have a scope in improving the nutritional value of the daily diet. The microbial flora in fermented milks play a significant role in contributing to the nutritional and sensory attributes of the product. Hence an attempt is made is to develop a novel wheat based fermented dried milk product.

Methods: Lactic acid bacteria and yeast were isolated from homemade dahi samples and evaluated for its fermentation potential. The selected isolates were identified and symbiotic effects of theses starter cultures on product preparation was studied. The best yeast lactic acid bacteria consortium was used for the preparation of novel wheat based fermented dried milk product. The nutritional, sensory and microbial quality of the product was evaluated as per standard protocols.

Results: A combination of *Lactiplantibacillus pentosus* and *Candida kefyr* was found to produce an organoleptically superior product (Score=98/100). The dried product was found to have moisture (3%), carbohydrates (71.14%), protein 9.71%,fat (3.26%), pH 4.4 and energy 345.4kcal. Despite the lengthy fermentation and air-drying steps of the product, there was no evidence of contamination by spoilage or pathogenic bacteria.

Conclusion: This novel product developed can be suggested as a nutritionally balanced diet for elderly and sensitive persons.

Key words: Food, Fermentation, Lactic acid bacteria, Yeast, Milk, Cereal

AGRICULTURE & FOOD SCIENCES-24 REG. No. 15513

Piriformospora indica Significantly Affects Mechanisms Involved in Mitigating Drought Stress in Rice

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Background: In the present scenario of climate change with uncertainty in receipt of rain, drought stress at critical growth stages can unfavourably affect growth and yield of rice. In the present study, potential of *Piriformospora indica* to mitigate drought stress in rice was evaluated.

Method: The field experiment was undertaken in the low land paddy fields with *P. indica* colonized and noncolonized rice seedlings under three irrigation intervals of 30 mm, 35 mm and 40mm cumulative pan evaporation and two irrigation depths of 1.5 cm and 3 cm. The crop was raised as per the KAU package of practices recommendation and observed for the growth yield, root and physiological characters.

Results: Plants colonized with *P. indica* significantly enhanced the growth and yield attributes, root biomass, nutrient uptake, relative leaf water content and cell membrane stability index irrespective of interval and depth of irrigation. Yield and water use efficiency of *P. indica* colonized plants subjected to severe stress, were observed to be equivalent to those of non-colonized plants under moderate stress.

Conclusion: Colonization resulted in saving of 30 mm water or 3 irrigations or 3 lakh liters of water and could help rice to combat drought stress by enhanced root biomass, nutrient uptake and water use efficiency during summer.

Keywords: climate resilient agriculture, drought, moisture stress, root endophyte, summer rice

AGRICULTURE & FOOD SCIENCES-25 REG. No. 15638

Rice Husk Ash: A Potential Soil Ameliorant for Homestead Vegetable Cultivation

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Background: Soil acidity is a major fertility constraint in the vegetable cultivation of Kerala. To improve the acid soils for better crop performance liming is inevitable. The high cost of conventional liming materials necessitates the use of low-cost, internally sourced, environmentally friendly and adoptable organic sources that could serve as liming agents and fertilizer for vegetable production. Rice husk ash can be effectively utilized as a cheap and environment friendly soil ameliorant. Moreover it is a rich source of silica and potassium. Si helps to increase nutrient availability, decrease nutrient toxicity and minimize biotic and abiotic stress in plants.

Method: Present study has been undertaken to evaluate the effect of rice husk ash (RHA) in soil acidity management in homestead vegetable cultivation using tomato var. Vellayani Vijai as test crop with six treatments replicated thrice.

Results: The highest number of fruits (29.3) and yield per plant (0.855 kg plant^{-1}) were recorded in T6(Soil test based recommended dose of fertilizers + Rice husk ash @ 125% lime as per soil test) and was at par with treatment T3(Soil test based RDF + 100 % lime as per soil test). The highest B: C ratio (2.7) was also recorded in T6. In all the treatments where, RHA was used as soil ameliorant, the available Si and K content in soil increased as RHA served as good source of Si and K and reduced the iron uptake.

Conclusions: In the case of home stead vegetable cultivation, rice husk ash can be used as an alternate source of lime. Application of rice husk ash @ 125 % lime as per soil test was effective as lime in managing soil acidity in the homestead vegetable cultivation in Onattukara. The use of rice husk ash as a substitute for lime will be reducing the difficulty of lime application.

Keywords: Rice husk ash, soil acidity, homestead, vegetable cultivation

Biotic and Abiotic Constrains of Cabbage Cultivation in South Kerala

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Cabbage (*Brassica oleracea* L.var.*capitata*) is a popular green leafy vegetable belonging to the family Brassicaceae. Cabbage is comparatively a new crop in Kerala particularly in the plains. The high range regions of Kerala offers great scope for cultivation of cabbage and it is cultivated in the cool climate of the hill tracts of Idukki and Wynad districts. But with the development of tropical varieties and hybrids which can grow and form head at high temperatures, cultivation of cabbage was made possible in the plains of the state. The present study was conducted at the Department of Vegetable Science, College of Agriculture, Vellayani, during the period October 2012 to March 2013. The study was conducted for identification of tropical cabbage varieties suitable for plains of southern Kerala and o know the influence of date of planting on yield and quality and their interaction effects. Elevan early/ mid season cabbage genotypes were used for the study (Table 1) under four dates of sowing viz. October 1,October 15, November 1 and November 15.

Abiotic stresses exhibited in the form of physiological disorders occur as a result of environmental stress, nutritional deficiencies or excesses on the plants. Physiological disorders observed in the study were multiple head/blindness and burst head. It was observed only in October 1st and November 15th sowing. It was observed that incidence of multiple head and burst head were found only in genotypes Gayatri, Summer Cross, Indam 1299, Asia Cross and BC-38 sown on October 1st and November 15th. Temperature, rainfall and relative humidity are the critical climatic factors that have profound effect on incidence of pests and diseases.

During the course of the study, the important biotic stress factors noticed were leaf caterpillar (*Spodoptera litura*), rhizoctonia blight (*Rhizoctonia solani*), alternaria leaf spot and head rot (*Alternaria brassicae*). Least incidence was observed in November 1st sowing, since the active vegetative period and heading time coincided with low temperature, rainfall and relative

humidity. Low incidence of leaf caterpillar, alternaria leaf spot, head rot and rhizoctonia blight were observed in November 1st sowing of genotypes NS 183, New Orient, Veer- 333 and Red C-05.High incidence of pests and diseases like leaf caterpillar, alternaria leaf spot, head rot and rhizoctonia blight were observed for certain treatments during the period. Among the varieties low incidence of these pests and diseases were noticed in NS 183, New Orient, Veer- 333 and Red C-05.

AGRICULTURE & FOOD SCIENCES-27 REG. No. 15539

Characterization of Humic Substances in Selected Organic Manures and Soils

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Background: Humic substances, derived through the decomposition of plant and animal residues are very important components that improve soil health and nutrient absorption by the plants. In agricultural soils, humic substances are formed mainly through the application of organic manures, while in forest soils natural decomposition of plant and animal residues leads to the formation of humic substances. The study focus mainly with the objective of characterizing the humic substances naturally present in the soils of forest ecosystems and plantations, as well as in the organic manures commonly used in agriculture.

Methods: The forest soils and manure samples were analysed for pH and organic carbon. The humic fractions (humic acid and fulvic acid) extracted from the soil and organic manure samples were subjected to the functional group analysis using Fourier Transform infrared spectroscopic (FT-IR) technique.

Results: The spectra described for humic fractions showed the presence of OH group (3200-3500cm^{-1}), COOH and COO groups (1000-1320cm^{-1}), which are the most characteristic features of soil humic materials. It also showed prominent peaks of aromatic components. The spectra of humic acid from the soils of evergreen forest showed the characteristic peak of OH (phenolic group) and carboxylic acid group. In the case of fulvic acid, soils of teak plantation showed the characteristic peak for phenolic group followed by moist deciduous forest. As

in the case of soils, organic manures also contain evident peaks for humic substances like H bonded OH group (phenolic group (3200-3500cm^{-1}).

Conclusion: Evergreen soil has the characteristic peak of OH (phenolic group) and carboxylic acid group among the soils and weed compost showed the characteristic peak for the phenolic group in both humic and fulvic acid among the organic manures. Antioxidant property of organic manures is related to the presence of this phenolic group. Hence weed compost was considered as most effective with respect to anti oxidant property.

Keywords: Humicsubstances, Humic acid, Fulvic acid

AGRICULTURE & FOOD SCIENCES-28 REG. No. 15530

Biology and Developmental Parameters of *Aphis gossypii* Glover, 1877 (Hemiptera: Aphididae) on Chilly Plant, *Capsicum annum* Under Laboratory Conditions

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Aphis gossypii Glover (1877) is a small, adaptable, easily spread aphid species, with a rapid reproductive rate and the ability to cause serious plant injury in isolated communities. During the present study, the life cycle of *A. gossypii* was studied by rearing the species on the leaves ofchilly plant, *Capsicum annum* L. collected from Kakkodi, Kozhikode district, Kerala during the period of March-June, 2021.The leaves of infested by the pest aphid, on microscopic examination revealed the presence of varying levels of damage symptoms resulted through the feeding activity of the various life stages of the aphid. Laboratory cultures of individual stages of the pest aphid were maintained adopting agar-leaf method at constant temperature and relative humidity conditions.The biological and reproduction parameters of this aphid species were found to be significant by looking at the way that reduces host plant vigor. *A. gossypii* life cycle in this studyexhibited as four stages namely, as nymphal, pre-reproductive, reproductive and post reproductive. Nymphal stage includes four instars with the duration 1.43, 1.35, 1.23 and 1.32 days respectively. Their reproduction was parthenogenetic where

female aphid gives young ones during the reproductive stage. The mean durations of the pre-reproductive, reproductive and post-reproductive periods under viviparous mode of reproduction were recognized to be 0.52, 7.67 and 1.35 days respectively. This aphid is extremely polyphagous on more than 700 host plant species. They distributed globally but prefers warmer regions.This study has aimedon the basic information about the reproductive biology of *A. gossypii*, which is crucial for their proper management. The duration of biological parameters varies with climatic factors, survival potential and the host plant species.

Keywords: *Aphis gossypii, Capsicum annum*, life stages, agar-leaf method, viviparity

AGRICULTURE & FOOD SCIENCES-29 REG. No. 15504

Biochemical Characterization of Lodging Resistance in Mutagenated Rice

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Background: Lodging is a major constraint in most of the cereal crops including rice. It reduces the yield and adversely affects the quality of produce. Mutation breeding is one of the strategies for upgrading a well adapted variety by altering the trait limiting its potential. Swarnaprabha (PTB 43) and Vaisakh (PTB 60) are two high yielding upland rice varieties released from Kerala Agricultural University. But the major problem associated with these varieties is lodging. Irradiation of crop varieties can induce variability which can be further used to develop varieties resilient to climatic changes.

Method: Swarna Prabha (PTB 43) and Vaishak (PTB 60), suited for upland growing conditions were treated with gamma irradiation with radiation dose varying from 375-550 Gy at 25Gy interval. The effective dose for mutagenesis was fixed using probit analysis after counting the germination percentage of irradiated seeds in replications. M_1 generation raised and seeds were harvested and M_2 raised by pedigree method. Observations were recorded for yield and yield related traits along with biochemical parameters like cellulose and starch content, which confers rigidity to stem.

Results: Significant reduction was noticed in germination percentage with increase in radiation dose. From the correlation studies it was noted that characters such as plant height, length of the first and third internodes, culm diameter, starch content and cellulose content recorded highly significant positive correlation with lodging resistance. From the present study it was noted that increase in cellulose and starch content can induce lodging resistance.

Conclusion: Mutation breeding can induce variability in the genes which influence cellulose and starch biosynthesis and there by enhancing the chance of breeding for lodging resistance.

Keywords: Upland rice, Mutation breeding, Lodging resistance

AGRICULTURE & FOOD SCIENCES-30 REG. No. 15881

Insecticidal and Biological Activities of Four Different Essential Oils Against Stored Grain Pests

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Background: Owing to hazardous nature of synthetic pesticides, use of plant products for the management of stored grain insects has become essential because they are biodegradable and having least mammalian toxicity. Thus, among the plants products, essential oils have been well documented as stored grain protectants.

Methods: Basil oil, Citronella oil, Eucalyptus oil and Orange oil were taken to check the insecticidal activity against., *Callosobruchus chinesis* and *Tribolium castaneum*, different bioactivity assays (Contact toxicity, Fumigant toxicity, Repellence test, persistence test) were done to check the potency.

Results: Essential oils were procured from Synthite Industries private Limited, Kolenchery.

Basil EO, Citronella EO, Eucalyptus EO and Orange EO are the oils procured. The chemical characterization of Eos is done by using GC-FID and GC-MS, the components and its percentage were calculated. The major

components present in the Eos are Methyl chavicol (75.7% in Basil EO), Limonene (96.1% in Orange EO), 1,8 Cineole (76.96 % in Eucalyptus EO) and Geranial (59.1% in Citronella EO). Toxicity bioassays, were conducted to check the insecticidal activity of four different Eos against the storage pests, *T. casteanum* and *C. chinesis*. It is very evident that the subjected Eos have insecticidal activity. As comparing with the contact toxicity and fumigant toxicity the Essential oils shows better results in fumigant toxicity, the LC 50 and LC 90 had been calculated for all four Eos against the test organisms in 24 and 48 Hrs respectively. Among all four Essential oil, Basil EO shows upper hand in contact and fumigant activity against the stored grain pests. The least activity is shown by Orange Eo and rest of the Eo shows mediocre activity. Repellence test is done to check how the test insects are attracted or repelled in the treated area. *T. casteanum* shows 100% repellence at 2 % in all Eos and it gradually decreased and 0% activity in 0.10%, while in C. *chinesis* 100% repellence is shown in 1% and 0% in 0.03% in all four Eos. A persistence assay was done to check how prolong the insecticidal activity of Eos exists. In T. *casteanum* the persistence order is Basil Oil (37 days), Citronella Oil (35 days), Eucalyptus Oil (29 days) and Orange Oil (29 days). The *C. chinesis* persistence order is Basil Oil (39 days), Citronella Oil (39 days), Eucalyptus Oil (37 days) and Orange Oil (35 days).

Conclusions: The subjected Essential oils are very potent against the stored pests and these oils are biodegradable in nature and thus no environmental abuse is seen.

Keywords: *Callosobruchus chinesis*, *Tribolium castaneum,* persistence.

AGRICULTURE & FOOD SCIENCES-31 REG. No. 15642

Pre-Sowing Seed Invigouration with a Combination of KNO_3 and *Pseudomonas* Improves Germination and Growth Parameters in Vegetable Seedlings

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Background: Seedling establishment is a critical element and largely depends on seed germination and vigour. Seed invigouration technique has the ability to boost the seedling vigour and germination of normal seeds. Since seed priming has been proven to be a useful method, it is necessary to standardise it across all crop species, particularly in vegetables crops. Chemical substances or bio-control agents can be used to treat the seeds.

Method: A study was carried out at the Department of Vegetable Science, College of Agriculture, Vellanikkara to find out the best seed invigouration treatment in tomato, chilli, cucumber and okra. The experiment comprised of nine treatments replicated three times and conducted in a completely randomized design. Seeds of tomato var. Anagha, chilli var. Anugraha, cucumber var. Heera and okra var. Salkeerthy were soaked in different concentrations of KNO_3 (0.5 %, 1 %, 2 %), 1 % *Pseudomonas* and in combinations of these for twelve hours. Treated seeds were shade dried for 30 minutes and sown in pro-trays filled with coir pith compost, vermiculite and perlite (3:1:1 ratio v/v). To provide nutrients N: P: K source 19:19:19 was applied after twelve and twenty days of sowing at 3 g/l (Bharathi *et al*., 2014). Observations were recorded at the stage of commercial sale (15 DAS) and statistical analysis was done.

Results: The results revealed that 0.5% and 1% KNO_3 alone, as well as in combination with 1% *Pseudomonas*, performed effectively in all the four crops evaluated. It can be inferred that seeds treated with 0.5% and 1% KNO_3 concentrations alone or in combination with 1% *Pseudomonas* yielded good growth parameters *viz*., plant height, root length, leaf area, collar girth, vigour index I and vigour index II, while seeds treated at 2% KNO_3 concentrations was detrimental for seedling growth.

Conclusion: A combination of 0.5% KNO_3 and 1% *Pseudomonas* can be effectively used for seed treatment in vegetables. Apart from giving good vigour, the combination of KNO_3 and *Pseudomonas* also confers resistance to soil-borne diseases

Keywords: Pre-sowing seed invigouration.

AGRICULTURE & FOOD SCIENCES-32 REG. No. 15687

Profiling of Rice Varieties of Kerala for Amylose Content Using Molecular Markers: An Approach Towards Diabetes Management

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Background: Amylose and amylopectin the two constituents of starch in rice endosperm greatly influences the quality of rice. Glycemic index (GI) is an estimate to score foods how quickly they raise blood glucose level after consumption. Glycemic index value and amylose content are negatively correlated. Therefore, consuming foods having high amylase content would help in maintaining the blood glucose level in diabetic patients. There is a rich genetic diversity of rice in Kerala and therefore, screening rice varieties of Kerala can help identify varieties with high amylose content.

The present work aims to identify rice varieties with high amylose content using molecular approach. The Waxy (Wx) gene encodes the Granule-Bound Starch Synthase I (GBSSI) enzyme primarily regulates amylose synthesis in grains. Several PCR based molecular markers linked to the Waxy gene are available to identify alleles of Wx carried by the rice varieties and can successfully correlate to the amylose content. This research will help identify accessions with low GI which will be a boon to the breeders to develop low GI lines suitable to the consumer's preference and market quality, particularly in Asia.

Method: Traditional rice varieties from Kerala were collected and germinated for DNA isolation. Rice seedlings were established to collect leaf samples from two to three week old seedlings for DN isolation. DNA was isolated from leaf samples as described in simple CTAB method (Doyle and Doyle 1987). Quantity check was done using UV spectrophotomer and quality check was done using 1% agarose gel electrophoresis. DNA isolated from rice leaf samples were subjected to PCR amplification with primers linked to *Waxy* locus. Bands visualized using 1% agarose gel electrophoresis. The primers used are as follows:

Results: A total of 18 rice varieties from Kerala were screened with three markers linked to Waxy allele. Glu23 was used to amplify DNA fragment containing the 23-bp duplicate region, which discriminate between varieties with *Wx* and *wx*. All the

rice varieties screened showed an amplification of 173 bp allele which corresponds to *Wx* allele classifying them as non waxy rice varieties. Genotypic screening o the rice varieties with marker specific to Wx^b produced no amplification. The samples were then screened with Waxy-intron primer followed by restriction digest of the PCR fragment of the region amplified using restriction endonuclease AccI. After analysis of the resulting banding pattern, 257bp band was observed indicating no digestion which confirms the presence of Wx^a allele. The varieties were also analysed with Wx^{in} marker to identiy intermediate-amylose cultivars. However, there was no amplification observed with all the test samples indicating that these varieties contain amylose content higher than 24%.

Conclusion: In summary, this work identifies traditional rice varieties of Kerala with high amylose content based on molecular screening. This method of using molecular markers overcomes the shortcomings of amylose content measurements by other spectrophotometric methods.

Keywords: Rice, amylose content, Waxy allele, diabetes, molecular markers

AGRICULTURE & FOOD SCIENCES-33 REG. No. 15690

Pegylated Iron Oxide Nanoparticles: Smart Nanovector for Seed Germination and Mineral Fortification

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Background: Biopolymer based Iron Oxide Nanoparticles (IONPs) are deliberated as upcoming nanovectors in the field of Plant Biotechnology. Several studies have been conducted during the past two decades to elucidate the effect of NPs in the plant system and both positive and negative responses have been observed. The current study focuses on the effect of pegylated iron oxide nanoparticles in the seed germination of *Solanum melongena*.

Methods: Pegylated iron oxide nanoparticles were synthesized and characterized by UV-Vis spectroscopy and transmission electron microscopy. *Solanum melongena* seeds were subjected to germination in the presence of IONPs solution at concentrations- 5, 10, 15 and 20 ppm particles in basal MS medium. Plant biomass and

growth index were analyzed after germination.Iron accumulation in the tissues was analyzed using Perl's staining.

Results: IONPs induced a statistically significant dose-dependent increase in growth index in *Solanum melongena* plantlets compared to untreated seedlings. Studies in root and stem sections showed the higher accumulation of IONPs in the treated seedlings compared to untreated seedlings. IONPs exhibited substantial enhancement in seedling growth (double the growth rate compared to untreated seedlings) both in radicle and plumule regions.
Conclusion: Pegylated iron oxide nanoparticles can serve as a promising delivery system for rapid seed germination and iron fortification.

Keywords: Nanoparticles, Germination, MS medium, Growth

AGRICULTURE & FOOD SCIENCES-34 REG. No. 15861

Endophytic *Bacillus* Promotes Plant Growth and Suppresses Web Blight *(Rhizoctonia solani kuhn)* Disease of Bush Cowpea *(V*igna *unguiculata* (L.) Walp.)

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Background: Cowpea, a widely grown vegetable crop in the wetland fallows in Kerala, suffer from serious setback due to its susceptibility to several pests and diseases. Among various fungal diseases, web blight incited by *Rhizoctonia solani* Kuhn, has become a severe problem in cowpea growing tracts across the state. *R. solani* cause substantial yield loss (20 – 40 %) per annum across worldwide. However, indiscriminate use of chemicals may result in residual effect on the vegetable. Hence, biological control using endophytes is an alternative way for plant growth promotion and management of web blight disease in cowpea.

Method: Endophytic bacteria were isolated from healthy root, stem and leaves of fodder cowpea and bush cowpea. The isolates of endophytic bacteria were screened against *R.solani* by adopting dual culture technique and culture filtrate assay. Bio-priming with selected bacterial endophytes at 10^8 cfu/ ml were performed using roll towel assay. The promising endophytic bacterial isolates were tentatively identified through morphological,

cultural and biochemical characters and further confirmed through 16S rRNA analysis.

Results: Thirty-eight endophytic bacterial isolates were obtained from healthy root, stem and leaves of fodder cowpea and bush cowpea. Based on the results of direct and indirect antagonism of endophytic bacteria, 20 isolates were selected as promising ones for biopriming of cowpea seeds. Based on the results of roll towel assay the isolates CFLE3, CBRE5 and CBSE5 were selected as the best three bacterial endophytes for further studies. The identities of the species of these isolates were further confirmed through 16S rRNA analyses as *Bacillus subtilis* CFLE3 (OL719066), *B. amyloliquefaciens* CBRE5 (OL719067) and *B. velezensis* CBSE5 (OL719068). Under *in vivo* conditions, seed biopriming for 4 h along with foliar application (20 and 40 DAS) of *B. velezensis* CBRE5 was most effective treatment for the management of web blight of cowpea whereas, combined seed biopriming for 4 h along with foliar application (20 and 40 DAS) of *B. amyloliquefaciens* CBSE5 and *B. velezensis* CBRE5 was the best treatment in plant growth promotion. Production of IAA, ammonia, phosphorus and siderophore were also investigated for elucidation as plant growth promoting traits.

Conclusion: This study elucudiated *B. velezensis* CBRE5 as putative PGPR and potent biocontrol agent against web blight disease incited by *R. solani*

Keywords: Cowpea, Endophytic bacteria, *Rhizoctonia solani*, Antagonists, Plant Growth Promotion

AGRICULTURE & FOOD SCIENCES-35 REG. No. 15569

Soil Carbon Dynamics Under Long Term Fertilization in Rice-Rice Cropping Sequence of Onattukara

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Background: Soil organic carbon (SOC) is an important index of soil fertility because of its relationship to crop productivity. Declining SOC level often leads to decreased crop productivity. Hence, maintaining SOC level is essential for agricultural sustainability.

Method: This experiment comprised of field experiment using various combination of nitrogen, phosphorous and potassium fertilizers in rice variety Jaya at Onattukara. Soil analysis for various carbon fractions in soil were carried out using the standard procedures. Various computed carbon indices like carbon pool index, carbon lability index, carbon management index were worked out to determine the sustainability of management practices.

Result: Carbon fractions, computed indices, carbon build up rate and carbon sequestered were found the highest in treatment receiving integrated application of organic and inorganic fertilizers. All the treatments recorded a positive critical carbon input which indicates that additional carbon has to be given inorder to sustain the present level of SOC stock.

Conclusion: Present study provided an insight on how management practices affect soil carbon buildup and carbon sequestration in rice-rice cropping sequence of Onattukara. Integrated nutrient management significantly improved carbon fractions, carbon buildup rate and yield.

Keywords: Soil organic carbon, carbon pool index, carbon lability index, carbon management index.

Piriformospora indica Helps in Establishment of TC Banana Plantlets and Tolerance to BBrMV in Field Condition

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Background: *Banana bract mosaic disease* (BBrMD) is a serious virus disease of banana. Nendran variety is more prone to this disease and the incidence of disease ranges from 5 to 36 per cent. Virus diseases are difficult to manage and tissue cultured (TC) banana plantlets are extensively used to produce virus indexed and free planting material. As a vector borne disease, *Banana bract mosaic virus* (BBrMV) symptom are also observed in TC banana cultivated field. TC plants are more sensitive to stress conditions. Acclimatization phase is the most important stage of tissue culture banana plantlets. Beneficial root-colonizing endophytic basidiomycete fungus, *Piriformospora indica* conferes enhanced plant growth and yield in addition to increased resistance/ tolerance to (a) biotic stress in crop plants. Present study elucidates the role of *P. indica* in the establishment of TC banana plantlets, banana suckers and its evaluation against BBrMV.

Method: Work deals with colonization of *P. indica* with different stages of TC banana (Var. Nendran) and suckers. Standardization of different method of *P. indica* co-cultivation with banana plants was carried out. Assessment of biometric parameters and evaluation of BBrMV tolerance of *P.indica* colonized plants were done.

Result:*P. indica*-root colonization helped in establishment of TC banana plantlets in the secondary hardening and subsequently in the field with enhanced root and shoot biomass in Nendran. *P.indica* could colonize inside the roots irrespective of their age and growth phase. *P. indica*-colonized TC plants produced more number of roots, rootlets and root hairs, thus improved the root architecture compared to the non-colonised plantlets. The colonized plantlets also recorded increased leaf area. *P. indica*-colonized plantlets could reduce symptoms of BBrMV in field condition under its natural incidence.

Conclusion: The present study demonstrated that the beneficial fungal root

endophyte *P. indica* helped in the establishment of banana suckers, TC plantlets and conferred increased tolerance to BBrMV with enhanced growth.

Keywords: *Piriformospora indica, TC banana plantlets, Banana suckers, BBrMV*, Growth promotion, Disease tolerance

Acknowledgement: Kerala State Council for Science, Technology and Environment (KSCSTE) for funding the project and Kerala Agricultural University for providing facilities.

AGRICULTURE & FOOD SCIENCES-37 REG. No. 15481

Profitability of Tannia (*Xanthosoma sagittifolium* (L.). Schott) Grown in Coconut Gardens as Influenced by Tillage and Nutrition

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Background: Tannia (*Xanthosoma sagittifolium* (L.). Schott) is one of the six most important tuber crops grown world-wide. Soil compaction of agricultural soils is a well recognized global problem which can be reduced by tillage. Crop residues can be applied to enhance crop productivity. A positive response of tannia to organic manures and chemical fertilizers is revealed. Hence, a study was taken up to identify the ideal tillage system, soil conditioner and nutrition for profitable cultivation of tannia as an intercrop in coconut gardens.

Method: The experiment was laid out in split plot design with four replications. The main plot treatments consisted of four tillage systems and sub plot treatments were two soil conditioners along with a control and two nutrient management practices.

Results: Significantly higher yield was obtained due to deep tillage and pit system. Coir pith as soil conditioner resulted in higher yield. Organic nutrition significantly improved tuber yield compared to INM. Deep tillage followed by pit system under organic nutrition without any soil conditioner recorded the highest net income and BCR.

Conclusion: Tannia can be profitably intercropped in coconut gardens by adopting deep tillage followed by pit system of planting and providing organic nutrition.

Key words: Economics, Organic, Tannia, Tillage, Yield.

Productivity Enhancement in Watermelon [*Citrullus lanatus* (Thunb.) Matsum. & Nakai] Through Fertigation, Drip Irrigation and Vertical Training Under Rain Shelter

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Background: Watermelon is the most popular and widely cultivated warm season crop of cucurbitaceae family. Traditionally watermelon is cultivated by trailing on the ground and adopting surface irrigation with soil application of fertilizers. Recently, vertical training of vines has emerged as an alternative to horizontal training, especially in protected cultivation adopting drip irrigation and fertigation.

Method: An experiment was conducted at Department of Olericulture, College of Agriculture, Vellayani, Kerala, to study the effects of fertigation, drip irrigation and training levels on yield and quality of watermelon hybrid 'Prachi' under rain shelter. The treatments were factorial combinations of three fertigation levels (75 %, 100 % and 125 % recommended dose (RD) of 70:50:120 NPK ha^{-1}), two irrigation levels (0.6 and 0.8 evapotranspiration (ET) rates) and two training levels (nipping to one vine, nipping to two vines) arranged in randomized block design with two replications and control with surface irrigation, soil application of fertilizer and horizontal training of vines. Plants were trained vertically in rain shelter.

Results: Fruit weight, yield per plant and crop duration were significantly affected by fertigation and irrigation levels under rain shelter, whereas number of fruits per plant was affected by training levels. Fertigation treatments registered higher yield and longer crop duration compared to control. Highest yield was recorded in fertigation at 100 % RD, 0.8 ET and training to two vines under rain shelter. Water use efficiency was highest at 0.6 ET. TSS content was not affected by fertigation, irrigation and training levels. Deficit irrigation had influence on lycopene and ascorbic acid contents under rain shelter.

Conclusion: The results revealed that

the yield of watermelon increased under drip irrigation and fertigation than the conventional surface irrigation and soil application of fertilizer. Training to two vines per plant showed better performance for number of fruits per plant and yield of mini watermelon.

Key words: Watermelon, fertigation, drip irrigation, training

AGRICULTURE & FOOD SCIENCES-39 REG. No. 15469

Estimation of Heterosis for Yield and Yield Attributing Traits in Tomato *(Solanum lycopersiucm* L.) Under Protected Conditions

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Background: Heterosis breeding is a potential method to achieve improvement in production and productivity of tomato under protected conditions.

Method: In this experiment, half diallel analysis was carried out using nine parents and check Naveen under protected conditions. The parents were crossed in a half diallel fashion excluding reciprocals to obtain 36 F_1 hybrids during 2013-2015.

Results: The study revealed that heterotic vigor was present for growth and yield characters among hybrids. Heterosis was negative for days to first flowering and positive for fruits per plant, and yield per plant. Considerable variation was noticed for fruits per plant with EC-775046 x EC 608365 recording the maximum fruits per plant (103.93). EC 608365 x EC-775045 recorded the highest yield of 3114.03 g per plant. Wide range of heterobeltiosis was manifested by the hybrids for the characters considered. The results revealed that the hybrids exhibited a heterobeltiosis for yield in the range of -47.14 (EC 608244 x EC-775045) to 89.54 (EC-775046 x EC 608365).

Conclusion: The present investigation helped to quantify the variability among tomato genotypes for yield and yield related characters under protected conditions. Based on the mean performance, standard heterosis and *sca* effects three potential crosses viz., EC 608365 x EC-775045, Akshaya

x Manulakshmi and EC-775046 x EC 608365 could be advanced for further study under protected conditions. Thus the present study reveals that heterosis breeding is useful for development of tomato through exploitation of heterosis under protected conditions.

02

Biotechology

Oral Presentation

BIOTECHOLOGY-01 REG. No. 11096

Recombinant Expression of an Antimicrobial Peptide Penaeidin From Speckled Shrimp *Metapenaeus monoceros* and its Functional Characterization

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Background: Shrimps mainly depend on innate immunity and the antimicrobial peptides are an important component of the innate immune system. The development of antimicrobial peptides provides a possible alternative to antibiotics in the modern era of increasing antibiotic resistance.The present study deals with the recombinant expression and functional characterization of the antimicrobial peptide Penaeidin from *Metapenaeus monoceros.*

Method: The pET-32a (+) expression vector with the mature peptide region of the target gene *Mm*- Penaeidin isolated from *Metapenaeus monoceros* was transformed into the expression host *E. coli* Rosettagami™ B (DE3) pLysS cells. The fusion protein was expressed after induction with IPTG. The proteins were purified, desalted and cleaved with enterokinase enzyme to remove the thioredoxin fusion tag. The purified peptide was quantified and the antimicrobial activity of the peptide was tested by broth micro dilution assay against twelve pathogens of aquaculture and clinical importance.

Results: The r*Mm*-Penaeidin with a molecular weight of 5.84 kDa was expressed in the *E. coli* Rosettagami™B (DE3) pLysS cells. The peptide after purification and enterokinase cleavage of the thioredoxin tag showed potent antimicrobial activity. The growth inhibition percentage of the peptide r*Mm*-Penaeidin at the highest concentration of 16 µM were as follows; *Staphylococcus aureus*- 13.02%, *Bacillus cereus*- 92.89%, *Escherichia coli*-56.57%, *Edwardsiella tarda*- 33.73%, *Aeromonas hydrophila*- 6.45%, *Pseudomonas aeruginosa*- 56.55%, *Vibrio parahaemolyticus*- 60.41%, *Vibrio alginolyticus*-97.14%,*Vibrio cholerae*-77.4%, *Vibrio proteolyticus*-70.39%, *Vibrio fluvialis*-94.05%, *Vibrio harveyi*-67.99%.

Conclusion: The present study reports the recombinant expression of the *Mm*-Penaeidin from *Metapenaeus monoceros*in the *E. coli* Rosettagami™B (DE3) pLysS cells, and its antimicrobial potential against clinical and

aquaculture pathogens. Further studies on the bioactive potential of the peptide might open a new avenue for the development of novel drugs to fight microbial infections.

Keywords: Antimicrobial peptides, *Metapenaeusmonoceros*, Penaeidin.

BIOTECHOLOGY-02 REG. No. 13194

Quorum Quenching Activity of a Novel Strain of *Bacillus velezensis* and its Application in Biofilm Control

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Background: "Quorum Quenching" (QQ) is a novel approach, demonstrated as a better substitute for traditional biofilm mitigation strategies which are energy intensive or not environment friendly. In this approach, the microbial cell signaling mechanism (Quorum Sensing) is interrupted without causing any detrimental effect on cell viability which in turn imparts less selection pressure on the ecosystem. In this scenario, the present study focuses on developing a bacterial system exhibiting QQ property that can be translated for controlling biofilm formation on different surfaces.

Methods: Enrichment culture strategy was adopted to promote the growth of QQ bacteria. N-Acyl Homoseriene Lactone (AHL) molecule was provided in the growth medium, and several bacteria were isolated and screened for QQ activity. For screening purpose, few bacterial strains such as a mutant strain of *Chromobacterium violaceum* CV026 and wild strains such as *Chromobacterium violaceum* sp. NIIST, *Serratia marcescens* sp. NIIST and *Pseudomonas aeruginosa* (ATCC27853) were used. One of the isolates exhibiting prominent QQ activity was identified using 16SrRNA sequencing. The QQ activity of the isolated bacterium, including inhibition of biofilm was established and through molecular probing, the mechanism behind the QQ activity was also elucidated.

Results: Through enrichment culture, a novel strain of *Bacillus velezensis* (isolate PM7) was isolated that exhibited significant extracellular quorum quenching activity. The cell free supernatant of the strain was found to affect the quorum sensing phenotypes such as pigment production, motility,

exopolysaccharide production, cell surface hydrophobicity and virulence factor expression of *C. violaceum*, *S.marcescens* and *P.aeruginosa* without affecting the cell viability. It was demonstrated that the PM7 decreased the biofilm forming capacity of these bacteria by 66%, 58% and 70% respectively. Molecular studies confirmed the presence of AHL lactonase gene (aiiA), which could be the reason for the QQ activity of the isolated strain.

Conclusion: The isolated novel strain of *B. velezensis* PM7 exhibited significant inhibition in bacterial biofilm formation without affecting cell viability (reason for antimicrobial resistance). The mechanism of QQ was found to be through extracellular AHL Lactonase activity. The wide substrate specificity and extracellular enzyme activity of *B. velezensis* PM7 mediated quorum quenching can be developed further as a feasible method for biofilm mitigation on different surfaces that will have high application potential.

Keywords: Biofouling, Quorum sensing, N-Acyl Homoseriene Lactone

BIOTECHOLOGY-03 REG. No. 15517

Production and Characterization of Antineoplastic Enzyme L-Asparaginase from Novel *Geosmithia pallida* Strain KLR04

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Background: L-Asparaginase is an antineoplastic agent used in the treatment of acute lymphoblastic leukemia, lymphomas and other cancers. The present study deals with the production of this chemotherapeutic enzyme drug from fungal strain *Geosmithia pallida* KLR04.

Methods: A total of 249 isolates were used to screen out efficient microorganisms for enzyme production. Identification of the potent strain KLR04 was based on conventional morpho-taxonomic methods and molecular phylogenetic analysis using sequence homology of ITS region. The enzyme from KLR04 was purified by column chromatography and the finest enzyme was further characterized.

Results: Of the 249 fungal isolates screened, the strain KLR04 showed maximum L-asparaginase activity. The potent strain was identified as *Geosmithia pallida*

and chosen for L-asparaginase production under submerged fermentation. *Geosmithia pallida* KLR04 L-asparaginase showed an apparent molecular weight 65 kDa by SDS-PAGE. The enzyme was active in a pH range of 7.5-8.5 with maximum activity at pH 8.0. The enzyme was optimally active at 40 ˚C and was stable at 0-50 ˚C.

Conclusion: The study explored the *Geosmithia pallida* KLR04 as a potential fungal source for high yield production of antileukemic enzyme drugs.

Keywords: *Geosmithia pallida*, L-Asparaginase, KLR04, Submerged fermentation, Purification, Thermostability.

BIOTECHOLOGY-04 REG. No. 15622

Response to induction of the cellulases of *Penicillium janthinellum* NCIM 1366: The expression of cellulases is preceded by reorganization of metabolic and stress-responsive pathways and their associated regulators

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Background: Current efforts to bring to life the concept of an "integrated biorefinery", in which fungi are grown on lignocellulosic feedstock to produce the necessary enzymes, call for the use of organisms that can secrete high titers of efficient hydrolases. Since cellulase production by fungi is tightly regulated in response to environmental cues, understanding the mechanisms of cellulase gene induction and regulation will provide vital clues for the systemic improvement of their cellulase production.

Method: This work explores the transcriptional and secretome response

of the hypercellulolytic fungus *Penicillium janthinellum* NCIM 1366 (PJ-1366) to induction using different carbohydrate substrates. This data has been correlated with the distribution of transcription factor (TF) binding sites on the promoters of its cellulases so as to glean an understanding of the regulators and pathways that govern the early induction of cellulases.

Results: Cellulase, xylanase, BGL and peroxidase activities were higher for cultures grown on a combination of cellulose and wheat bran, while endoglucanase activity was stimulated by disaccharides. Analysis of correlations between the proteome response of induced cultures and the distribution of transcription-factor binding sites on the promoter regions of the cellulases identified 13 transcription factors that are positively correlated with cellulase production, of which Rox1, Ste12 and Gcn4 were highly correlated. Correlation analysis of the transcriptional response of these regulators and transcription factor binding sites on their promoters indicated that cellulase expression is possibly preceded by up-regulation of 12 TFs and down-regulation of 16 TFs, which cumulatively regulate transcription, translation, nutrient metabolism and stress response.

Conclusion: This work identifies the appropriate inducers of different cellulases in PJ-1366, and gives preliminary information on the metabolic pathways that are co-regulated with the expression of cellulase genes in this fungus.

Keywords: *Penicillium*, fungal, cellulase, transcription, pathway, induction

BIOTECHOLOGY-05 REG. No. 15650

Non Polar Extract from *Polyalthia korintii* Leaves Inhibits Proliferation, Migration, Invasion and Induces Apoptosis in Human Colorectal Carcinoma Cells

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Background: *Polyalthia korintii* is an Indo - Sri Lankan endangered species with ethnomedicinal claims and is reported in Ghats of India. Though Polyalthia species is extensively studied for its anticancer potentials,

P. korintii remains scientifically unexplored. Thus the present study attempted to evaluate the anticancer potentials of this species.

Methods: Leaves were extracted with petroleum ether by soxhlation. Cell viability, migration, and invasion were detected by MTT assay, scratch wound-healing assay, and transmembrane invasion assay, respectively. The cytotoxic mechanism was analyzed by microscopy, FACS, DNA fragmentation and western blot. GC-MS analysis was employed to identify the phytoconstituents present in the non-polar extract.

Results: Non-polar extract of *P. korintii* exhibited potent anti-proliferative activity in dose and time dependent manner. The induction of apoptosis was confirmed by presence of characteristic DNA fragmentation pattern and PARP cleavage. The study revealed the in vitro antimetastatic potential of PE extract on treatment with sub-lethal concentrations by inhibiting the migratory and invasive ability of the HCT116 cells. The putative phytocompounds responsible for anticancer activity were identified. This is the first ever study reporting the anticancer potential and the presence of these phytoconstituents in *Polyalthia korintii* leaves.

Conclusion: The plant possesses significant anticancer potential against human colorectal carcinoma cells and is a reservoir of unexplored bioactive secondary metabolites. Studies are in progress to discern other biological potentials of the plant. The present work thus discloses the anticancer potential of an endangered Polyalthia species and necessitates the need for its conservation.

Keywords: *Polyalthia korintii*, anticancer, apoptosis

BIOTECHOLOGY-06 REG. No. 15652

TLX3 is a Crucial Determinant for Early Cerebellar Patterning

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Background: Tlx3 is expressed in granule neurons of the posterior cerebellum during a short window period from E16 to PN20 and regulates few genes involved in Autism spectrum disorders (ASD). Nevertheless, the underlying functional relevance for this restricted expression pattern of Tlx3 in the posterior cerebellum during this time point is unknown. Here we demonstrate the functional role of Tlx3 in the posterior cerebellum by using Tlx3 conditional knockout mice (Tlx3 cKO).

Method: Cerebellum specific Tlx3 conditional knockout mice were generated by crossing $Tlx3^{fl/fl}$ and Atoh1 Cre mice. We have carried out Immunohistochemistry, TUNEL Assay, BrdU labelling, qRT PCR, cerebellar granule neuron culture and behaviour experiments for motor function, Anxiety and Neurodegeneration.

Results: Tlx3 cKO mice showed an evident defect in the patterning of cerebellum. Furthermore, this is followed by the alternation in each of the Glutamatergic and GABAergic cell types of the cerebellum and Tlx3 expressing granule neurons of the cerebellum have lost their potential to proliferate in Tlx3 cKO compared with the control. qRT PCR analysis also showed that ablation of Tlx3 from granule neurons of cerebellum affects the inherent molecular markers, proliferation, and few ASD candidate genes. In addition to that, Tlx3 deleted granule neurons were also failed to form proper connections *in vitro*. Moreover, these defects directly influenced the behaviour of the Tlx3 cKO mice, where motor function is affected and showed mild anxiety symptoms but no severe neurodegenerative defects.

Conclusions: In a nutshell, our study has shown that Tlx3 is required for the proper cerebellar patterning, formation of different cell types, the proliferation of granule neurons, and connections of the cerebellum. Furthermore, the loss of Tlx3 from the posterior cerebellum can change internal molecular signatures of the

cerebellum through gene expression. Altogether, dysfunction of the cerebellum induced by the deletion of Tlx3 give rise to motor function defect and mild anxiety symptoms, but not to neurodegenerative condition.

Keywords: Tlx3, Posterior cerebellum, Patterning, Proliferation, Motor behaviour, Anxiety.

BIOTECHOLOGY-07 REG. No. 15660

Analysing the Microbiome of A Marine Sponge *Stellata* Sp., Through Cultivation-Dependent and Cultivation-Independent Approaches

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Background: Marine environment is a relatively unexplored ecosystem, which consists of marine invertebrates such as sponges that produce potent bioactive metabolites with antimicrobial as well as cytotoxic properties as part of their chemical defense system. However, they are often present in minute quantities and it has been found that the microbes associated with the sponges are the real producers of these metabolites. Although microbial fermentation has the obvious advantage of providing a cheap and sustainable source of metabolites, the vast majority of sponge symbionts remain uncultured. The cultivation independent metagenomic approach helps in accessing the full genetic potential of these associated microbes.

Methods: This work explores the use of both cultivation dependent and cultivation independent methods to unearth the diversity of microbes associated with the sponge *Stellata* sp. Culturable bacteria and actinomycetes were isolated according to standard protocol and cultured on Zobells marine agar and Actinomycetes isolation agar respectively. The DNA was isolated and sequenced following standard protocols of 16S rRNA sequencing. The unculturable bacteria isolated from sponge were sequenced following standard protocols of DNA sequencing using Illumina Miseq platform.

Results: Bacillus dominated the bacterial population during culture based methods, while *Pseudomonas*

spp. was dominant in metagenomics based approach. The actinomycetes isolates MRS 12, MRS 13 showed 100% and 98% similarity with *Streptomyces chumphonensis* and *Nocardiopsis alba* respectively. The uncultured prokaryotic community present in the sponge sample encompassed a vast phylogenetic diversity, including isolates belonging to Proteobacteria, Firmicutes, Actinobacteria, Bacteroidetes, Euryarchaeota, Verrucomicrobia, Planctomycetes, Gammaproteobacteria, Chloroflexi, Acidobacteria, Fusobacteria, TM7, Spirochaetes,and Crenarchaeota.

Conclusion: This work establishes the use of metagenomic approach to compile the diversity of bacteria associated with the marine sponge *Stellata* sp. Integrating both cultivation dependent and cultivation independent approaches helps to analyse the diversity within the microbiome of marine sponge *Stellata* sp. extensively. Understanding the diversity of microbiome further aids to mine the bioactive potential of marine bacteria associated with the marine invertebrates. The present work provides a baseline data on the diversity of bacteria associated with sponge *Stellata* sp. off Kovalam coast, Kerala, India.

Keywords: Sponges, Metagenomics, *Stellata* sp., Microbiome.

BIOTECHOLOGY-08 REG. No. 15681

Development of Host-Specific Bicistronic Vector System for CRISPR/CAS-Based Genome Editing in *Danio rerio*

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Background: Clustered regularly interspersed short palindromic repeats/CRISPR-associated protein (CRISPR/Cas) genome-editing method is a promising tool for targeted genetic manipulations in animals and enables to identify and characterize the roles of genes and their variants by evaluating the consequence of gene editing on trait of interest. *Danio rerio* is one of the model organisms and the application of gene editing in *D. rerio* cell line could be a molecular tool to study molecular genetics, functional genomics, developmental biology, and most importantly, diseases in fishes and other genetically similar organisms. However efficient gene-editing

platform suitable to fish cell lines particularly for *D. rerio* is limited due to the lack of host-specific vectors that use active promoters to drive the expression of both single guide RNA (sgRNA) and the Cas9 protein within a single expression platform that is vital for efficient and cost-effective genome editing.

Method: For the application of vector-based CRISPR/Cas9 delivery system, RNA polymerase type III promoters such as U6 (*ZU6*) and endogenous promoter such as elongation factor 1 alpha (*ZEF1α*) were amplified from *D. rerio* genome and cloned into mammalian specific CRISPR/Cas9 delivery system by replacing human U6 promoter (*hU6*) which direct the expression of sgRNA and chicken beta actin (*CBh*) promoter, direct the expression of *Streptococcus pyogenes* Cas9 (spCas9) protein. The generated host-specific bicistronic vector is then transfected into the *D. rerio* Gill cell line (*DrG*) and the expression of CRISPR components is analysed by reporter gene assay.

Result: The reporter gene assay showed that the *D. rerio* specific bicistronic vector could effectively drive the expression of sgRNA and Cas9 protein in *D. rerio* Gill cell line, which is essential for the optimal functioning of CRISPR/Cas9 delivery system.

Conclusion: This work establishes a new and unified vector that included *D. rerio* U6 promoter and EF1α promoter could effectively drive the expression of sgRNA, spCas9 and mCherry protein. Thus, it could be an efficient and economical CRISPR/Cas9 tool for gene editing application in *D. rerio*.

Keywords: CRISPR/Cas, Gene editing, *Danio rerio gill celline*, Reoporter gene assay.

BIOTECHOLOGY-09 REG. No. 15695

Characterization of an Amylase Producing Halophilic Archaeon *Haloferax mucosum* MS1.4 from a Solar Saltern in Tamil Nadu, South India

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Introduction: Haloarchaea thrive under extreme salt conditions and are potential sources of enzymes capable of functioning under harsh environments. Here we discuss an amylase producing haloarchaeon *Haloferax mucosum* MS1.4 which indicated potential for amylase production under high saline conditions. Amylases which hydrolyse starch in to polymers have great potential for application in food, fermentation and pharmaceutical sectors. Though, amylases can be sourced from plant, animal and microbial sources, microbial α-amylases have found wider applications in food, textile, paper and detergent industries. Halophilic amylases can withstand high salt concentrations and yet retain activity at low salt concentrations and hence have great potential for industrial applications. The halophilic archaeon *Haloferax mucosum* MS1.4 described here, which was found to be a potential source of halotolerant microbial α-amylase, was isolated from a solar saltern in south India.

Materials and Methods: For the screening of amylase producing haloarchaea, brine and sediment samples were collected from a saltpan located in Tamil Nadu, south India. Archaeal specific medium with 30% salt (ASM) was used for the isolation of archaea. Screening for amylase producing archaea was done by spotting the archaeal isolates on ASM plates supplemented with 1% extra soluble starch. The plates were incubated at room temperature for 7 days. After the incubation period, amylase production was confirmed by development of a clear zone around the colonies when flooded with Lugol's iodine solution. Among the isolates screened, the strain MS1.4 isolated from saltern sediment exhibited good amylase activity on starch agar plate and was selected for further investigations.

MS1.4 was identified by phenotypic and biochemical characteristics as well as using molecular tools. The archaeal strain MS1.4 was grown in mineral medium having 30% NaCl with 1% extra soluble starch as soul carbon source and the crude enzyme was extracted by centrifugation. The amylase in the crude extract was purified by ammonium sulphate precipitation followed by dialysis using a dialysis tubing (SIGMA) of molecular weight cut off (MWCO) >12 kDa. The protein content of the partially purified enzyme was estimated spectrophotometrically and molecular mass was determined by SDS-PAGE. Optimization of conditions for maximal amylase production was carried out by response surface methodology (RSM) using Box–Behnken design.

Results: The light pink pigmented halophilic archaeon MS1.4 isolated from solar saltern sediment was identified as *Haloferax mucosum* based on phenotypic, biochemical and molecular characteristics. The 16SrRNA gene sequence of the strain was submitted in NCBI GenBank with Accession no. OL780830. The strain MS1.4 exhibited good α-amylase activity on starch agar forming clear zones around the colony when flooded with Lugol's Iodine and was selected for further investigations. The response surface methodology was effectively utilised for optimizing the parameters for maximal α-amylase production by the haloarchaeal strain *H. mucosum* MS1.4. The effect of various parameters on the yield of the enzyme was observed to be influenced significantly by concentration of salt as well as the substrate, period of incubation and $CaCl_2$ levels.

Conclusion: The haloarchaon *H. mucosum* MS1.4 exhibited good potential for production of halotolerant α-amylase which could find industrial applications.

Keywords: α-Amylase, *Haloferax mucosum,* Soalar saltern, RSM

BIOTECHOLOGY-10 REG. No. 15703

Machine Learning Approach for the Rapid Estimation of Biomass Chemical Composition from FTIR Spectra for Biorefinery Applications

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Background: A fundamental understanding of the cell wall composition of rice straw is essential to adopt appropriate process conditions for biofuel production and any biorefinery operations. The conventional wet methods for composition analysis are laborious, time-consuming and expensive. Industrial scale production of biofuel using rice straw, demands rapid estimation of chemical composition. So, a Machine learning (ML) based rapid classification and estimation of cell wall composition using ATR – FTIR spectroscopy is proposed in this study.

Method: The study used five model rice straw (MRS) samples pretreated differently to have structural and compositional distinction. FTIR spectra of each MRS were recorded and composition analysis was performed. A peak identification based variable (wavenumber) selection strategy was implemented. Classification methods like Random forest classifier (RFC) and support vector machine (SVM) were trained using the spectra to classify MRS based on their composition and partial least squares regression (PLSR) models were used to relate FTIR spectra with the composition.

Results: Among the RFC and SVM classifiers trained using the SNV normalized FTIR spectra, RFC outperformed SVM with a specificity of 89 .09%, 92.72%, 94.64% and 91.07% for the five MRS. Classifiers trained using the identified peaks showed phenomenal performace with a specificity of 100% in classifying MRS based on their composition. Also the PLSR calibration models predicted the cellulose, hemicellulose and the lignin content of different MRS 1-5 with an R^2_P of 92.7%, 93.92% and 95.18%, respectively.

Conclusions: Both classification and regression models trained using the peaks showed phenomenal perfor-

mance. The results suggest that the ML approach using the FTIR spectra could be an efficient alternative to rapidly estimate the composition of rice straw in a biorefinery operation. This could significantly aid accurate process designs and increase production yield.

Keywords: biofuel, machine learning, rice straw, FTIR, composition analysis, peak identification.

BIOTECHOLOGY-11 REG. No. 15715

Mass Spectrometry-Based Proteomic Investigation and immunological Cross-Reactivity Studies of *Naja naja* (Indian Cobra) Venom from the Western Ghats in Kerala

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Background: *Naja naja* belongs to the 'big four' snakes' category and is one among the medically important snake species found in India. It belongs to genus Naja of the Elapidae family and its venom is mainly involved in inducing neurotoxic effects on envenomed victims. Since geographical and prey-specific variations contribute to the vast differences in venom proteome profiles, *Naja naja* venom from several biogeographical zones in India has been studied in detail. However, the venom proteomics and antivenom studies on cobra venom from the Western Ghats in Kerala has not been explored so far.

Method: Venom proteome profiling was achieved through mass spectrometry-based conventional bottom-up and homology-assisted (*de novo* sequencing) proteomic approaches. Immunoblotting and ELISA were used in assessing the reactivity and specificity of antivenoms towards cobra venom.

Results: Bottom-up proteomics approaches enabled in the determination of 115 proteins belonging to seventeen snake venom protein families. In addition to this, *De novo* analysis yielded 39 peptides with specific amino acid substitutions. ELISA results indicated that compared to Virchow (EC_{50}; 6.03 µg/mL) and PSAV (6.04 µg/mL) antivenoms,

VINS (2.48 µg/mL) was showing better immunological cross-reactivity profiles towards crude cobra venom. From the western blot analysis, it was observed that the binding specificities of antivenoms towards high- and low-molecular-mass proteins varied significantly.

Conclusions: Our findings suggest that though Indian antivenoms were raised using the venom from 'big four' snakes that include Indian cobra venom also, they show varied efficacies in detecting and binding the venom antigens. The influence of geographic variation in venom composition and its impact on antivenom efficacy could provide insights for developing species/regional-specific antivenoms.

Keywords: *Naja naja*; De *novo* sequencing; Mass Spectrometry; venom proteomics; Immunological cross-reactivity

BIOTECHOLOGY-12 REG. No. 15718

Implications of Differential Hes-1 Expression in Adult Sub-Ventricular Zone (Svz) Neurogenesis

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Background: Notch pathway is a well established factor which has been found to be critical in the multi-staged and highly complicated phenomenon of neurogenesis in the adult rodent sub-ventricular zone (SVZ), even though contradictions exist. Based on the available literature and previous work from our lab, it has been hypothesized that the neural stem cells set aside as a quiescent sub population during development and are maintained upto the adult stage can be Notch independent Hes-1 (NIHes-1) expressing.

Methods: The technique of *in vivo* electroporation along with tailor-made plasmid constructs have been made use of to study the existence of Notch dependent (NDHes-1) and NIHes-1 expression in the adult mouse SVZ. Two different conditional knock-out (cKO) models wherein Notch-1 and Notch-1 independent region of Hes-1 promoter can be knocked out from Nestin expressing neural stem cells (NSCs) upon tamoxifen injection have been generated so as to study their respective roles in adult sub-ventricular zone (SVZ).

Results: Differential Hes-1 expression exists in adult mouse SVZ. The NI Hes-1 expressing cells in the adult SVZ have been found to be slow dividing or quiescent and of an embryonic origin. Knocking out of Notch-1 derails neurogenesis in SVZ thereby affecting the faculty of fine olfaction. The deficit once caused in the faculty of fine olfaction persists even though the number of newly born neurons in the olfactory bulb increases.

Conclusion: This study unveils the role of differential Hes-1 expression in the maintenance of the NSCs in the adult SVZ and its implications at the behavioural level.

Keywords: Adult quiescent NSCs, embryonic origin, faculty of fine olfaction

02

Biotechology

Poster Presentation

BIOTECHOLOGY-13 REG. No. 10902

Genus Level Identification of Fungal Endophytes from Indian Mangrove *Ceriops tagal*

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Background: Endophytic fungi are a group of microorganisms which inhabits in the internal tissue of all healthy plants. They do not cause any symptoms of disease in the host cell. They mainly belong to the ascomycetous group, whereas basidiomycetes, deuteromycetes and oomycetes are rarely found. These endophytic fungi are rich source of unique and diverse natural compounds with various biological activities.

Method: The endophytic fungi was isolated from the Indian mangrove, *Ceriops tagal* collected from Saktikulangara north, Kollam. Healthy leaves of the plant were collected, surface sterilized, cut into small segments and placed on the Potato Dextrose Agar (PDA) for 2-3 weeks for the isolation of endophytic fungi. The fungal endophytes were characterised by its macroscopic and microscopic features and the genus level identification was done.

Result: A total of 102 endophytic fungal isolates belonging to 8 genera obtained from the leaf tissues of *Ceriops tagal.* The phenotypic characteristics of the isolates were determined by the morphology of conidia, colony and spore morphology and all the isolates were identified up to the genus level. Out of the 8 genera *Aspergillus* sp. is the dominant one followed by *Penicillium* sp. and *Schizophyllum* sp.

Conclusion: The study reveals that the mangrove plant, *Ceriops tagal* is colonized by diverse number of fungal endophytes.

Keywords: Endophytic fungi, Mangrove, *Ceriops tagal*, Diversity

BIOTECHOLOGY-14 REG. No. 13391

Yes Associated Protein—Coordinately Modulate TNBC Cellular Fate via Lyn-Dependent EGFR Activation

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Background: Breast cancer is the most frequent female cancer with an estimated 2.3 million new cancer cases and surpassed lung cancer as the leading cause of death. Triple-negative breast cancer (TNBC) is a highly heterogeneous subtype of breast cancer with unique molecular and biological characteristics. The alarming increase in the incidence of new TNBC cases and the mortality rate demands immediate attention. The dysregulation of Hippo pathway is found to play a critical role in tumorigenesis and cancer survival in a vast range of cancers; nevertheless, our understanding of how core components of the pathway regulate breast cancer cellular characteristics remains unresolved.

Method: In this study we investigate the significance of Hippo pathway in the TNBC thriving. Transient silencing, pharmacological inhibitions, MTT assay, Acridine Orange-ethidium bromide staining, colony formation assay, mammosphere formation technique, western blotting, Real time PCR, wound healing assay, Transwell assay and flow cytometric analysis were employed to test our hypothesis.

Results: We have observed a higher YAP expression in TNBC cells which is associated with increased proliferation, survival and invasive ability of the cells. Compared to the 2D culture, 3D cultured cells exhibited increased nuclear accumulation of YAP and the mammosphere formation was highly dependent on the YAP transactivation. YAP nuclear activity associated with activation of LYN, and conversely LYN inhibition elevated cytoplasmic retention of YAP. Individual depletion of YAP and LYN resulted in decreased EGFR activation and attenuated TNBC aggressiveness. Importantly, YAP reactivation in these both scenarios restored the EGFR expression and the characteristic cellular traits of TNBC.

Conclusions: Our work elucidates the intricate role of Hippo pathway effector-YAP on atypical cellular and molecular persona of TNBC. The present study unearths the novel molecular cross- talk of YAP in mediating the

TNBC aggressiveness. Our observations implicate that LYN-dependent EGFR activation in TNBC cells is highly reliant on the YAP-TEAD transactivation and activated LYN in turn further enhances the YAP activity. In effect, we suggest that YAP in TNBC cells represent a central vulnerability that may be exploited therapeutically.

Key words: Triple negative breast cancer, Hippo pathway, YAP, LYN.

BIOTECHOLOGY-15 REG. No. 15463

Quantitative and Molecular Analysis of Coagulant Property of Plants *Moringa oleifera*, *Azhadirachta indica* and *Carica papaya* in Water Samples

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In Indian mythology, water is considered as one of the essential elements of "Panchabhotha" for the existence of life in the planet. In other words, scientifically there is no life without water. So, it is the duty of every man to conserve water resources of water as well as to protect the water from excess, loss and contamination. In the present era, over exploitation of the natural resources including water for modern household and industrial activities has become a trend of urbanization. Protection of water resources from pollutants and other contaminants by people caused effective treatment process is inevitable part of human existence. Despite the chemical processing of water treatment, the usage of natural component especially plant resources as coagulant for purifying is the part of environment research today. In the present investigation, an attempt was made to determine the coagulant property of leaves and seeds of the plant *Moringa oleifera*, *Azadirachta indica* and *Carica papaya* using natural water samples. Compared with chemical coagulant, the results of the study demonstrates that the leaves and seeds of the plants have prominent effect in purifying river and muddy water better than chemical coagulant. It was also observed that the seeds of Papaya and Moringa have wonderful

coagulant property for removing the water impurities without changing the standards pH value. Besides the deposition of impurities, a sound depletion of the microbial load in the water sample was noticed during treatment. The reduction of the bacterial load was supported by the marker gene 16s rRNA in treated samples. In the treated samples, no amplification of 16s rRNA gene was observed indicating the suppression of bacterial growth in water samples. Though the study stands as a preliminary phase, the derived data provides sufficient insight to extend the study for using the seeds of Moringa and Papaya as coagulant for purifying water effectively in a cost-effective way. Such studies are being undertaken at the department.

BIOTECHOLOGY-16 REG. No. 15472

Bioactivity of Alkaloid Fraction from Marine Sponges of Kerala Coast

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Background: The marine environment is enriched with a variety of organisms that harbors a wide range of biologically important compounds that are useful for the pharmaceutical benefit of humans. In the last few decades, marine sponges (phylum Porifera) are being studied by biologists because many species have been considered as drug treasure houses with respect to the great potential regarding their secondary metabolites.

Methods: In the present study, the two marine sponges were collected from Vizhinjam, Thiruvananthapuram, and were subjected to *in vitro* screening to determine their bioactive potential. The collected samples were identified by universal primers LCO1490 and HCO2198. Alkaloid extraction from both sponges was performed using the modified acid-base method and quantified. Further, the study also examined the pharmaceutical potential of the purified alkaloid fraction such as antioxidant, antimicrobial, anti-biofilm, and α- amylase inhibitory activities.

Results: Using universal primers, the collected samples were identified as *Spongia* sp. (SP1) and *Tedania tubulifera* (SP4). In DPPH radical scavenging

assay, the alkaloid extracts, ALSP1 and ALSP4 showed an IC_{50} value of 3.3µg/ml and 5.46µg/ml respectively. ALSP1 and ALSP4 also exhibit potent antioxidant activity in ABTS assay with IC_{50} of 2.38µg/ml and 2.47µg/ml. Both the sponge-derived alkaloids expressed significant antibacterial activity, alkaloid ALSP1 (11.25µg/ml) showed maximum activity against *Bacillus cereus* with an inhibition zone diameter of 32mm. Whereas ALSP4 (8.75µg/ml) exhibits maximum potential against *Escherichia coli* with a zone of 23mm. The crystal violet assay unveils the potency of ALSP1 and ALSP4 samples in the eradication of preformed biofilm of *S. aureus* strain by 80.30% (22.5 µg/ml) and 85.84% (17.5 µg/ml). ALSP1 and ALSP4 also exhibited significant α-amylase inhibitory activity with an IC_{50} value 13.7µg/ml and 21.0µg/ml respectively and is comparable with standard acarbose with an IC_{50} of 38.40 µg/ml.

Conclusions: These findings suggest that alkaloids from both sponge samples which have potent antioxidant, anti-biofilm, and α-amylase inhibitory activity have the potential to be developed as a pharmaceutical product.

Keywords: Marine sponges, alkaloids, antioxidant, anti-biofilm, α-amylase inhibitory activity

BIOTECHOLOGY-17 REG. No. 15480

Exploration of Probiotic Properties and Antagonistic Traits of *Staphylococcus warneri* Isolated from Fermented Rice Water

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Background: Food safety employing use of fermented traditional foods is now considered to be vital for ensuring preeminence to health strategies in developing countries. Fermented rice water, a staple traditional drink has been employed as rehydration solution for ages to treat diarrhea in extreme cases of malnutrition. Fermented food derived beneficial bacteria or probiotics have been explored and applied in health sector owing to their multitudes of health benefits as a food supplement.

Method: Bacteria was isolated from fermented rice water and further identified by 16srRNA typing, sequence deposited and GenBank accession number was obtained. Further, the probiotic properties and cell surface

properties of the strain to confirm the ability of the strain to survive in the gut environment and competitively exclude pathogens. Additionally, exopolysaccharide production ability from the bound and supernatant fractions of the strain was determined. To predict the ability of the strains to bind to extracellular matrix (ECM), *in vitro* binding assay was performed with gelatin and heparin (1mg/mL) as ECM proteins. We also attempted to partially purify proteins from the isolate by ammonium sulfate precipitation and the inhibitory potential against two indicator pathogens *Klebsiella pneumoniae* (MTCC 3384) and *Enterococcus faecalis* (MTCC 6845) was determined by microbroth dilution assay. Further, liquid kill assay with *C. elegans* as a *in vivo* model was performed to check the ability of the protein fraction from the isolate to inhibit *K. pneumoniae.*

Results: The strain isolated was *Staphylococcus warneri* MN336185 and it demonstrated acid, bile, and gastric juice tolerance, produced exopolysaccharides and exhibited significant binding affinity with gelatin and heparin in *in vitro* experiments. The protein fractions from the strain inhibited *K. pneumoniae* and *E. faecalis* with MIC concentrations of 500 µg/mL and 700 µg/mL respectively. Protection assays conducted in *C. elegans* demonstrated an increased survival rate of the worms infected with *Klebsiella* (86%) providing a strong cue for application of this strain to target bacterial pathogens of concern.

Conclusions: The present study explored the possibility of exploring strains other than Lactic acid bacteria with beneficial properties from staple food sources like fermented rice water. In silico PCR amplifications have shown that *S. warneri* strains generally populate lesser virulence traits when compared to *S. aureus* strains. Probiotic combinations hold a greater promise to behold these strains as functional foods supplements.

Keywords: Fermented rice water, probiotics, food safety, malnutrition, beneficial gut bacteria

BIOTECHOLOGY-18 REG. No. 15498

Screening of Primary and Secondary Metabolites in *Aspergillus niger* for its Application in Waste Water Treatment

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Background: Persistence of pollutants and enteric pathogens in sewage is always a threat to mankind, especially in places where the sanitation is poor. The inefficiency of chemical, physical and other mechanical methods of removal of these pathogens from wastewater demands the urge for development of novel biological strategies. The attractiveness of fungi as biocontrol agents, in particular, is due to their general ubiquitous nature, ability to completely oxidize many impurities, the high degree of host specificity, destruction of the host, persistence, dispersal efficiency, ease of culture and maintenance in the laboratory. *Aspergillus niger* is a widely distributed saprotrophic fungi known for its repertoire of many bioactive compounds.

Method: This study aimed at determining the biocontrol potential of the fungus *Aspergillus niger* by screening for production of primary and secondary metabolites. Primary metabolites were screened using media with specific substrates and phytochemical assays were performed to screen for secondary metabolite production in ethyl acetate fraction of *A. niger* crude extract. Antibacterial activity of extract was determined by well diffusion assay.

Results: Our results show that *A. niger* acts as a good producer of primary metabolites like enzymes mainly protease, amylase, phosphatase, chitinase, lipase and acids. Also screening of secondary metabolites using the ethyl acetate extract of *A. niger* showed the presence of sugars, alkaloids, phenols and tannins. The ethyl acetate extract showed antibacterial activity against *Staphylococcus aureus* and *Vibrio cholerae* proving its ability as a biocontrol agent.

Conclusion: This work proves that *A. niger* can be considered as a good candidate with a potential source of enzyme and metabolites in the removal of organic waste and enteric pathogens in biological wastewater treatment.

Keywords: Sanitation, *Aspergillus niger*, biocontrol, primary metabolites, enzymes, secondary metabolites, antibacterial activity.

BIOTECHOLOGY-19 REG. No. 15518

Association of Autophagy in Cardiac Hypertrophy: an Insight into Use of Autophagy-Targeted Drugs

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Background: Cardiovascular disease (CVD) forms the major cause of deaths worldwide among non-communicable diseases. Hypertension ranks among the first risk factors for heart disease. Cardiac hypertrophy occurs due to sustained hemodynamic load imposed by hypertension on the heart. Even though an initial adaptive response to sustain a normal cardiac output, hypertrophy leads to heart failure in the long run. In view of this fact, it is appropriate to prevent the progression of hypertrophy to failure. Autophagy, a cellular homeostatic mechanism, may play a role in pathology and has the potential to be the target for the treatment of specific human diseases. In this backdrop, we examined the association of autophagy in cardiac cell hypertrophy. The study gives an insight into whether activation / inhibition of autophagy in hypertrophy is protective or detrimental in hypertrophic conditions.

Method: H9c2 cell line (rat embryonic cardiomyoblasts) was used for the experiments. Isoproterenol (ISO;10μM), a β_1- adrenergic agonist, was used for the induction of hypertrophy in these cell lines. Rapamycin (rapa) and chloroquine (chloro) were used as the activator and the late-stage inhibitor of autophagy respectively. The different experimental groups consisted of control, ISO, rapamycin (rapa), chloroquine (chloro), ISO +rapamycin (ISO/rapa) and ISO + chloroquine (ISO/chloro). Protein markers of hypertrophy and autophagy were investigated. Flow cytometry, confocal microscopy, ELISA etc. were employed for the studies.

Results: ISO-stimulation induced hypertrophying (27% increase in cell size) of the H9c2 cells. Autophagy was assessed in the different treatment groups and ISO was found to demonstrate significantly lower autophagy when compared to control ($p \leq 0.05$). On the other hand, ISO/rapa showed a heightened induction of autophagy ($p \leq 0.05$) that corresponded to a higher degree of hypertrophying of the cells

($p \leq 0.05$). In contrast, ISO/chloro showed significantly lower autophagy ($p \leq 0.05$) which corresponded to a lower degree of hypertrophying of the cells ($p \leq 0.05$). The different groups also demonstrated a positive correlation in the levels of BNP, the cardiac hypertrophic marker. The level of Beclin-1 was found to be significantly high in ISO/rapa group ($p \leq 0.05$) when compared to ISO, whereas ISO/chloro demonstrated significantly lower levels ($p \leq 0.05$). Analysis of LC3B protein revealed a significantly higher accumulation of LC3 puncta in ISO/chloro group ($p \leq 0.05$) when compared to other groups. This indicates inhibition of LC3 turnover in ISO/chloro group. Analysis of lysosomal activity revealed the presence of significantly higher activity in the ISO group ($p \leq 0.05$) despite the lower autophagic activity, when compared to control. At the same time, lysosomal activity correlated well with the autophagic activity in ISO/rapa group. LAMP-2A levels were established to be high in ISO when compared to control ($p \leq 0.05$) indicating chaperone- mediated autophagy in the ISO group. At the same time, LAMP-2A was found to be significantly low in the ISO/rapa group when compared to ISO ($p \leq 0.05$). On the other hand, Bnip3, the mitophagy marker, was found to be significantly higher for ISO/rapa and lower for ISO ($p \leq 0.05$).

Conclusions: In hypertrophied cells (ISO group), there is leading participation of chaperone-mediated autophagy, whereas in excessive autophagy as in ISO/rapa, a lower level of LAMP-2A was demonstrated. On the contrary, ISO/rapashowed significantly higher Bnip3 level when compared to ISO, suggesting that mitophagy isplaying a dominant role in excessive autophagy in the hypertrophied state.

The results indicate that efforts to target autophagy will be a novel therapeutic approach in the treatment of cardiac hypertrophy. Moreover, Kerala Science Congress may hopefully provide a platform for suggestions regarding the selection of natural products targeting autophagy in this scenario.

Keywords: cardiac hypertrophy, H9c2 cell line, autophagy, rapamycin, chloroquine

BIOTECHOLOGY-20 REG. No. 15541

Dye and Metal Ion Removal Ability of Byssus Thread Complex: A Strategic Value Addition of Mariculture Waste

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Mussel byssus thread is a tough, durable, and strong biopolymer consisting of water and proteins. These natural biopolymer fibers have been intensively studied due to their mechanical and adhesive properties; however, the byssus thread is considered one of the waste materials in mariculture. Many researchers are only working on the industrial application of the mussel shell, and there are few studies on the application of byssus thread. This study aimed to understand the dye and metal ion removal efficacy of byssus thread. We collected byssus thread from indigenous mussel species and is used for dye and metal ion adsorption analysis. We documented the dynamicity of byssus thread dye and metal removal at different pH (pH 2–10) and different concentrations. The highest amount of metal removal was observed at pH 6.0, and the dye removal efficacy is related to the property of the dye (i.e., anionic or cationic dye). Adsorption of dye and metal ions has little effect on the byssus thread's thermal and mechanical properties. Our findings concluded that byssus thread could be used as a strong adsorbent for dye and metal ion removal from water.

Keywords: Bio-adsorbent material; Mussel byssus thread; dye and metal ion removal; thermal property

BIOTECHOLOGY-21 REG. No. 15559

Mechanistic Insight into the Interaction of S1 Domain Delta and Omicron of SARSCOV2 Spike Protein with Antibodies: A Molecular Docking and Dynamics Studies

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Background: In the present scenario, the whole world has seen the existence of mutated **Delta** (B.1.617.2) and **Omicron** (B.1.1.529) variants of SARSCOV2 which causes rapid transmissibility, increase in virulence and decrease in the effectiveness of public health. Majority of mutations are seen in the surface spike and they are considered as antigenicity and immunogenicity of the virus. Hence, finding suitable cross antibody or natural antibody and understanding its biomolecular recognition for neutralising surface spike are crucial for developing many clinically approved COVID-19 vaccines. Here, we aim to design both variants in two different approaches and hence, to understand its mechanism, binding affinity and neutralisation potential with several antibodies.

Methods: Ten complete sequences of mutated delta were collected from NCBI Virus SARS-CoV-2 Data Hub of NCBI website. Structures of S1 of spike protein from the lineage **Delta** were constructed from homology modelling of SWISS MODEL. All these models are characteristically favourable models based on Ramachandran plot and QMEAN score. The impact of mutations was analysed using Dynamut server. Mutations on the **Omicron** were carried out by pymol software. Molecular docking between the spike protein model and antibodies were performed on the CLUSpro2.0 server. Stability of both variants were studied by molecular dynamics as implemented in GROMACS software.

Results: All mutations on **Delta** always increase the stability (ΔΔG) and decrease the entropies which causes the unfolding of all designed protein models. Changes in vibration entropies are in between 0.133 kcal/mol/K to -0.004 kcal/mol/K. Temperature dependent free energy change values (ΔG) for wild type is found to be -0.1 kcal/mol whereas all models exhibit ΔG between -5.1 to -5.5 kcal/mol. Further, molecular docking analysis on the RBD of truncated **Delta** and **Omicron** with human antibody (**CR3022**), Etesevimab (**LY-CoV016**),

Bebtelovimab (LY-CoV-1404), BD-368-2, and Casirivimab (REGN10933) show many close interactions. Molecular dynamics simulations reveal their structural stability from RMSD, Cα fluctuations (RMSF), intermolecular hydrogen bond interactions, effect of solvent accessibility (SASA) and compactness (Rg) factors which is in good agreement with the docking results.

Conclusion: Several interactions with CR3022 have appeared compared to Wild for Delta variant and hence, it is suggested that modification on the CR3022 antibody could further improve for the prevention of viral spread. Antibody resistance decreased significantly due to numerous hydrogen bond interactions which clearly indicates that these marketed/ launched vaccines will be effective for **Delta** and **Omicron** variants also.

Keyword: SARSCOV2, CR3022, vaccines, Homology modelling, Molecular dynamics simulations.

BIOTECHOLOGY-22 REG. No. 15563

Industrially Important Proteases Produced by an Endophytic *Bacillus subtilis* Strain Isolated from a Marine Macro Algae, *Ulva lactuca*

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Background: Proteases are a large group of enzymes capable of proteolytic cleavage, hence are widely used as industrial enzymes in detergent, leather, dehairing, pharmaceutical, bioremediation and food industries. Endophytic organisms, particularly bacteria belong to Bacillus species have proven to produce different types of proteolytic enzymes.

Methods: A protease producing endophytic bacterial strain isolated from a marine macro algae, *Ulva lactuca* was identified based on the biochemical and 16S rRNA gene sequencing method. The isolated organism was compared with a reference bacterial strain for its morphological features and extracellular protease production ability. The extra cellular proteins were partially purified from the culture media by ammonium sulphate saturation followed qualitative and quantitative analysis. The effect of physico- chemical parameters such as pH, temperature, presence of metal

ions, chelators, inhibitors on protease activity and enzyme stability were also determined. Mass spectrometry-assisted proteomic experiments were followed to identify the individual proteases present in the partially purified enzyme cocktail.

Results: A protease producing endophytic bacterial strain was isolated from a marine macro algae, *Ulva lactuca* and was identified (accession no. GQ861468.1). The strain shown to have 98% sequence similarity to *Bacillus subtilis* LXB3. The isolated endophyte possesses high proteolytic activity when compared with a reference strain, *Bacillus subtlilis* 168. The partially purified enzyme displayed an optimum enzyme activity at pH 10.0 and at 40 ºC. The activity is enhanced in the presence of $Mg2^{+}$ and $Ca2^{+}$ and was completely inhibited by PMSF. Mass spectrometry-assisted proteomics characterization revealed the presence of several proteases including arginases, aminopeptidases, and minor extracellular protease precursor.

Conclusion: The present study evaluates the molecular and biochemical characteristics of an endophytic bacteria isolated from a marine green algae, *Ulva lactuca*. The biochemical and enzymatic properties and protein profile obtained by mass spectrometric analysis revealed that this endophytic bacteria can be used as a potential source for various industrially important proteases. Further studies have to be conducted for the complete purification of individual proteases to deeply unravel their biochemical characters, structural organization and discover their possible industrial applications.

Key words: Endophyte, Protease, *Ulva lactuca*, Mass spectrometry

BIOTECHOLOGY-23 REG. No. 15620

Pharmacoepigenetics of Antiepileptic Drug

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Background: Antiepileptic drugs are the mainstay for the treatment of epilepsy. Studies in human have been shown that these AEDs tend to have teratogenic potential. And it is becoming evident that these pharmaceutical drugs can cause changes in gene expression that persist long after the exposure has ceased. Pharmacoepigenetic studies explain the role

of epigenomics in intrapersonal and interpersonal variations in response of individuals to drugs, in the effects of drugs on gene-expression profiles, in the mechanism of action of drugs and adverse drug reactions.

Method: The present study involves assessing the epigenetic modifications induced by antiepileptic drugs in cell culture model. The effect of AEDs on global DNA methylation and underlying gene expression was studied. The experimental cell line was treated with varying concentration of AEDs at different time intervals, following global DNA methylation assay and the gene expression of epigenetic modulators including DNA methyltransferases (DNMTs) and Ten-eleven translocases (TETs) was assessed.

Results: Data suggests decreased global DNA methylation for AED treated cells and the global DNA methylation changes show similar pattern with respect to DNMTs gene expression .As treatment duration increased from 12 to 48 hours, we observed a decrease in DNMTs (methylation) and increase in TETs (demethylation) expression. Global DNA methylation at 48 hour Phenytoin treatment show decreased methylation .When considering the epigenetic gene expression, all DNMTs show increased expression at 48 hour PHT treatment. TET1 is also showing increased expression at 48hr, so we assume that increased expression of TET1 must be the reason for the decrease in global DNA methylation at 48 hour treatment.

Conclusion: The antiepileptic drug induced changes in global DNA methylation were observed in HEK293 and the modulation of global DNA methylation status in cell line can be attributed to variability in underlying DNMT and TET gene expression.

Keywords: Antiepileptic drugs, Pharmaco-epigenetics, DNA methylation, DNMTs, TETs.

BIOTECHOLOGY-24 REG. No. 15674

Screening and Optimization of Antibiotics for Use in Molluscan Cell Culture

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Background: The molluscs contribute a large share to the world aquaculture production. But alike any other group of animals, they are also succumbed to infectious agents, and among them, viruses have paramount importance. To study such viral pathogens and to develop preventive health care strategy, cell lines from the respective animals are essential. In the process of developing such cell culture systems and cell lines, contamination by attached bacteria and fungi poses immense difficulties to accomplish the task. This situation is primarily due to the filter-feeding behaviour of the animal. Therefore, to develop axenic cell culture system, an appropriate antibiotic formulation is required.

Method: Contaminant organisms resulted from the primary cell culture systems of various tissues of the oyster, *Crassostrea madrasensis* were subjected to antibiogram using 15 different antibiotic discs, and also screened for sensitivity to the cell culture grade penicillin and streptomycin. Based on the results, an antibiotic formulation was optimized for use in the development of axenic molluscan cell culture systems.

Results: The contaminant bacteria were resistant to penicillin, streptomycin, ampicillin, oxytetracycline, cefpirome and cefepime, and highly sensitive to neomycin, moxifloxacin and gatifloxacin. Based on these results, neomycin was incorporated into antibiotic formulation whereas penicillin and streptomycin were removed. The optimized antibiotic formulation yielded contamination-free cell culture systems from different tissues of *C. madrasensis*.

Conclusions: This study establishes the preliminary requisites towards the development of axenic cell culture systems from various tissues of the mollusc *C. madrasensis*.

Keywords: Primary Cell Culture, Mollusc, Antibiotic, Decontamination

BIOTECHOLOGY-25 REG. No. 15696

Preliminary Characterisation of a *Vibrio alginolyticus* Specific Lytic Bacteriophage PhPV1.3

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Background: *Vibrio alginolyticus* belonging to the class Gammaproteobacteria found ubiquitously in the marine and brackish environment causes vibriosis in fish and is considered an emerging human pathogen that induce seafood poisoning. Bacteriophages highly specific to these pathogenic bacteria are considered having potential for phage therapy in aquaculture, in the scenario of emergence of antibiotic resistant bacteria due to indiscriminate use of antibiotics in aquaculture.

Methods: A highly specific lytic bacteriophage PhPV1.3 has been isolated from the coastal waters off Kochi, south India, using *Vibrio alginolyticus* strain PV1.3 isolated from the same source and identified by molecular and biochemical methods.

PhPV1.3 phage was characterised by transmission electron microscopy and using molecular tools. Determination of optimal multiplicity of infection (MOI); burst size through one-step growth curve; optimal growth conditions in terms of temperature and pH were also undertaken. Further, host spectrum of the phage was investigated. Total nucleic acid was isolated from concentrated phage lysate and was treated with nucleases (RNase A, DNase 1 and S1 nuclease) and was found to be double stranded DNA. The DNA was then analysed by restriction digestion using *Eco*RV, *Sma*1, *Hin*f and *Hind*III. The extracted DNA after treatment with RNase A was then subjected to PCR amplification and sequencing for molecular characterisation.

Results: Transmission electron microscopic studies showed that the bacteriophage PhPV1.3 belongs to the order *Caudovirales*. The phage was found to be moderately thermotolerant, remaining stable up to 50°C and

biologically active over a wide range of pH from 3 to 9. Optimal multiplicity of infection was estimated as 1. It has a latent period of 68 min and burst size was observed to be 53 phages per cell. Phage genome was cleaved by enzymes *EcoR*V and *Sma*1, and was confirmed to be double stranded DNA from restriction digestion using endonucleases.

Keywords: Burst size, Caudovirales, MOI, TEM, *Vibrio alginolyticus.*

BIOTECHOLOGY-26 REG. No. 15771

Y-Chromosome Microdeletion Analysis of SY255 at AZFc Region in Infertile Males with Sperm Abnormalities

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Background: It is common for couples to struggle with infertility. For one out of five infertile couples, the problem is solely with the male partner. Semen parameters are frequently abnormal in the male partners of infertile couples. These abnormalities are often due to Y- chromosomes microdeletions or abnormal karyotypes. The most common molecular genetics cause of severe male infertility is deletion of the AZFc region in distal Yq.

Methods: semen samples were microscopically examined for abnormalities and karyotyping was carried out to check abnormalities in Y-chromosomes. Further the occurrence of SY255 locus deletions at AZFc was analyzed with polymerized chain reaction.

Result: 27 out of 50 infertile couples (54%) were diagnosed with male infertility after primary semen analysis. Fourteen infertile male subjects had spermatogenic abnormalities such as oligospermia (14), asthenospermia (8), Tetratospermia (3), Zoospermia (4), and three of them had all the abnormalities (Oligoasthenoteratozoospermia-OAT), which were all taken for further analysis. In spite of the fact that all 14 subjects showed normal karyotypes, there were 2 cases (14.3%) of AZFc deletion at SY255. All 4 abnormal conditions were present in subject with such deletions, and they were all diagnosed with OAT.

Conclusion: It is found in this study that the occurrence of microdeletion at the sequence tagged site SY255 of AZFc region correlates significantly (66.66%) with Oligoasthenoteratozoospermia. These data show that in addition to complete AZFc deletions, specific partial deletions also play a role in male infertility.

Keywords: AZFc, Y-chromosome microdeletions, male infertility, OAT, sperm abnormality.

BIOTECHOLOGY-27 REG. No. 15824

Symbiotic Effectiveness of *Ceratobasidium* Sps. on the Seed Germination and Seedling Development of *Rhynchostylis retusa* (L.) Blume

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Background: Seed of orchids lack significant reserves of nutrients and require a mycorrhizal fungus to germinate and nourish their young plants in the wild. The most frequent orchid mycorrhizal fungus belong to the Rhizoctonia genus, which is attributed to the Basidiomycota genera *Ceratobasidium, Thanetophorus, Tulasnella,* and *Sebacina*. In managed or restored settings, the existence of a suitable fungal mycobiont for seedling recruitment and plant nutritional support is thus critical for orchid long-term survival. The present work is to prove hypothesis that the endophytic fungus belonging to *Ceratobasidium* sps. imparts *in vitro* symbiotic seed germination in *Rhynchostylis retusa*, an exquisite orchid of Western Ghats.

Methods: Isolated the endophytic fungus from the roots of *R.retusa* through root cutting method using fungal isolation and Potato Dextrose Agar Medium (FIM & PDA). Morphological & cytological characteristics of fungi were studied. Modified CTAB method was used for the isolation of fungal DNA. Mature seeds of *R.retusa* were co-inoculated with endophytic fungus isolated from roots of *R.retusa* in Oats Meal Agar medium (OMA). Five to seven replicates were maintained for each treatment and the whole experiment was repeated thrice. Seeds without fungus culture were taken as control. For asymbiotic germination, seeds were inoculated in Mitra+ CH medium.

Results: Endophytic fungus (Rr) isolated from *R.retusa* was characterized and identified. Fungus showed right angled branching and possessed barrel shaped monilioid cells in long chains. The moniloid cells were binucleate. ITS sequencing followed by phylogenetic analysis revealed that Rr showing 95.59% sequence similarity with *Ceratobasidium* sp. M–13 with 99% query coverage. Sequences were deposited in NCBI and obtained accession number as *Ceratobasidium* sp. isolate Rr-OL374043. Seed germination studies revealed that *Ceratobasidium* sp. Isolate Rr triggered symbiotic seed germination of *R. Retusa* on co-inoculation in Oats Meal Agar medium. A series of development starting with the promeristem formation, first leaf development or second leaf initiation occurred in 88% of the protocorms in a time interval of 90 days. Asymbiotic culture facilitated 90% germination of seeds but further development was drastically slow.

Conclusions: Symbiotic germination supported fast germination and seedling development in 90 days much faster than asymbiotic method of germination. The endomycorrhiza from *R.retusa* characterized and evaluated are proved useful for conservation and cultivation of the vulnerable orchid species.

Key words: Endomycorrhiza, Symbiotic seed germination

BIOTECHOLOGY-28 REG. No. 15870

Valorization of Biodegradable Waste Using Microbial Consortium: An Alternative Panacea

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Background: Waste management is given utmost priority in the present-day scenario and has become a part of our routine life. Effectiveness of a single microbial consortium to valorize mixed bio-waste, poultry waste and tannery solid waste into advantageous product(s) was evidenced. High performing, fast acting microbial consortium turned up as a promising tool for the comprehensive management of the significant wastes.

Method: Consortium members were selected based on the results of pathogenicity test, maximum enzymatic activities and co-existence ability. Coir pith served as carrier. Composting

efficiency of the inoculum on mixed bio-waste and poultry waste was checked in bio-composter bins, heaps and larger windrows. Biodegradation of proteinaceous tannery solid waste material along with rice water as a growth medium and inoculum at 37°C was evaluated for liquefaction.

Results: Microbial consortium was a perfect blend of enzymatically active safe microorganisms. Coir-pith based microbial consortium resulted in leachate, odor and insect free composting which took < 20 days to degrade mixed bio-wastes and < 15 days to breakdown poultry waste into nutrient rich quality compost. Interestingly, rapid liquefaction of the tannery solid waste was observed within 12 hours of incubation. Products proved as plant growth enhancers.

Conclusions: The present work emphasizes the efficacy and safeness of a microbial consortium that could act as an alternative panacea for harsh chemical/physical treatment methods. Unhealthy disposal of underutilized waste could be prevented and recovery of biomolecules would support the growing societal needs.

Keywords: Bio-waste, Microbial Consortium, Poultry Waste, Tannery Solid Waste

03

Chemical Sciences

Oral Presentation

CHEMICAL SCIENCES-01 REG. No. 15158

Marine Macroalga-Derived Polygalactan-Built Metallic Nanoparticle for Osteogenesis

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Background: Naturally derived polygalactan based metallic nanoparticles with their size and drug release potentials, have appeared as promising biomaterials for osteogenic differentiation. Bisphosphonates and anabolic drug therapy for prevention and treatment of osteoporosis would lead to adverse effects. A metallic nanoparticle (GS-AgNP) prepared from a sulfated polygalactan isolated from a marine macroalga *Gracilaria salicornia* exhibited prospective osteogenic effect.

Method: Powdered leaves (thalli) of marine macroalga *Gracilaria salicornia* were subjected to alkali treatment followed by neutralization and extracted with hot water to yield an aqueous crude. The residual mass was clarified and precipitated with ethanol to derive a precipitate that was fractionated by anion exchange chromatography to yield a homogenous sub-fraction GSP-2, which was subjected to hydrolysis, methylation, and reductive cleavage and characterized. The structure of isolated polysaccharide GSP-2 was elucidated by spectroscopic analyses, such as FTIR, NMR (coupled with 2D-NMR) and HR(ESI)MS. Synthesis of GS-AgNP was performed by adding silver nitrate solution to different concentration of polysaccharide solution followed by ultrasonication. The synthesized nanoparticle was characterized with spectroscopic and microscopic techniques.

Results: Macroalgal sulfated polygalactan was isolated, characterized and assessed for osteogenic effect. Structure of homogenous polysaccharide fraction (GSP-2) was comprised of 2-*O*-methyl-6-SO_3-β-(1→4)-galactopyranose (unit A) and 2-*O*-methyl-3,6-anhydro-α-(4→1)-galactopyranose (unit B) as repetitive structural units. Sequence of linkage pattern (1→3)/(1→4) between the alternatively repeating monosaccharides of methyl galactopyranose and methyl anhydro galactopyranose were confirmed. Upon treatment with studied GS-AgNP, alkaline phosphatase activity

was significantly elevated (88.9 mU/mg) in human mesenchymal osteoblast stem cells (hMSC) compared to normal control (33.7 mU/mg). Mineralization study of GS-AgNP demonstrated an intense mineralized nodule formation on hMSC surface. Fluorescence-activated cell sorting study of osteocalcin and bone morphogenic protein-2 (BMP-2) expression resulted an increased population of osteocalcin (78.64%) and BMP-2 positive cells (46.10%) after treating with GS-AgNP on M2 macrophages. Cell viability study of GS-AgNP exhibited its non-cytoxic nature.

Conclusion: The polygalactan-built nanoparticle could be developed as promising bioactive pharmacophore against metabolic bone disorder and the treatment for osteogenesis therapy.

Keywords: Marine macroalga, *Gracilaria salicornia*; osteogenic differentiation; human mesenchymal osteoblast stem cells

CHEMICAL SCIENCES-02 REG. No. 15189

Seaweed Polysaccharide-Based Nanoparticle with Promising Anti-Osteoporotic Effect: An *in vivo* Study

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Background: Osteoporosis is a metabolic bone disorder that is associated with low bone mass density and structural deterioration of bone tissue followed by an increase in bone fragility. Several adverse side effects of synthetic anti-osteoporotic medications have triggered an urge to focus on the discovery of alternative natural therapeutic strategies to treat against osteoporosis. Naturally occurring polysaccharide-based nanoparticles have developed as promising materials for treatment of bone health disorders. On account of this fact, anti-osteoporotic silver nanoparticle was prepared with natural polysaccharide isolated from aqueous extraction of *Sargassum tenerrimum*.

Method: Pretreated seaweed sample of *S. tenerrimum* was extracted with water and purified with anion exchange chromatography to obtain sulfated polysaccharide. Polysaccharide-based nanoparticle was synthesized by adding silver nitrate

solution to different concentration of polysaccharide solution followed by ultrasonication. The synthesized nanoparticle (ST-Ag^{NP}) was characterized with various spectroscopic and microscopic techniques. Bioactivities of polysaccharide-based nanoparticle were carried out on human mesenchymal stem cells (hMSC). Also, therapeutic effect of polysaccharide-based nanoparticle was observed against glucocorticoid-induced *in vivo* osteoporosis model.

Results: Structure of the isolated polysaccharide (STP-2) was elucidated as sulfated galacto-fucopyranose comprising of recurring structural entities of 2-SO_3-α-(1→3)-fucopyranose and 6-*O*-acetyl-β-(1→4)-galactopyranose. Subsequent treatment with ST-Ag^{NP}, activity of alkaline phosphatase (63 mU/mg) was raised in osteoblast stem cells than that in control (30 mU/mg). Concentrated development of mineralized nodule on the surface of hMSC was apparent following treatment with ST-Ag^{NP}. Increased population of BMP-2 (23%) and osteocalcin$^+$ cells (50%) on M2 macrophages were apparent following treatment with ST-Ag^{NP} (0.25 mg/mL). Significant recovery of serum biochemical parameters along with serum E2 and PTH were observed with ST-Ag^{NP} treated animals compared to disease control. Following treatment with ST-Ag^{NP}, serum calcium and phosphorus contents were significantly recovered with disappearance of osteoporotic cavities displaying nearly normal distribution and content of collagen fibers in trabecular bone.

Conclusion: The study revealed the isolation and characterization of sulfated polysaccharide and a nanoparticle (ST-Ag^{NP}) synthesized from the seaweed-originated carbohydrate biopolymer exhibiting potential activities against osteoporosis or related bone disorder.

Keywords: Sulfated polysaccharide; biopolymer; nanoparticle conjugate; glucocorticoid-induced osteoporosis

CHEMICAL SCIENCES-03 REG. No. 15231

Development of Co-rGO Supported Alloys for Enhanced Hydrogen Evolution Reaction in Alkaline Solution

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Electrocatalytic water splitting driven by renewable energy input to produce clean hydrogen has been widely viewed as a promising strategy of the future energy portfolio. Currently, the state-of-the-art electrocatalysts for hydrogen production by water splitting in alkaline solutions are Pt based precious metals.[1] Realization of large-scale hydrogen production from water splitting requires competent nonprecious electrocatalysts. Despite the advances of decades in this field, several challenges still exist and need to be overcome. Most efforts in the design of non-precious electrocatalysts have focused on developing HER catalysts for alkaline conditions owing to their thermodynamic convenience, potentially resulting in incompatible integration of the two types of catalysts and thus inferior overall performance.[2] Researchers have aimed to develop high-performance electrode materials based on non-precious and abundant transition metals such as Co, Ni, Fe, Mn, etc., for industrially large scale hydrogen production. Moreover, to further reduce the cost and complexity in real-world application, efficient HER catalysts are economically and technically desirable.[3] This paper emphasizes concepts and fundamentals relating to the kinetics, energetics, and stoichiometries of adsorption of hydrogen on a cobalt decorated reduced graphene oxide (rGO) supported on NiP alloy electrode.The NiP electrode incorporated with Co nanoparticles uniformly deposited on reduced graphene oxide is prepared through a facile two-step approach. The as-prepared Co-rGO-NiP is investigated as an electrocatalyst for the hydrogen evolution reaction (HER). It is found that the Co-rGO-NiP composite electrode shows an enhanced catalytic activity with a smaller Tafel slope, a much larger exchange current density than pure NiP. Such enhanced catalytic activity stems from the abundance of active

catalytic sites, the increased electrochemically accessible surface area and significantly improved electrochemical conductivity of the electrode. A variety of analytical techniques and electrochemical measurements suggest that the catalytically active sites are associated with the metal centres coordinated to graphene. The good catalytic activity demonstrates that the Co-rGO-NiP could be a promising electrocatalyst in hydrogen production.

Keywords: electrocatalyst; HER; graphene; overpotential

CHEMICAL SCIENCES-04 REG. No. 15277

A Molecularly Imprinted Polymer Based Electrochemical Sensor for the Selective Determination of Xanthine

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Background: Electrochemical sensors have become one of the fascinating area of research due to their advantages such as rapid response, capability of miniaturization and simple instrumentation. Voltammetry is one of the prominent electrochemical technique used for developing sensors and it involves measurement of current of the electro active species of interest under the applied potential range. Apart from its advantages, voltammetric sensors often suffer from serious interferences from probably coexisting species and selective determination of target analytes is of at most interest. In this context, molecularly imprinted polymers have gained great interest due to their selective molecular recognition property. Molecularly imprinted polymers are polymer containing imprints of the target molecules and can enable selective detection of target molecules.

Method: This work explains the development of a molecularly imprinted polymer based electrochemical sensor for the determination of xanthine. The monomer o-phenylenediamine was electropolymerised in presence of xanthine onto the surface of a glassy carbon electrode initially modified with a conducting polymer layer of l-serine. Extraction of xanthine molecules from the polymer to create the imprints were then carried out using 1:1 v/v mixture of methanol and 0,1 M NaOH.

Results: The fabricated sensor was characterised using FE-SEM, Impedance and cyclic voltammetric techniques. The sensor was able to selectively determine xanthine in the range from 8.00×10^{-5} M to 2.00×10^{-6} M with a detection limit of 5.49×10^{-7} M. Practical utility of the proposed method was also validated in synthetic physiological fluids with good recovery and RSD values. The sensor also displayed promising applicability for the determination of xanthine in real tea and coffee samples.

Conclusions: This work involves the development of a selective voltammetric sensor for the determination of xanthine. The proposed sensor enabled the selective determination of xanthine over a wide linear range and its practical applicability was also successfully verified in synthetic physiological fluids and in real tea and coffee samples.

Keywords: Sensor, Voltammetry, Molecularly imprinted polymers, Xanthine

CHEMICAL SCIENCES-05 REG. No. 15352

A Simple and Facile Turn on Fluorescence Sensor for the Determination of Biliverdin

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Background: Fluorescence techniques are considered to be the best tools for the sensitive determination of multifarious compounds where variation in fluorescence intensity of the fluorophore upon the addition of the analyte is being measured.

Method: This work describes the use of fluorescent copper nanoclusters (CuNCs) for the sensing of an important bile pigment- Biliverdin (BVD). Herein, the fluorescence intensity of ascorbic acid capped copper nanoclusters (AA CuNCs) gets increased upon adding different concentrations of BVD. Moreover, the parameters like the effect of time, medium and concentration have also been noted along with selectivity and interference studies.

Results: The emission maxima of AA CuNCs at 445 nm upon irradiating at 365 nm gets enhanced upon adding BVD along with a red shift. The particles were found to have an average size of 2 nm. The proposed

sensor was successfully utilized as an efficient platform for BVD determination within the linear range 1.00×10^{-5} M to 2.00×10^{-6}M where the limit of detection (LOD) was obtained to be 2.88×10^{-7} M. Mechanism of sensing was found to be aggregation induced enhanced emission (AIEE).

Conclusion: This simple, facile and reliable sensing strategy was also applied in the determination of BVD in artificial body fluids.

Keywords: Fluorescence, Sensors, Biliverdin, copper nanoclusters, Enhancement

CHEMICAL SCIENCES-06 REG. No. 15668

Electropolymer Modified Electrode as A Sensitive Voltammetric Sensor for the Determination of Monoamine Neuromodulators: Norepinephrine and Octopamine

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Background: Norepinephrine (NE) one of the important neurotransmitter found in peripheral and central nervous system in mammals seems to coexist with octopamine (OA). Among, different electroanalytical techniques, voltammetry has been extensively employed to determine neuromodulators due to its advanced features and high sensitivity. In this work, the simultaneous voltammetric determination of NE and its cotransmitter OA has been done on tyrosine modified glassy carbon electrode (p-Tyr/GCE).

Methods: The effectiveness of the surface modification was analysed using Field Emission Scanning Electron Microscopy (FESEM) and surface area calculations of the bare and modified electrodes. The electrochemical behaviour of these analytes on p-Tyr/GCE was studied using square wave voltammetry (SWV), electrochemical impedance spectroscopy (EIS) and cyclic voltammetry (CV).

Results: The appropriate analytical conditions were optimized for the maximum analytical performance. The electrocatalytic response of the sensor was possible in the linear working range of 1.00×10^{-5} M to 1.00×10^{-7} M for NE and 1.00×10^{-5} - 2.00×10^{-6} M and 1.00×10^{-6} - 2.00×10^{-7} M for

OA. The modification, p-Tyr/GCE enabled remarkable electrocatalytic activity and faster electron transfer for the simultaneous determination of NE and OA. The limit of detection obtained for NE and OA were found to be 1.37×10^{-8} M and 4.74×10^{-8} M, respectively. The developed sensor was successfully applied for the quantification of NE and OA in artificial biological samples.

Conclusion: A voltammetric sensor for the individual and simultaneous determination of NE and OA has been developed using p-Tyr/GCE in square wave mode. Under optimized conditions, the sensor enabled the quantification of NE and OA in wide linear ranges with low detection limits. The practical utility of the sensor for the determination of NE and OA has been verified in artificial blood serum samples.

Keywords: Norepinephrine, Octopamine, Tyrosine, Electrochemical impedance spectroscopy, Square wave voltammetry, Cyclic voltammetry

CHEMICAL SCIENCES-07 REG. No. 15776

Voltammetric Sensor for the Simultaneous Determination of Uric Acid, Xanthine, Hypoxanthine and Theobromine

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Background: Uric Acid, Xanthine, Hypoxanthine and Theobromine are potent biomarkers for certain diseases. Since all these purine bases and derivatives shares number of common physiological features it would be more significant to determine all these structurally similar compounds by employing a single sensing platform.

Method: Square Wave Voltammetry (SWV) was employed owing to its sensitivity. The 1×10^{-2} M concentration of the analytes were freshly prepared as stock solutions and required concentrations of the analytes are prepared by diluting the former with millipore water. Appropriate concentration of analytes were added to 10 mL of the supporting electrolyte taken in the electrochemical cell and SWV was recorded. 0.1M phosphate buffer solution was used as the supporting electrolyte.

Results: Under optimized conditions,

the sensor showed well defined and well separated peaks for the oxidation of these potent biomarkers. The sensor offered the individual and simultaneous determination of these analytes over a broad linear range with very low detection limits. The clinical applicability of the developed sensor was ensured by conducting experiments in artificial urine and blood serum by spiked recovery analysis. The results showed excellent recovery rates.

Conclusion: Thus a simple and reliable voltammetric sensor based on electrochemically modified GCE for the determination of uric acid (UA), xanthine (XA), hypoxanthine (HX) and theobromine (TB) is proposed in this article. The sensor showed sensitivity, stability and reliability in terms of low detection limit, wide linear range repeatability and reproducibility.

CHEMICAL SCIENCES-08 REG. No. 15786

A Mechanistic Insight into Electro-Reduction of Co_2 to Ethanol by a Co-Macrocyclic Complex

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Background: A sustainable, cheap alternative energy source for fossil fuel has been a topic of constant discussion among both scientists and environmentalists. CO_2 reduction offers a viable way of achieving this with the added benefit of lowering these anthropogenic emissions. Out of the different methods available, electrochemical conversion of CO_2 to ethanol is a powerful method to convert electrical energy into C2 building blocks for fuels and C2 base chemicals. Catalysts have been a bottleneck in such CO_2 reduction reactions due to their inherent high overpotentials. This limitation can be overcome by the correct tuning of the frontier molecular orbital energy levels of the molecular catalyst. Taking input from this concept, immobilization of a functionalized Co-corrole molecular catalyst has been performed on carbon free electrode

which enables the reduction of CO_2 to ethanol at a low overpotential. The catalyst shows excellent activity for C-C step towards C2 product, ethanol with high selectivity. The reduction produced Co(I) centre which bear highly nucleophilic d^8 which initiate the reduction process.

Method: Detection and quantification of the CO_2 reduced products were done using various spectroscopic methods like ^1H- and ^{13}C-NMR spectroscopy and GC-MS. All the geometries were fully optimized by employing density functional theory (DFT) using a range separated hybrid functional wB97XD which contains empirical dispersion correction term by Grimme as implemented in Gaussian 09 quantum mechanical software package. The geometry optimizations were carried out using a Pople basis set of valence triple ζ quality (6-311G) over all the atoms (Co, S, P, O, N, C and H). We have optimized both low and high spin geometries for all the compounds.

Results: The analysis show that the initial reduction of metal centre from Co(III) to Co(I) is followed by the adsorption of CO_2 molecule onto the metal centre. This is followed by the formation of carboxyhydroxyl intermediate which then depending upon the input current further gives ethanol and methanol products with the regeneration of the catalyst.

Conclusions: This work gives a mechanistic insight into the heterogenous reduction of CO2 into ethanol and methanol using a Co-Corrole complex. On simulating the reactivity of Co-corrole, we found that in contrast to the CO pathway our catalyst proceeds via a formic acid pathway

Keywords: CO_2 reduction, C2 product, Cobalt Corrole, Mechanism

CHEMICAL SCIENCES-09 REG. No. 15920

Perovskite Nanocrystal/Squaraine Dye Composite for Security and NIR Photography Applications

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Background: Visibly opaque and near-infrared transmitting (VONIRT) materials play a crucial role in forensic detection, security imaging, night-vision photography, and biomedical applications. Since the currently being used inorganic-based materials are expensive and difficult to synthesize and fabricate, the development of materials that are low-cost and easy to make and process is highly desirable. In this work, we have developed a VONIRT material/filter consisting of halide perovskite nanocrystals (PNCs)/squaraine (SQ) dye composite.

Method: PbI_2 (0.086 g, 0.187 mmol) and 1-octadecene (5 mL) were added to a 25 mL round-bottom flask, dried for 1 h at 120 °C, and mixed with oleic acid (1 mL, 120 °C) and oleylamine (0.5 mL). The mixture was cooled to 80 °C, the preheated FA-oleate precursor (2 mL) was injected. After 10–60 s of stirring, the solution was cooled to room temperature in a water bath. The crude solution was centrifuged for 5 min at 12,000 rpm, the supernatant solution was discarded, and the precipitate was redispersed in toluene. The nanocrystals were finally washed with toluene for further studies. PNC/SQ dye composite consisting of 1.2 wt% of SQ dye was prepared by adding 60 μL of squaraine dye solution (1 mg in 1 mL toluene) into PNC solution (5 mg in 1 mL toluene) followed by ultrasonication for 5 min. 100 μL of PNC/SQ dye composite was drop cast onto a quartz substrate followed by drying under ambient atmosphere to obtain visibly opaque and NIR transmitting filter.

Results: The development of VONIRT material was achieved by gradually increasing the size of PNCs followed by attaching them with a novel low-bandgap SQ dye as a capping ligand. The acid group present in the SQ dye efficiently interacts with the surface of the nanocrystals via non-covalent interactions. Incorporation of SQ dyes onto PNCs yielded composite films with uniform transmittance of

below 2% in the visible region (380-740 nm) and above 60% in the NIR region, the prime requisites for VONIRT materials. Opaqueness in the visible region and excellent NIR transparency of the nanocomposite make them useful as a security material and for NIR photography applications.

Keywords: Halide Perovskites, Nanocrystals, Squaraine dyes, NIR transmittance, Security materials

03

Chemical Sciences

Poster Presentation

CHEMICAL SCIENCES-10 REG. No. 12796

Effect of Structural Tuning to Enchance the Nonlinear Optical Response of Salen Type Ni(II) Compounds

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Background: Designing of switchable materials with large contrasts of nonlinear optical properties has been the focus of research in recent decades because of their widespread applications in optoelectronics. The development of this area depends on the continuous discovery of new materials with improved NLO parameters, and how to enhance such optical response. In this scenario, our compounds are significant since they show high value of third order susceptibilities ($\chi(3)$) which is in the semiconductor range (10^{-13}-10^{-10} esu) and exhibit excellent optical limiting properties.

Method: In order to study the nonlinear optical behavior and also the effect of substituent in their nonlinear behavior third order NLO properties of these compounds were studied using open aperture Z-scan technique. The experimental results were substantiated with frontier orbital calculations carried out using DFT at B3LYP/6-31G* level of theory.

Results: Third order nonlinear optical (NLO) activity of the complexes were probed using laser pulses of wavelength 532 nm by employing open aperture Z-scan technique. Compound which belonging to the salphen family exhibited the highest activity then followed by one with ethylene diimine spacer group. It can be seen that both the compounds exhibit high degree of π-delocalization when compared to the others and this is critical for the enhancement of NLO response. Moreover, on performing optical limiting experiments all the complexes were found to be excellent optical limiters. Frontier orbital calculations and visualization reveal that in all the complexes the donor group is the methoxy moiety and the acceptor is mainly concentrated on the metal centre. The computed values of first hyperpolarizability (βhyp) carried out at B3LYP/6-31G* level of theory agree well with the trend of the experimentally obtained values of two photon absorption coefficient (β).

Conclusions: In this work, we report five Ni(II) salen complexes with excellent non-linear activity of the order of polymers and semiconductors. The high value of first order hyperpolarizability and two photon absorption coefficients along with good optical limiting capabilities make these complexes as a perfect prospect for the development of NLO devices.

Keywords: Nonlinear optical activity, DFT studies, salen complexes, optical limiting

CHEMICAL SCIENCES-11 REG. No. 14295

A Copolymer Based Voltammetric Sensor for the Simultaneous Determination of Neuroendocrine Tumour Biomarkers

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Background: Determination of the biomolecules Hydroxyindolacetic acid (HIAA) and Vannillyl mandelic acid (VMA) simultaneously is important since they act as biomarkers of neuroendocrine tumours. A voltammetric sensor based on a copolymer modified glassy carbon electrode has been developed for the sensitive determination of these biomarkers.

Method: The glassy carbon electrode was modified with a copolymer of taurine and glutamic acid was fabricated. It was characterized and sensor parameters were optimized and applied for the simultaneous as well as individual determination of HIAA and VMA artificial urine samples using square wave voltammetry.

Results: Poly taurine-glutamic acid modified glassy carbon electrode can be used for the simultaneous determination of HIAA in the linear concentration range 5.00×10^{-6} to 3.00×10^{-7} and for VMA in the range 1.2×10^{-5} to 4.00×10^{-7} with limit of detection 4.19×10^{-8} M and 6.16×10^{-8} M respectively.

Conclusion: A simple copolymer based voltammetric sensor has been developed for the simultaneous determination of neuroendocrine biomarkers which can be applied in real sample analysis.

Keywords: Hydroxyindolacetic acid, Vannillyl mandelic acid, taurine, glutamic acid, copolymer, voltammetry

CHEMICAL SCIENCES-12 REG. No. 15345

A Turn-Off Fluorescence Sensor for the Detection of Histamine Using Tryptophan-Au/Ag Bimetallic Nanoclusters (Tryp-Au/Ag BNCs)

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Background: Fluorescence sensor measures the changes in optical properties of the recognition element induced by an analyte. Fluorescent sensing is a fascinating field of research due to its versatility and simplicity. The recent progress in nanotechnology and nanomaterials has been incorporated into analytical chemistry for the design of highly sensitive fluorescent sensing probes. Any phenomenon that results in a change of fluorescence intensity, lifetime or anisotropy can be used for sensing. Analyte induced luminescence emission intensity is the basic principle of fluorescent sensors.

Method: The present works explores the development of a turn-off fluorescence sensor for the determination of histamine using Tryp-Au/Ag BNCs. A blue fluorescence with emission maximum centred at 450 nm has been obtained for the BNCs when excited at 370 nm. Sensing of histamine has been studied by adding different volumes of histamine in an increasing order while keeping the volume of BNCs as a constant. A linear range for the determination of histamine was obtained by plotting I/I_0 value against the concentration of the analyte, where I and I_0 are the intensity of the BNCs in presence and absence of histamine.

Results: Under the optimal analytical conditions, a linear quenching in fluorescence intensity with the concentration of histamine was observed in the range of 4.0×10^{-6} M to 8.5×10^{-5} M. The limit of detection obtained was 9×10^{-7} M. Selectivity and interference studies were done in presence of structurally similar as well as co-existing species. Application studies were done in synthetic urine and blood serum.

Conclusions: Histamine quenched the of fluorescence intensity of Tryp-Au/Ag BNCs. Under optimal conditions, a linear concentration range has been obtained from 4.0×10^{-6} M to 8.5×10^{-5} M with a detection limit of 9×10^{-7} M. Application study of the proposed sensor has been done in artificial urine and blood serum.

Keywords: Fluorescence sensor, histamine, bimetallic nanoclusters, quenching.

CHEMICAL SCIENCES-13 REG. No. 15612

Polyether Macrolide Analogues, Marginolides A-B, from Marine Octopus *Amphioctopus marginatus*: Anti-Hypertensive Leads Attenuate Angiotensin-Converting Enzyme

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Background: Angiotensin-I-converting enzyme (ACE) plays an important physiological role in renin-angiotensin-aldosterone assembly as it catalyses the conversion of angiotensin-I to angiotensin-II, a powerful vasoconstrictor leading to hypertension and heart failure. Synthetic ACE inhibitors were reported to cause adverse health problems, which triggered an urge to focus for the search of effective and antioxidant dietary food supplements as alternative medications for hypertension treatment. Being a traditional Chinese medicine and nutritionally rich source of bioactive metabolites, bio-chemical examination of marine octopus, *Amphioctopus marginatus* has resulted structurally diverse oxygenated bioactive polyether macrolides marginolides A-B.

Method: Lyophilized octopus sample was extracted with organic solvent to prepare crude extract of *A. marginatus*. Bioactivity supported liquid chromatographic purification of the organic extract resulted in the isolation of two 20-membered polyether macrolide analogues, marginolide A and B. Isolated metabolites was subjected for free radical scavenging and anti-hypertensive assays using *in vitro* models. Structure-bioactivity correlations were performed by various physico-chemical molecular parameters. *In silico* molecular modeling analyses of the marginolides against ACE to evaluate attenuation potential and drug target interaction in the active site of the enzyme.

Results: Among the isolated secondary

metabolites, marginolide A exhibited considerably greater attenuation property against angiotensin converting enzyme (IC_{50} 0.58 mM) than that displayed by marginolide B (IC_{50} 0.72 mM). Greater antioxidant properties of marginolide A against the oxidant species (IC_{50} ~ 1 mM) than standard α-tocopherol (IC_{50} ~ 1.6 mM) also supported its potential ACE inhibitory activity. Higher polar characteristics along with acceptable hydrophobic-hydrophilic equilibrium (partition coefficient of octanol-water, log P_{OW} 2-4) along with lesser binding energies (~ -10.20 kcal mol^{-1}) and inhibition constants (K*i* ~ 30 nm) manifested the potential anti-hypertensive activities of the studied marginolides.

Conclusion: The study demonstrated that the previously undescribed polyether macrolide analogue, marginolide A isolated from a marine octopus *Amphioctopus marginatus* could be used as a promising anti-hypertensive pharmacophore attenuating angiotensin-converting enzyme.

Keywords: *Amphioctopus marginatus*; marine octopus; polyether macrolides; marginolides A-B; angiotensin converting enzyme; anti-oxidant

CHEMICAL SCIENCES-14 REG. No. 15705

Thermally-Induced Blue to Red Fluorochromism in a Lead-Freehybrid Halide Material

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Background: Organic–inorganic metal halide hybrids (OIMHs) have attracted widespread attention among the research community because of their diverse applications in photovoltaics, LEDs, and lasers. Considering the toxicity of lead (Pb)-based materials, the research world sought after alternative candidates. Thus, less toxicity, earth-abundance, cost-effectiveness makes the Cu(I) halides promising for optoelectronic applications.

Method: Synthesis of $(Bz)_2Cu_2I_4.H_2O$ Single Crystals: The $(Bz)_2Cu_2I_4.H_2O$ single crystals were synthesized by dissolving 0.19 g of CuI (1 mmol) and 0.215mL (2 mmol) of benzylamine in 2.5 mL of 57% aq. HI acid. The mix-

ture was heated to 398 K, and water was added to make the solution clear. The reaction mixture was stirred for 30 minutes at 398 K. It was then allowed to cool slowly to room temperature. Plate-like transparent crystals were formed, which were subsequently washed with diethyl ether.

Result: Herein, we introduce a two-dimensional Pb-free OIMH single crystal with a formula $(Bz)_2Cu_2I_4.H_2O$ (Bz: benzylamine). In the crystal form, the dimeric units $[Cu_2I_4]^{2-}$ are connected through corner and edge-sharing in an alternative manner to form a cyclic hexagonal cage-like two-dimensional array. The material exhibits a blue emission centered at 470 nm, which could be originating from the self-trapped excitonic emission mechanism. The large stokes shift of 162 nm, and a broad full-width at half maximum (FWHM) of ~95 nm are the highlights of the emission characteristics. It exhibited outstanding reversible thermally-induced fluorochromism from blue to red at a temperature near 100 °C.

Keywords: Organic–inorganic metal halide hybrids, lead-free materials. Self-trapped excitonic emission, Thermally-induced fluorochromism.

CHEMICAL SCIENCES-15 REG. No. 15884

Thermoelectric Properties of Doped Benzodithiophene-Based Copolymer/Single-Walled Carbon Nanotube Hybrids

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Background: Organic thermoelectric materials attracted considerable attention for thermoelectric (TE) applications. TE devices can convert waste heat into electric energy, which has been regarded as a new type of green energy source. The TE performances are assessed by the dimensionless figure of merit,

where S, σ, T, and κ are the Seebeck coefficient, electrical conductivity, temperature, and thermal conductivity, respectively. Therefore, large S, high σ, and low κ are required to obtain good TE efficiency. Organic materials usually exhibit low thermal

conductivity (<1 $Wm^{-1}K^{-1}$).

Methods: The desired amount of SWCNT is added to the polymer dissolved in o-DCB and probe sonicated for 30 min. The hybrid film is prepared by drop-casting on glass substrates and annealed at 65 ºC for 2 hours. The hybrid film was doped by immersing in 0.05 M $FeCl_3$ solution in acetonitrile for 30 min followed by annealing at 60 ºC for 30 min. The doped hybrid film was further annealed at 200 ºC for 15min. A flexible thermoelectric generator (TEG) consisting of 7 p-type legs was fabricated on a polyimide substrate.

Results: The film morphology was observed by SEM and AFM images indicating good dispersion of SWCNT in the polymer matrix. The crystallinity of the hybrid films was studied by XRD, and the intermolecular interactions between SWCNTs and polymer were examined using Raman spectroscopy. The TE behavior of hybrid films by varying SWCNT wt% has been studied. The hybrid films exhibited a p-type TE characteristic that increases with the addition of SWCNT. To assess the thermal stability of the hybrid films, TGA was performed. Further, TE devices were fabricated with the doped hybrid film using silver as the electrode. A flexible 7-leg TEG provided an output power of 90 nW at $\Delta T \sim 60$ K.

Conclusions: We have prepared and characterized a p-type polymer hybrid film with 50 wt.% SWCNT, exhibiting a power factor of 64 $\mu W/m^1K^2$ at room temperature. For doped hybrid film annealed at 200°C, the electrical conductivity was doubled compared to the hybrid film. Thus, the power factor raised to 76 $\mu W/m^1K^2$, leading to the highest value for the benzodithiophene-based conjugated polymer/SWCNT hybrid film and could be used for sustainable power generation from thermal sources.

Keywords: Organic thermoelectric materials, Conjugated polymers, Doping, Flexible devices.

CHEMICAL SCIENCES-16 REG. No. 15919

Ligand Controlled Spectroelectrochemical Diversification and Molecular Permeability in Electrochromic Metal-Organic Assemblies

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Background: Several materials such as metal oxides, viologens, conjugated conducting polymers, etc. are being explored for electrochromic color switching, but the real-world applications of such systems are hindered by low optical contrast, laborious processibility, slow color switching, low cycle life, and high cost. Hence the demand for novel high performing stable and easily processable electrochromic materials has attracted much attention over the past few years. Coordination based metal-organic thin films are a relatively less investigated class of electrochromic materials, with excellent prospects in terms of optical contrast, ease of switching, redox reversibility, facile processibility, low power consumption, and high cycle life.

Methods: Spray coated films were characterized using UV–vis spectroscopy, atomic force microscopy (AFM), X-ray photoelectron spectroscopy (XPS), electrochemistry and spectroelectrochemistry, and thickness measurements using a profilometer. Electrochromic devices were fabricated by keeping bare FTO on top of a modified substrate and the gel electrolyte was injected in between. Molecular permeability studies were done using cyclic voltammetric response of three quinone-based redox probes of different molecular dimensions at identical concentration.

Results: Electrochromic devices fabricated using these films showed switching from transparent colored state (Fe^{2+}) to transparent yellow state (Fe^{3+}) by application of voltage. The fabricated films and devices exhibited high optical contrasts up to 76% and 56%, respectively. Both the devices and films exhibited pulse width dependent changes in the contrast ratio. High coloration efficiencies were also obtained for the electrochromic films (up to 1050 cm^2/C) and

devices (up to 641 cm^2/C) operating at low input voltage. The spray coating process was also used for creating patterns and images by masking selected areas of the FTO substrate. Molecular permeability studies using three quinone-based redox probes shows size selective permeation in the films in which their porosity is in the order Fe(II)-Ph-TPy > Fe(II)-Thio-TPy > Fe(II)-TPE-TPy

Conclusions: Ligand design allowed for control of porosity and spectro-electrochemical diversification, that are otherwise difficult to achieve in surface confined assemblies of coordination polymer comprising of a single type of metal ion. The combination of the spray coating process and designed ligand systems offers a powerful tool for the realization of smart and functional coordination polymer network films with modulable properties and multifarious applications.

Keywords: Electrochromic devices, Coloration efficiency, Molecular permeability

CHEMICAL SCIENCES-17 REG. No. 15940

Thermochromic Metal Organic Complexes for Multi State Volatile Memory and Counter Operations

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Background: Chromogenic materials have attracted tremendous interest over the past few decades due to their applications in smart technology.[1] Thermochromism is the reversible change in optical properties of a material when subjected to different temperature, leading to corresponding variations in its physico-chemical properties.[2] Organic[3] and inorganic[4] thermochromic systems have been extensively investigated; however, many of the inorganic systems are limited by their moderate reversibility and a large number of the organic counterparts suffer from poor stability.[5] Hence recent focus is being diverted to highly stable organic-inorganic hybrids with considerable reversibility in their thermochromic behavior.

Methods: Stock solutions were

prepared by accurately weighing the ligand L1-L3 (10.0 mg) and $FeCl_2 \cdot 4H_2O$ (10.0 mg) in an oven dried clean glass vial. DMSO (1.0 mL) was added to each vial. Equal amounts of each of the above solutions were mixed and made up to 2.0 mL in a vial and the absorbance of the resulting-colored solution was adjusted to ~1 a.u. The solutions thus prepared were allowed to rest overnight to ensure the completion of reaction before starting the experiments. Concentration dependence of thermochromism was also investigated using three different concentrations of $FeCl_2 \cdot 4H_2O$ and L1. Experiments using $CoCl_2 \cdot nH_2O$ and $NiCl_2 \cdot 6H_2O$ were also carried out under similar conditions, however, employing different ratios of the metal salt to ligand. Typically, 1:2 molar ratio of $CoCl_2$ to L1 and 1:4 molar ratio of $NiCl_2$ to L1 were used.

Results and Discussion: In the present work, we report on the development of metal complexes capable of exhibiting thermochromism in solution. Temperature dependent optical spectroscopy was used to demonstrate the switching leading to 'color-to-colorless' and 'color-to-color' transitions in these reversible thermochromic systems. Kinetic studies confirmed temperature dependent multi-step thermochromic switching. Using this, we have demonstrated multi step logic enabled volatile memory and couter operations. Careful manipulation of these systems may lead to applications in dynamic windows capable of regulating indoor lighting and heating leading to energy efficient buildings. [6]

Conclusion: Thus, we have successfully developed a metal organic complex in solution exhibiting thermochromic color switching that would perform multi state volatile memory and counter operations. The demonstration of color/opacity switchable window prototypes of thermo-responsive systems along with the previously unexploited precise temperature regulated sequential logic-enabled multi-state volatile memory and arithmetic operations, underline the functional accessibility and untapped potential of metal-organic complexes and their hybrid gels.

Keywords: Thermochromism, Logic enabled volatile memory and counter operations, Smart windows.

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04
Earth & Planetary Sciences

Oral Presentation

EARTH & PLANETARY SCIENCES-01 REG. No. 15639

Tracing the Precipitation Microphysics of Mesoscale Weather Events Over Kerala

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Background: A comprehensive understanding of the physical properties of clouds and precipitation microphysics is very essential for the adequate representation of clouds and precipitation mechanisms in weather forecasting model for reliable prediction of extreme weather events on a regional scale. The Western Ghats, influence on the formation of monsoon rainfall and mesoscale convective systems in pre-monsoon and post-monsoon seasons. Here we deal with the macrophysical properties of clouds, associated precipitation microphysics and time scale growth of precipitation particles over Western Ghats orography in order to understand the formative processes of extreme rainfall, thunderstorm and lightning events using observatories set at different elevations on the Western Ghats province.

Method: Using ceilometer observations retrieved from cloud physics observatories at coastal and high altitude sites, the vertical distribution of clouds, cloud thickness and its influence of rainfall on the wind-ward side of Western Ghats are investigated . The measured raindrop size spectra at surface using disdrometer and at vertical air column with micro rain radar are used for the microphysical analysis of rainfall. Satellite and reanalysis data set are used to understand the thermodynamic and dynamic conditions in different precipitating systems over Kerala.

Results: Precipitation and cloud layers exhibit a strong diurnal variation with early afternoon convective initiation, more prominently in pre-monsoon season at elevated location of High Altitude Cloud Physics Observatory (HACPO) in Western Ghats. In contrast to the highland, the coastal region has higher contribution of convective rainfall in pre-monsoon (81.15%) and post-monsoon (76.87%) seasons. The rainfall at coastal region occurred from low to high level clouds, with ice cloud initiated microphysical growth of raindrops. The distinct dynamical and thermodynamical conditions at coastal and HACPO locations influence the

rain formation processes resulting in intense rainfall with large drops at costal station associated with thunderstorm and lightning, while small drops at HACPO results in moderate rainfall with less lightning events. The prolonged rain spells or intense rain spells in short duration from mixed phase clouds in association with monsoon low level jet generate extreme rainfall over the elevated terrain of Western Ghats that leads to flooding in the lowlands.

Conclusions: The evolution of rainfall over the coastal location is influenced by the microphysical processes associated with deep convective precipitating clouds, whereas over the high-altitude location on the windward side of Western Ghats, shallow precipitating clouds are predominant during the pre-monsoon and post-monsoon seasons. The deep convective clouds due to the orographic effect favour the occurrence of mini-cloud burst (MCB) events on the high-altitude region of Western Ghats leading to flash floods in the monsoon season.

Keywords: Monsoon, Mesoscale Convective Systems, Extreme rainfall, Western Ghats

EARTH & PLANETARY SCIENCES-02 REG. No. 15593

Spatio-Temporal Variability of $PM_{2.5}$ Over India Using Multi-Year Space-Borne Lidar Observations and its Implications

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Background: Monitoring Particulate Matter (PM) receives great importance in the context of air quality degradation and pollution-induced health hazards which include enhanced premature mortality, adverse weather conditions and, impaired road safety and air traffic due to poor visibility. Understanding the extent and trends of air pollution is essential for generating emission inventories with improved accuracy for reliable forecasting and developing climate mitigation policies as well.

Method: Present study estimates the $PM_{2.5}$ mass concentration over the Indian sub-continent using near-surface observations of aerosol backscatter (2007 - 2021) by Cloud-Aerosol Lidar with Orthogonal Polarization

onboard CALIPSO satellite, combining with aerosol reanalysis datasets and satellite-based relative humidity measurements.

Results: The present study shows that crop-residue burning over Northern India during the onset of the winter season is significantly correlated with $PM_{2.5}$ concentration during the winter season (Dec - Feb). Winter-time near-surface $PM_{2.5}$ over the Indo-Gangetic Plain is controlled by anthropogenic fire emissions rather than the meteorological parameters. The influence of crop-residue burning in November over Punjab and Haryana extends up to Peninsular India indicating its far-reaching influence in the country.

Conclusion: The present study highlights the implications of anthropogenic post-harvest crop-residue burning in attributing extreme air pollution during the winter season. Urgent measures are to be taken to restrict anthropogenic fire emissions and provide sustainable solutions to contain the excessive emission of particulate matter ($PM_{2.5}$) and associated socio-economic impacts.

Keywords: $PM_{2.5}$, Lidar, CALIPSO, Aerosols, anthropogenic fire-emissions

EARTH & PLANETARY SCIENCES-03 REG. No. 15523

Chronology and Facies of Invertebrate Fossil Assemblages of Central Kerala Coast, South India and its Implications on Late-Quaternary Sea-Level Changes

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The Holocene coastal sediments in Kerala are preserved in two distinct geomorphological settings; in palaeo-mudflat/ coastal swamp deposits occurring inland, which are bordered by medium to fine sandy beach-ridge sequence, sub-parallel to the modern shore. While the palaeo-beach ridges generally devoid of shells, the equivalent ancient low

energy tidal flats and coastal lagoon deposits show well preserved shells, mostly autochthonous. The study aims to understand the change in palaeo-environments using the abundance of species assemblage of shells in the sediments and radiocarbon dating to constrain the age of deposition. Shells from the sediments were collected from four different locations of Thrissur district, Kerala. The sections display lenticular bedding within the mudflat sediments and fossil shells where embedded in the grey sandy clay to clayey substratum at variable depth (between 2-10.5m). The taxonomic compilation of the shells shows that the specimens largely composed of bivalves and gastropods in the invertebrate macro-fauna with their characteristic environment of occurrence ranging between marine, marginal marine and estuarine. Radiocarbon ages constrain the timing of this deposits in distinct periods of shell accumulation during 6870±220, 7080±200, 3350 ±160 yrs BP and >40 ka BP. The shell deposit displays an abundance of well-preserved Holocene shell specimens and slightly altered shells due to the effect of differential taphonomic conditions during late Pleistocene. The marine influence in the species assemblage and hence the evidence of formation of these landforms as a consequence of late-quaternary sea-level fluctuations and associated environmental response is deduced.

Keywords: Quaternary, Sea-level changes, Marine shells, Radiocarbon age.

EARTH & PLANETARY SCIENCES-04 REG. No. 15728

Petrogenesis of Charnockites in the Western Parts of Palghat-Cauvery Shear Zone, Southern India

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The Southern Indian Granulite Terrain (SGT), one of the largest exposed Precambrian continental crust exposes the lower crustal portions of lithospheric scale shear systems and provide opportunities to study the geodynamic evolution of continental crust. The Palghat-Cauvery Shear Zone System (PCSZ), which marks the boundary between the northern Archean terrain

and southern Proterozoic granulite blocks within the SGT, is considered as a Late Neoproterozoic collisional suture which is formed during the final phase of amalgamation of Gondwana supercontinent and later reactivated to form shear zone in this region. Most of the previous studies within this shear system are restricted to the eastern part as compared to the western side of PCSZ. However, the western parts of PCSZ are considered to be the "gap proper" consisting of charnockites, migmatitic gneisses and granites provide ample scope for understanding intracrustal magmatic and metamorphic processes, which eventually causes the evolution of continental crust. The present study is an attempt to understand the petrology and geochemistry of the high-grade rocks of the western parts of the PCSZ and describes their petrogenesis. The study area is within the transition zone between PCSZ and Moyar Bhavani Shear Zone (MBSZ) with charnockite and migmatitic gneiss as major rocks. Major and trace element analysis of representative samples from various locations across the terrain were show calc-alkaline affinity indicating collisional tectonics. Petrological and geochemical characteristics of the granulites suggest their formation during granulite grade metamorphism at a lower crustal level beneath a magmatic arc.

Keywords: Charnockite, Palghat Cauvery Shear Zone, Convergent plate margin

EARTH & PLANETARY SCIENCES-05 REG. No. 15117

Prediction of Tropical Cyclones Over the Indian Seas Using a Weather Prediction Model COSMO

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Background: Tropical cyclones are severe weather events, form over warm tropical oceanic environment, fuelled by the water vapour drawn inward from far away, and are characterized by low pressure at the centre, high winds and heavy rainfall. With its huge destructive power, these storms create massive destruction to the human life and properties over the region of its passage. Coastal belt of Indian subcontinent surrounded by the Bay of Bengal, the Arabian sea and equatorial Indian ocean is

always prone to tropical cyclone activities. Accurate prediction of tropical cyclones in terms of its trajectories, intensities and probable location of land fall with sufficient lead time is crucial for disaster management and timely warning to the general public. Numerical weather prediction models serve as a tool for giving timely prediction of tropical cyclones and its associated activities. The present study investigates the performance of a numerical weather prediction model namely, the consortium for small scale modelling (COSMO) in the prediction of trajectories and intensities of cyclonic storms.

Method: With a view to evaluate the performance of COSMO model in the prediction of tropical cyclones, a total of 8 cyclonic storms over the Bay of Bengal and the Arabian sea are chosen for the study during the period of 2017 to 2019. The COSMO model is simulated on daily basis with initial conditions from ICON global model analysis fields. The necessary boundary conditions are provided by the ICON forecast fields.

Results: The estimated central pressure, pressure drop, maximum sustained wind speed and trajectory simulated by the COSMO model are validated against concurrent observations from the India Meteorological Department. Mean track error for a lead time of +24 hour was 95 km, while it was 140 km for a lead time of +48 hour. The intensity of the storms underestimated in terms of pressure drop and maximum sustained wind speed for lead time of +0 to +24. The COSMO model yields improved predictability of the track for very severe cyclonic storms. As the intensity of the storm changes from deep depression to very severe cyclonic storm, the track error associated with the model simulation tends to decrease, which is attributed to the robustness of COSMO model in the identification of the location of the cyclonic storm in its well- established stage.

Conclusions: Results obtained from the study show good credential of COSMO model in the prediction of cyclonic storms over Indian Oceans.

Keywords: COSMO, Cyclonic storms, Track, Bay of Bengal, Arabian Sea

EARTH & PLANETARY SCIENCES-06 REG. No. 15664

A New Water Extraction Technique for Wetlands Using Sentinel 2 MSI Image

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Background: Wetland ecosystem sustains many endangered species of plants and animals and act as the source of livelihood of many people living around it. Hence it is highly essential to constantly monitor the wetland ecosystem. Recently remote sensing has been widely used to assess open water bodies with high level of accuracy. Various surface water extraction techniques have been developed from high resolution satellite images using single and multiple bands. However, most of the methods have been developed to extract surface water with urban land cover features. The main focus of this study is to formulate an index that can extract open water bodies in a wetland area.

Method: In this context a new advanced water index for wetlands (AWIW) has been proposed using green, red and near infrared bands of Sentinel 2 MSI image. The new index was tested for accuracy and robustness in Vembanad wetland ecosystem which is a Ramsar site. The proposed index was compared with most widely used water indices namely Modified Normalized Difference Water Index (MNDWI) and Normalized Difference Water Index (NDWI). The accuracy assessment of AWIW was performed using producer accuracy, user accuracy, overall accuracy and kappa coefficient.

Results: A higher overall accuracy and kappa coefficient of 0.99 and 0.98 respectively was obtained for AWIW. The results also showed that the proposed water index exhibits higher contrast value of 0.96 with vegetation background compared to MNDWI and NDWI.

Conclusion: The proposed water index can effectively separate water from vegetation which is highly dominant in the study area. Moreover, this index can be used for monitoring the extent and variability of wetlands.

Keywords: Water index, Remote sensing, Sentinel, Kappa coefficient, Wetland

EARTH & PLANETARY SCIENCES-07 REG. No. 15791

Geospatial Evaluation of Groundwater Conditions in a High-Land Local Body, Thrissur District, Kerala

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Background:, Understanding the groundwater conditions in a given area in terms of quantity, quality, distribution, temporal fluctuations, usage etc., are of much important to cater the increasing demand. This study deals with the groundwater conditions in Thekkumkara Grama Panchayath of Thrissur District, Kerala.

Method: All the available secondary data were collected, compiled and analysed. A detailed field work was carried out in the study area and 60 dug wells were observed for data collection. Survey of India Toposheets, satellite imageries, USGS DEM, ASTER DEM etc. were were integrated in Geographical Information System (GIS) for detailed analysis.

Results: The study area, is characterised by Charnokites and Migmatites of Precambrian age, covered by Laterites and Lateritic soil. 60 dug wells were observed in the study area and the depth of these wells range between 3.14 to 9.92 m below ground level. The density of dug wells in the study area can be estimated as 220 wells/sq.km. Groundwater estimation was performed and mapped potential zones for the study area using GIS.

Conclusions: The net annual groundwater availability in Thekkumkara Grama Panchayat is estimated as 8.69 MCM and the total annual groundwater draft for domestic as well as irrigation purposes is estimated at 1.87 MCM and can be categorized as "SAFE" for future groundwater development activities. Through integrated GIS analysis, it is estimated that about 36% of the study area comes under the very high to high category in terms of groundwater potential.

Keywords: Groundwater Estimation, Groundwater Potential, Geographical Information System

04
Earth & Planetary Sciences

Poster Presentation

EARTH & PLANETARY SCIENCES-08 REG. No. 15866

Spatiotemporal Variation of Atmospheric Water Vapour over Indian Monsoon Region Using Satellite data

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The study analyses the spatial and temporal distribution of Atmospheric water vapour over Indian monsoon region using Atmospheric Infrared Sounder (AIRS) data. Climatological distribution of water vapour from 2003 to 2020 for different layers are studied. The average amount of water vapour over the region is from 8 to 16 g/kg. Eighteen year anomaly clearly depicts an increasing trend over the region with highest amount of variation in the lower troposphere. Water vapour concentration is found to be well marked and higher in the lower troposphere from June to the beginning of August for the years 2016 and 2021. Even though the general spatial and temporal pattern remains persistent, the positive anomaly in water vapour after 2012 and its linkage with climate change has to be further verified using more observational and other remote sensing data.

EARTH & PLANETARY SCIENCES-09 REG. No. 15686

Variability of Ocean Features and the Frequent Occurrence of Tropical Cyclones Over the Arabian Sea

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Tropical cyclones are the most dangerous extreme weather events which have likely impact on the society. The North Indian Ocean including the Arabian Sea and the Bay of Bengal witnessed lot of cyclones in the recent decades. Even though the number of cyclones formed over the Arabian Sea basin is less when compared to the Bay of Bengal, recent studies indicate

thatthe Arabian Sea is encountering more cyclones than the past years and can expect the occurrence of more cyclones in the near future. This can have devastating effect over the west coast region of India as well as on the coastal communities. The current study is an effort to understand the variability of ocean features and how it promote and enhance the formation of cyclones over the Arabian Sea basin. While analysing the pre and post- monsoon cyclones occurred over the Arabian Sea, the highest number are in the post monsoon than in the pre- monsoon. Large scale variability is observed in the Ocean Heat Content anomaly (D700) over the Arabian Sea when observed over a period of 30 years (1990-2020). Recent Ocean heat content anomaly over the Arabian Sea is around 12.5 x 10^{18} J respectively, with a gradual rise from 2003-2016. Accumulated cyclone energy calculated for the last 30 years showed and increasing trend from the year 2011 when compared to the last two decades (1990-2000, 2000-2010). Large ocean heat content and accumulated cyclone energy over the Arabian Sea can provide warmer ocean conditions and enhance the strength of Tropical cyclones. The consistent occurrence of cyclones over the Arabian Sea basin in the recent years has to be further studied and understood in order to mitigate the catastrophic effect of changing weather over Indian region.

Keywords: Tropical cyclones, Ocean Heat Content, Accumulated cyclone energy, Arabian Sea

EARTH & PLANETARY SCIENCES-10 REG. No. 10777

Chemical Denudation of Mountainous Catchments in Southern Western Ghats

A case study using hydro chemical tools and modelling

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Background: The hydrochemistry of rivers is being regulated by complex interactions of physical, chemical and biological processes taking place in the catchments. A better understanding of these processes is essential to address problems related to erosion and fertility loss etc. of soil apron in

the river catchments that sustain the life support systems of the area. The present study focuses on the water cycle dynamics, chemical weathering and solute transport through two rivers (Thuthapuzha and Bhavani rivers) draining different climatic regimes across the southern Western Ghats.

Method: Hydrochemistry data of Bhavani and Thuthapuzha rivers were obtained from systematic river water sampling and in-situ/laboratory analysis. The samples are then filtered with 0.45 μm membrane filters and all of the samples were stored at 4 °C until analysis. The ^{2}H and ^{18}O isotopes of water samples were analyzed using Off-Axis Integrated Cavity Output Spectroscopy (OA-ICOS) laser absorption spectroscopy technique. The concentrations of major elements in the surface water samples were analysed using an inductively coupled plasma-mass spectrometry (ICP-MS) under standard operating conditions. The Multivariate statistical method has been used to study the factors controlling the distribution of surface water stable isotopes and also to establish the relation existing among the chemical parameters and river water samples. To quantify the silicate weathering rate, the chemical mass balance forward as well as inverse models were performed.

Results: Parameters like EC, TDS, major ions generally show low values during southwest monsoon (SWM) compared to pre-monsoon (PRM) and northeast monsoon (NEM) seasons. Hydrochemical analysis of the river waters show that the cationic and anionic concentrations in the water samples are Ca^{2+}> Na^{+}>Mg^{2+}>K^{+} and HCO_3^{-}>Cl^{-}>SO_4^{2-}, respectively. When compared to Thuthapuzha river basin (TRB), Bhavani River basin (BRB) shows an elevated level of ionic contents and hence a higher degree of rock-water interaction and chemical denudation. The concentrations of the major anions and cations showed low values in SWM season compared to PRM and NEM seasons. At the same time, the annual dissolved flux contribution and denudation rate was higher during the SWM season. Compared to BRB ($\delta^{2}H$ and $\delta^{18}O$ values are -25.04±8.37 ‰ and -4.77±1.24 ‰), TRB ($\delta^{2}H$ and $\delta^{18}O$ values are -14.03±7.95 ‰ and -3.16±1.10‰) is characterised by enrichment of heavier isotopes in its surface waters, presumably indicating the difference in the moisture source contributing river discharge.

Conclusions: The water vapor recycling effect is found to have profound effect in the stable isotope composition of these tropical rivers draining the Western Ghats. The hydro chemical studies reveals that precipitation and discharge are the controlling factors influencing the solute transport. The mass balance Forward and Inverse

modelling approaches and weathering index values suggests the kaolinite-smectite formation are taking place in the soil profile as a result of silicate weathering.

Keywords: Chemical weathering, Solute transport, Carbon dioxide consumption rate, Mass balance modelling.

EARTH & PLANETARY SCIENCES-11 REG. No. 15899

Observations of Radar Bright Band Features of Mesoscale Convective System by Using C-Band Polarimetric Doppler Weather Radar

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Background: Daily observations from the first Indian C-Band Polarimetric Doppler Weather Radar (DWR) installed at Thumba Equatorial Rocket Launching Station (TERLS) are subjected here for various weather surveillance studies. Prolonged appearance of Radar Bright Band (RBB) is associated with flash flooding and the same is experienced during recent Kerala flood events. So, RBB is a potential phenomenon for the nowcast of very heavy rain activities. RBB have importance in both Aerospace and Aviation meteorology. The present study explores the characteristics of RBB for the first time over the Thumba.

Method: Based on the Radar reflectivity profiles, RBB is identified and studied for a few cases. One of the typical case (7th September 2017) is presented in this paper. The evolution and decay of thunderstorm is analysed using radar reflectivity, differential reflectivity, etc.

Results: A well-defined RBB is observed during the presence of thunderstorm. The spatial representation of reflectivity corresponds to a radius circle of 60 km from the radar center revealed the RBB in the form of a ring with surroundings reflectivity values compared to surroundings. The RBB is characterized with high values of differential reflectivity and low values in correlation coefficient. The conglomerate of ice-water mixture with larger surface area is clearly evident from the observations.

Keywords: Radar Bright Band, C-band polarimetric Doppler Weather Radar, Thunderstorm and Reflectivity.

EARTH AND PLANETARY SCIENCES-12 REG. No. 15520

Paleo-Drainage Network Identification in Central Kerala Using Remote Sensing and Machine Learning

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The response of fluvial system to natural/ anthropogenic forcing is manifested by the channel morphology or migration. Studying the paleo- river channels may be useful in deciphering the interaction of earth system forcing and fluvial system response to it. Machine Learning methods in conjunction with Remote Sensing techniques have been used for detecting paleo-drainage systems over large areas using vegetation indices and image enhancement techniques of a multi-spectral and multi-temporal dataset. The Periyar- Chalakudy River system in the central Kerala is the largest river network in the region. Further, the ancient river channels in the mid-and -low lands of this river system act as conduits of flood waters during extreme weather events, mapping the paleo-channels have become a pre-requisite in hazard management. The present study was aimed to delineate the paleo-drainage network of the River basin using machine learning techniques, and further understand the response of the river channels to climatic and anthropogenic forcing. Landsat 5 data, spanning over 28 years were compiled and processed for identifying paleo-drainage systems using a Java Script code in the Google Earth Engine Platform. The study has allowed identification of several paleo-drainage networks associated with Periyar and Chalakkudy Rivers. Majority of the identified channels are presently occurs as misfit streams with wider valleys, implying their genesis to a distinct hydrologic and climatic condition than present.

Keywords: Paleo-channels, Multi-temporal data, Vegetation Indices, Google Earth Engine,

05

Engineering & Technology

Oral Presentation

ENGINEERING & TECHNOLOGY-01 REG. No. 10522

Technology Development and Adaptation of Geopolymer Concrete

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Background: From the first earth summit held in Stockholm (Sweden) in 1972 world tried to be on the path of sustainable development. But the from the 3rd summit in 1992 at Rio de Janeiro, Brazil, the global warming and environmental issues thereof is a hot issue that is gaining momentum. To address this; meet came with Agenda 21,which is a non-binding action plan of the United Nations with regard to sustainable development originally targeted to achieve when the world enters 21st century in the year 2000. The 5th and the latest meet Rio+20 held at Rio realised the reality that countries are far away in achieving this agenda. None of the major participant countries were ready to accept the responsibility or willing to take any remedial measure. Whoever may be culprit the effect is global. The rich and the poor have to face the brunt of the impact. The major component (about 65%) among the Greenhouse gases is carbon dioxide and about 7% of this is contributed from cement industry. But the irony is that cement is inevitable binder for any development activity. It is a fact that concrete is only next to water in percapita (one tone percapita per annum) consumption. Another problem with cement is that it is highly energy intensive (4.5MJ/kg). It is in this context the search for an alternate greener construction binder with lower carbon dioxide emission ECO_2e and embodied energy (EE) began. Though the search is multi prong, it is converging to alkali activated inorganic polymer binder popularly known as Geopolymer. It is derived from alumina silicate industrial waste materials like Fly ash, GGBS etc. activated by alkaline solution. Even though many patents have been granted world over for such a binder, the commercial use on par with cement has not yet begun due to many inherent problems. In this paper we discuss how this wonderful material can be adapted at par with cement.

Method: The major hurdles in adapting Geopolymer concrete for

field application are difficulty in handling highly corrosive sodium hydroxide in alkali activator, need for heat curing (when fly ash alone is used), difficulty in slump retention & maintaining consistency and need for technical competency at field level. These hurdles can be overcome by using a proper combination fly ash and GGBS in conjunction with sodium silicate as activator solution. Using proper dosage of micro silica or proper admixtures and controlling water content we can improve the rheology characteristics. For cubic meter of concrete the desirable alumina-silicate material (Fly ash + GGBS) quantity required is 400 kg for 1:1.5:3 mix (M50-M60), 300 kg for 1:2:4 mix (M40 to M50), 200kg for 1:3:6 mix (M30 to M40) and 150 kg for 1:2:4 mix (M20 to M30). All ratios are by weight. Sodium silicate activator solution required is @ 50% binder powder and water to Geopolymer solids ratio @ 0.30. The coarse aggregate content requirement is 1200kg (12mm or 6mm or both) and fine aggregate @ of 600 kg. Ambient temperature curing in the range of 25 to 32 degree Celsius is sufficient when GGBS is added.

Results: Normal strength concrete of M20 grade to high strength concrete of grade M50 grade can be made by suitably blending GGBS and Fly ash; activated with sodium silicate. The proportion of fly ash can be 50 to 75% of binder powder and remaining part GGBS for normal strength concrete. Fly ash content shall be 25% to NIL (ie GGBS alone) and remaining part GGBS for high strength concrete.

Conclusion: Alkali activated binder materials could be made economical and cheaper than Portland cement but need special care and attention. The field staff need to be trained properly to sort out all the issues. It can lead to green construction techniques with low embodied carbon dioxide emission (ECO_2e) and embodied energy (EE).

Key words: Alkali activated concrete, Geopolymer, Geopolymer concrete, High performance concrete, Inorganic polymer binder, Cement substitutes.

ENGINEERING & TECHNOLOGY-02 REG. No. 13981

Instantaneous Autonomous Self-Healing in Ionic Liquid Modified Bio-Epoxy Resin

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Background: Self-healing in polymers play a pivotal role in reducing the carbon from waste disposal of structural failures. Self-healing can extend the life of polymeric materials from the damage due to failures. Among the numerous techniques towards self-healing, supramolecular interactions such as hydrogen bonding, ionic bonding, metal coordination bonding, van der Waals forces, pi–pi interactions and electrostatic effects are important due to their stable and reversible bonding compared to other stronger covalent bonds.

Method: In our study, we report the self-healing with ionic bonding in bio-based epoxy resin using 1-Butyl-3-methylimidazolium chloride ($[BMIL]^+[Cl]^-$) ionic liquid (IL). The modified bio-epoxy resin forms ionic association and exhibits reversible ionic interaction between the hydroxyl groups of epoxy resin and ionic groups in IL.

Results: In order to study the self-healing efficiency of the epoxy/IL blends, the tensile measurements and nanoindentation healing tests were conducted. The self-healing efficiency were calculated with the aid of mechanical tests. It is observed that approximately 50% of their mechanical properties are retained after self-healing. Furthermore, scratch repairing studies were conducted by making a nano-indentation mark on the blends and the required time to undergo autonomous self-healing were also measured. It was found the self-healing of epoxy/IL blends were initiated immediately (< 3sec) after the nanoindentation.

Conclusion: The modified bio-epoxy system showed excellent self-healing capabilities with good level of transparency. The samples were able to show superior self-healing ability under nanoindentation test. The prepared blend on ionic liquid is prom-

ising candidate in application areas such as flexible electronics and flexible coatings for indoor applications.

Keywords: Ionic liquid, epoxy resin, self-healing, nanoindentation and mechanical tests.

ENGINEERING & TECHNOLOGY-03 REG. No. 15355

Climate Change Impact Assessment on Stream Flow Over Vamanapuram River Basin

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Land use changes makes a significant impact on major components of hydrologic cycle such as precipitation, evapotranspiration, infiltration and runoff, which may leads to disasters like extreme flood and drought. In this study, we analyzed the stream flow changes over the decades due to change in landuse for a particular climate. SWAT model has been developed to simulate rainfall-runoff for the Vamanapuram river basin. The basin was divided into 12 sub-basins using an automated delineation routine with Cartosat DEM as input. The model was run with a fixed climate data of 35 years including 2 years of warm up period .SWAT-CUP was used to calibrate and validated the model using 1990 LU/LC. The SWAT model has been calibrated using monthly data of 20 years for two different land uses (1990, 2000) with observations from the Ayilam gauging station. The model with 1990 land use is calibrated for 10 years (1986-1995) and validated for 4 years (1996-1999). Similarly model developed using landuse map of the year 2000 is calibrated for another 10 years (2000-2009) and validated for 3 years (2010-2012). The models yielded satisfactory and reliable results with coefficient of determination and Nash-Sutcliffe Efficiency 0.73&0.72, 0.81 & 0.8 for calibration and 0.71 & 0.69, 0.73 & 0.76, respectively for validation of two models. The two models show a similar set of fitted parameters. The model again run with different land uses which is prepared using Landsat imageries with corresponding GCM climate and analyzedthe average annual change in steam flow over the decades.In the real situation, LU/LC and climate change occur simultaneously and the impact of both these

factors affected in the streamflow. To carry out analysis of both LU/LC and climatechange, we setup four different scenarios: near – baseline, mid – baseline and far – baseline. The change in surface runoff from baseline condition to future for RCP 4.5 and 8.5 at sub-basin scale are analyzed. The decreased precipitation along with rise in temperature contributes a decreased stream flow over the basin in future conditions. The land use classes like Built-up, plantation are increased, whereas forest and agriculture decreased. There is reasonable increase in stream flow observed between the years which was due to deforestation and urban growth

Keywords: SWAT; SWAT_ CUP; Landuse/landcover change, hydrological modelling

ENGINEERING & TECHNOLOGY-04 REG. No. 15558

Transient Analysis and the Risk in A Pumping Main

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Background: Hydraulic transients are inevitable in a hydraulic system and is the main cause of troubles and failure of the system. Hydraulic transients are initiated by abrupt flow changes because of pump trip, sudden valve closure etc; which are very common in a pumping main, and are fuelled by pipe alignment, pipe material and malfunctioning of existing hydraulic components in the system. Pressure hikes associated with transient flow cause damages to the pump and components, breaks the seals, and ruptures the pipe. Transient flow also induces water quality problems such as re-suspension of settled particles, detachment of biofilm and entry of pathogens into the system. The present study is focussed on a Raw Water Pumping Main (RWPM), consisting of a combination of rigid and viscoelastic pipes with 1 non-return valve, 52 air valves and 2 zero velocity valves, which is experiencing frequent pipe bursts causing total interruption in water supply system because of pump trip.

Method: Analysing the performance of the system under transient flow helps to identify the suitable surge protection devices, its size and location. A trial-and-error procedure is employed to understand the behaviour of the system during transient flow with single/combination of surge protection devices by using Pipe 2000 software. The procedure is repeated with different types and number of surge protection devices at various locations till the system is found to be safe.

Results: The transient analysis of the RWPM under various operating conditions helped to understand the behaviour of the system. The performance of the system under different types of surge protection devices can be sensed out by transient analysis, which helps to identify suitable surge protection devices, optimize its number and check the suitability of its location.

Conclusion: The hydraulic analysis of this system points out that the location of air valves has a significant effect on the transient pressures developed within the system. The effect of a surge protection device in a pumping main needs to be studied thoroughly to check its suitability for that system, to design the device and to determine its suitable location. Transient analysis needs to be carried out for large hydraulic systems - to understand the complex behaviour of the system under various operating conditions that are likely to occur several times during its design period so as to reduce the risk of failure of the system.

Keywords: Hydraulic modelling, Hydraulic transients, Air valve, Pipe 2000, Wave Characteristics Method.

ENGINEERING & TECHNOLOGY-05 REG. No. 15659

Real-Time Monitoring of Curing Process of Fast Drying Epoxy Resin Using Dynamic Laser Speckle Imaging

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Background: Dynamic laser speckle imaging is used for analyzing the fluctuations in intensities that scattered from turbid media. This work presents the application of dynamic laser speckle imaging for real time monitoring of curing process of an epoxy adhesive. Proper monitoring

of the curing phenomenon helps to improve the efficiency and quality of cure processing materials. Dynamic laser speckle imaging does not disturb the curing process while monitoring the process.

Method: An optical arrangement was set-up for generating the dynamic speckle images. The images were then analyzed using numerical methods such as Intensity Structure Function and Time History of Speckle images.

Results: A thin layer of the resin-hardener mix was applied on the surface of an Indian coin. Sequential speckle images were captured for monitoring the curing process of the epoxy mix. THSP, Co-occurrence matrices and ISF results the expected output.

Conclusions: Dynamic laser speckle technique is a real-time and non-destructive imaging technique with high spatio-temporal resolution. We could able to use dynamic laser speckle imaging efficiently for monitoring the curing phenomenon of epoxy adhesive.

Keywords: Dynamic laser speckle imaging, epoxy adhesive, curing process, Intensity Structure Function.

ENGINEERING & TECHNOLOGY-06 REG. No. 15662

Traffic Operation Plan for Erode City

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Erode district, situated in the north western part, is one of the industrialized districts in Tamil Nadu. Erode city, the headquarters of Erode district, has seen rapid urbanization in the aftermath of its economic growth which led to the formation of Erode City Municipal Corporation (ECMC) by merging neighboring municipalities and Panchayat into its jurisdiction. Erode Municipal Corporation extends between 10.36″ and 11.58″ North Latitude and between 76.49″ and 77.58″ East Longitude with an area of 109.52 sq.km. Erode is strategically situated between Coimbatore and Salem and is famous for its agricultural and industrial resources like turmeric and textile. This makes Erode and part of the Industrial corridor. Hence, the vehicles bypassing the city have also led to heavy traffic congestion and generated a need for solutions to decongest the city centre.

Reconnaissance surveys were conducted to understand the existing site situation and decide on the detailed surveys to be done. Stakeholder meeting and secondary data collection were done to analyse the previous situations and schemes. Traffic volume, parking, pedestrian, origin and destination, speed and delay are few of the traffic surveys which were used to analyse the key performance indicators of various roads in Erode Municipal Corporation. Road Inventory survey was conducted to find out the major road characteristics. The above data collected was analysed to conclude on the results and form feasible proposals in order to reduce the traffic congestion within the city centre.

Conceptual junction improvement schemes, pedestrian facilities, scheme for signs and markings for major roads within CBD areas and traffic circulation plan for goods, road widening, flyover/underpass constructions and development of bus terminals, shifting of activities from the city centre are few proposals planned for the city.

Keywords: Traffic operation plan, traffic surveys, capacity utilization, road widening, proposals

ENGINEERING & TECHNOLOGY-07 REG. No. 15848

Development of Mobility in Attingal Town

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Development of a country brings economic changes which initiates urbanization. Urbanization and rapid growth of the city made us to think about the effective urban planning. Urban planning has to be done at various hierarchies to integrate a large region with a small area so that the development can be done at a same pace. Urban planning involves various planning and development of sectors one such is Transport Infrastructure planning and development. The reform of urban mobility systems is one of the biggest challenges confronting policymakers, stakeholders and users today and to do it justice the study required a commensurately ambitious approach. This research looks into the development plan of Attingal, a town in Kerala, India. The passenger and freight traffic characteristics have been analysed based on extensive investigations of the Attingal

Muncipal area and collection of secondary data from various sources in the region. Furthermore, traffic on important roadways has been projected for various horizon periods, taking into account the research area's growth potential. A long-term Transportation Development Plan for the municipality has been developed based on traffic projections.

Key words: Urban Mobility, Passenger and Freight Characteristics

ENGINEERING & TECHNOLOGY-08 REG. No. 15879

Planning for Resilient Transport Infrastructure in a Disaster-Prone Area – A Case Study of Munnar Region

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Background: Kerala is a state highly vulnerable to natural disasters and the changing climatic dynamics given its location along the sea coast and with a steep gradient along the slopes of the Western Ghats. Kerala is also one of the most densely populated Indian states (859 persons per square kilometers) which make it even more vulnerable to damages and losses on account of disasters. Landslides a new reality for Kerala and the state has to evolve long term strategies to address the threat. Landslides are a major hazard along the Western Ghats in Wayanad, Kozhikode, Idukki and Kottayam districts. Hence the relevance of this paper paying adequate attention to study these landslides and risk and vulnerability assessment using the various tools of field surveying, remote sensing and GIS techniques.

Method: This work explores to create detailed landslide vulnerability and landslide risk (LR) maps of the Munnar region in Idukki district of Kerala by applying Geographic Information Systems (GIS) and Multi-Criteria Decision Analysis as the tools. Adopting the analytic hierarchy process (AHP) for a weighted linear combination (WLC) approach, eleven evaluation parameters were selected and risk and vulnerability assessment was carried out.

Results: Landslide Risk assessment map of the Munnar region is developed. The results were validated based on field verification and land slide prone maps obtained from Kerala State Disaster Management Authority. The length of road network and ward wise area of region under different risk levels are also identified based on analysis and demarcated in GIS platform.

Conclusion: This work establishes the use of Geographical Information System and MCDA approach for the determination vulnerability analysis and risk assessment of a region by considering the physical, environmental, social and economic factors of the area. The findings of the study could help in evolving recommendations for planning a resilient transport infrastructure for the region.

Keywords: GIS-Based Analysis, Risk Mapping, Hazard, Vulnerability

ENGINEERING & TECHNOLOGY-09 REG. No. 15906

Traffic Prediction Modelling for Major Highways in Kerala

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Background: Traffic prediction is necessary to explain the possible needs of future and provide standards for proper design and operation of the transportation system. The pattern of traffic growth and projected traffic volumes are important factors in the analysis of highway projects. The traffic growth factor has a major effect on highway investment decisions, such as whether to increase the capacity of existing highways and the construction of new facilities especially when funds are limited. The existing traffic prediction models have certain limitations, it is either underestimated or overestimated and does not meet the actual infrastructure needs. The scope of this project is limited to major highways of Kerala.

Method: In this paper, an attempt is made to develop traffic prediction models for highways in Kerala using socio economic data, traffic volume counts and fuel data as variables. The performance of K nearest neighbor regression, support vector regression and random forest regression were

compared. The obtained results were compared with the existing IRC method which is transport demand elasticity model.

Results: Regression results shows that random forest regression performs better than the other methods. The R square value obtained for K nearest neighbor regression, support vector regression and random forest are 0.68,0.32 and 0.97 respectively. The predictive performance of transport demand elasticity method was also low with R^2 value 0. 433.

Conclusions: This paper establishes the use of machine learning techniques for traffic prediction. The results of the paper indicate that the random forest regression model is the best option for predicting traffic for major highways in Kerala.

Keywords: K nearest neighbor regression, Random Forest regression, Support vector regression, Traffic prediction model etc.

ENGINEERING & TECHNOLOGY-10 REG. No. 15931

GetMap App – A GIS Based Android Application for Road Data Collection

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Background: Field staffs like survey agents need to collect various data during their tasks. While paper forms are fine for text, other data like coordinates and important points cannot be collected and stored effectively without an organized data system. An attempt has been made in the present study to solve this problem by developing a Geographic Information System (GIS) based user friendly android mobile application for real time field data collection.

Method: An android based application named GetMap is developed using the software Android Studio to install at the user side for recording the travel path of the user along with road inventory and cross sectional details. Location driver in the smartphone allows the app to publish updates to the device's physical location through the Android location services. The app automatically checks the user location from time to time, and plots the results on a real-time OSM maps using the

android library Osmdroid. The app also provides a method to record points in the travel path while they are travelling.

Results: Public users can download and install the app in their smartphones. While opening the app for the first time it prompts the user to give permissions to access location services and storage of the phone. The app mainly consists of two screens – Welcome Screen and Map Screen. After the Welcome Screen the app automatically loads the map of current location of the user in the Map Screen. Current project name, track name, speed, distance travelled and the number of satellites available are displayed on the Map Screen. The four major functions that can be performed using the GetMap app are Record Track, Add Road Inventory Details, Record Road Cross Sectional Data and Add Points to the Map.

Conclusions: Road survey related data can be simply collected using the GetMap app. Data in form of point and line features are stored as KML files, which can be directly open in Google Earth software, further this data can be opened in any GIS software by applying appropriate conversions. The app will be useful for the field data collection activities of all the agencies related to the road survey.

Keywords: Android Application, Field Data Collection, GIS, Record Travel Path

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Calibration of HDM-4 Distress Models for a National Highway

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Road transportation has significantly increased over the years improving connectivity between cities, towns and villages in the country. Timely maintenance of pavements is an essential requirement for the efficiency of any road network. The requirements for pavement maintenance and repair are continuously increasing, but the resources and funds are limited. Pavement management systems are therefore increasingly being used world-wide to assist the highway administration in making well-coordinated and systematic decisions regarding all activities related to pavement construction and maintenance. The World Bank developed Highway Development and Management Model (HDM-4) is an internationally recognized tool available for making timely and cost-effective maintenance management decisions for road networks. The pavement deterioration models included in HDM-4 are developed from the results of a large number of field experiments conducted in several parts of the world. The calibration of the models is necessary to improve the accuracy of pavement performance predictions. This paper explains the calibration of the HDM-4 Distress models for Roughness progression, Cracking progression, Ravelling progression and Pothole progression for a National Highway Network of Thrissur, Kerala, India. It is expected that the results of the study shall be useful for developing pavement maintenance management strategies for pavement networks with similar compositions, climatic conditions, and traffic characteristics.

Keywords: Pavement Management System, Maintenance, HDM-4, Distress, Calibration.

05

Engineering & Technology

Poster Presentation

ENGINEERING & TECHNOLOGY-12 REG. No. 10401

Prediction of Water Quality in the Upper Stretch of Pamba River Using Water Quality Model

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Pamba River, which is one of the main rivers in Kerala state is selected for this study. Conventional Water quality model was applied to the upper stretch of the river where pollution is high during the famous Sabarimala pilgrim season. One dimensional steady state model was applied to predict the effect of a polluted stream joining the main river in the upper reaches of Pamba river. BOD, NH_3-N, Nitrite, Nitrate, Organic Phosphorus parameters were predicted for the upper stretch of the river. BOD reaction rate constant was computed by using the method of moments. The predicted values by the model showed that the waste load coming from the polluted stream was found to have minimal effect on the last station. Field monitored values and predicted values were showing same trend along the river.

Keywords: Pamba River, pollution, water quality model

ENGINEERING & TECHNOLOGY-13 REG. No. 15496

Effect of Thermal Pre-Treatment On Biogas Yield and Pathogen Removal During Anaerobic Digestion of STP Secondary Sludge

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Background: The management of large quantity of secondary sludge (biosolid) is a major practical problem during sewage treatment plant (STPs) operation. The direct disposal of STP secondary sludge is not advisable, since it contains pathogenic micro-organisms, pharmaceutical residues, toxic chemicals, metals etc. Landfilling, incineration, thermal drying, composting and anaerobic digestion are commonly practiced for managing STP secondary sludge. Among this anaerobic digestion is considered as a better option due to its energy recovery potential, less operational cost, and formation of more stabilized final product. However, anaerobic digestion of biosolid reported less biogas yield, and different pre-treatment methods are reported for enhancing the biogas yield. Therefore, this study focuses on the effect of thermal pre-treatment on biogas yield as well as pathogen load present in the sludge during anaerobic digestion.

Methods: Secondary sludge, collected from a working STP was used for this study. Secondary sludge was exposed to different temperatures 60 to 90 °C, for 30 to 90 minutes. After the heat treatment, bio-methanation potential (BMP) of the heat-treated sludge was tested. Change in soluble COD (SCOD), change in bacterial pathogenic load during thermal pre-treatment and bio-methanation were also monitored. The results were compared with control and the data was statistically analysed.

Results: Anaerobic digestion of secondary sludge without any pre-treatment produced 27 ml biogas/g VS of secondary sludge. Compared with untreated sample, a significant increase in biogas yield was observed during thermal treatment (table). A substantial increase in soluble COD (5 to 18 folds, 700 to 1854 mg/l) was observed at 70, 80 and 90 °C pre-treatment than the untreated sample, that reflected in higher biogas yield. The tested temperature and time interval was not very effective to disinfect prominent pathogens present in the sludge.

Table: Biogas production at different temperatures and time periods.

Treatment method	No Pre-treatment	Pre-treatment at 90°C		Pre-treatment at 80°C		
		30min	60 min	30min	60 min	90 min
Biogas production (ml/g VS of SS)	27	111	147	90	93	96

Conclusion: The present study indicated an increase in biogas yield (up to 5 times) during anaerobic digestion of thermally pre-treated STP secondary sludge. Meanwhile, still higher temperature and exposure time may be required for the pasteurization of the sludge for removing pathogens.

Keywords: STP secondary sludge, Bio-methanation, Anaerobic digestion, Biogas

ENGINEERING & TECHNOLOGY-14 REG. No. 15589

A Modular Onsite Waste Water Treatment System for High Strength Greywater

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Background : The management of high strength greywater from small hotels, restaurants, catering units, canteens, etc. in cities without sewerage network is a major challenge. The disposal of untreated wastewater from these establishments adversely affects the water environment, and public health. Moreover, the direct discharge of these wastewater is a major cause of urban river and canals eutrophication. The existing treatment methods such as MBBR, SBR, MBR or DEWATS have inherent limitations such as high installation and operation cost, frequent sludge disposal, space requirement, etc. Moreover, these systems are designed mostly for sewage (COD ~500 mg/L) treatment, and cannot handle high strength greywater (COD >1000 mg/L). Therefore, there is an existing gap in this area for a treatment system for high strength wastewater. In this context, this study focuses on the development of a modular system for onsite treatment of high strength greywater, and recovering valuable resources such as reuse quality water and bioenergy.

Methods : The present system consisted of an integrated anaerobic and aerobic microbial processes unit, with an additional sludge handling module. The studies were conducted with a pilot scale (2 KLD) treatment unit, and actual wastewater from a departmental canteen (COD >1200 mg/L) was used for the treatment study. The organics (COD and BOD), nutrients (N and P), and pathogens were removed to discharge standard level. Detailed analysis of the inlet wastewater, anaerobically treated and final discharge was done as per APHA methods. A fixed film type bioreactor was adopted for the anaerobic treatment, whereas a suspended growth system was used in the aerobic treatment unit. Cyclic oxic-anoxic condition was maintained for removing nutrients in the wastewater. An electro-mechanical system was used for maintaining a stable active biomass (MLSS) within the aerobic treatment unit. The treated water produced was collected for external application, and biogas recovered can be used for heating.

Results: The characteristics of grey water sample used in the study were fluctuating and the range of COD, BOD, TKN and TP were 700 to 2500 mg/L, 300 to 500 mg/L, 80 to 200 mg/L and 5 to 16 mg/L respectively. The suspended solid was in the range 350 to 500 mg/L. The pilot scale modular treatment unit was operated continuously for 12 months treating the high strength grey water. Around 70 to 80% of the inlet COD was removed in the anaerobic module, and recovered as biogas (300 to 400 L/day). The residual COD and nutrients were removed in the aerobic module. The MLSS and DO in the aerobic module were around 2500 mg/L and 2.5 mg/L respectively. The sludge handling module could effectively maintain the MLSS level. A highly stable microbial system was observed in both anaerobic and aerobic modules, more specifically higher trophic communities indicating a stable microbial system. The present treatment system could remove COD (96%), BOD (99%), TN (100%) and TP (100%) well within the existing guidelines (NGT) for discharge water that can be reused.

Conclusion: The present system found to be suitable for treating high strength grey water from small hotels, restaurants, canteens, and agro-based MSMEs, etc. Compared with existing technologies the present system has many advantages like less foot print, less installation and operational cost, it recovers both reuse quality water and bioenergy, and free from frequent secondary sludge disposal.

ENGINEERING & TECHNOLOGY-15 REG. No. 15727

Cryogenic Chilldown Experimentation Through Coated Transfer Lines

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Background: Reduction in the chill downtime is an essential criteria for effective and efficient cryogen transport as it'll lead to minimal cryogen consumption and thereby saving energy. In this work, cryogenic chilldown trials were conducted on 150 mm long vertical stainless steel pipe (9.5 mm ID,1.5 mm wall thickness). Liquid nitrogen as the working fluid at different mass flux conditions and Polyurethane coatings belonging to the family of Teflon have been used as coating material. The performance of the regular stainless steel tubes and one with a coating at corresponding pressures were compared. The results indicated that an increase in heat flux and reduction in the chill downtime can be attained by interposing an insulating coating between the boiling liquid and the surface across which the heat is to be transferred.

Method: Two test sections were used for the experiment, first the normal stainless steel pipe with internal diameter 9.5 mm and length 150 mm and second the stainless steel pipe with its interior coated with a low thermal conductive polyurethane coating (thickness of PU coating is 0.1 mm). Thermocouples are attached to the test section at four different sections at 30 mm, 60 mm, 90 mm and 120 mm from the inlet of the test section. At each point three thermocouples are attached at 120° apart. The heat in-leak to the test section was minimized using a thick layer of polyurethane foam insulation (thermal conductivity of 0.02 W/m K, density of 11 kg/m3) which is a type of expanded foam insulation. Test section was also covered by yarn and then by Nitrile rubber insulation. Temperature measurement of the test section was done using T-type thermocouples connected to Keysight 34972A data acquisition / data logger switch unit with scan frequency of 30 milliseconds which was also connected to the personal computer for data analysis. The average mass flux was measured using a Single phase volume flow meter having an accuracy of 0.05 mm3/s at the exit line from the test section. To ensure single phase gas flow entering

the flow meter, the outlet line is placed in hot water bath heated by electric heaters. Pressure gauge is provided for measuring and regulating initial pressure. Different flow control valves are provided to control the flow.

Results: The experiment was conducted for three different flow rates of 66 kg/ m2s, 86 kg/ m2s and 102 kg/ m2s. The time temperature plot for various mass fluxes are analyzed. The results presumed that a considerable reduction in chilldown time can be obtained by providing a coating of low conductivity on the inner walls of the conducting tubes. For a mass flow rate of 86 kg/ m2s, the maximum heat flux of 35000 W/m2K is obtained for coated tube and the corresponding value for uncoated tube is 11000 W/ m2K. Also it can be inferred that the coated tube attains maximum heat flux earlier than the uncoated tube. For a mass flow rate of 102 kg/ m2s, the maximum heat flux of 22500 W/ m2K is obtained for coated section. Maximum heat flux of 8500 W/m2K is obtained for uncoated section. Also it can be inferred that the coated tube attains maximum heat flux earlier than the uncoated tube.

Conclusions: The addition of a low thermal conductivity coating will drop chill downtime. The time reduction is found to be over 50 in all the trials conducted for three different pressure conditions. The coated test section has a lower chill downtime for different mass inflow rates. The smallest chill downtime attained is 397 seconds corresponding to 10 psi force pressure. The use of coatings with low thermal conductivity on the heat transfer surface permits us to gain film boiling extremity at lesser temperature drops and its transfer to transition boiling with further effective heat transfer. In coated transfer line, the film boiling region attained is short as compared to the uncoated transfer line.

Keywords: Chilldown, Cryogenics, Heat flux, Liquid nitrogen

ENGINEERING & TECHNOLOGY-16 REG. No. 15760

Parametric Sensitivity Studies in a SSR FCC Unit

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Background: Fluid Catalytic Cracking (FCC) is a process for converting low value heavier hydrocarbons (Vacuum Gas Oil, Heavy Coker Gas Oil) into

high value lighter products such as Gasoline, LPG, Propylene, Naphtha etc. FCC has a significant role in improving the annual profits based on the market demands. The performance of the FCC units plays a major role on the overall economics of refinery plants. Any improvement in operation or control of FCC units will result in dramatic economic benefits.

Method: In this study, a steady state simulation for SSR Fluid Catalytic Cracking Unit was done using Aspen HYSYS software. In Aspen HYSYS, Fluid Catalytic Cracking Unit is modelled as a 21-lump kinetic model.

Results: The steady state simulation of a Single Stage Riser(SSR) Fluid Catalytic Cracking Unit (FCCU) is presented. The closed loop performance of the unit is evaluated for a conventional control scheme proposed earlier for FCCU operating under complete combustion mode. By varying the key input parameters of the process, the performance of the unit under both open and closed loop operations is evaluated. It is found that the reactor section strongly influences the regenerator but not vice versa. Under closed loop operation, the feed oil temperature or the oxygen concentration in the flue gas needs to be adjusted to restore the yield of Naphtha.

Conclusions: The steady state simulation of a SSR FCC Unit was carried-out in Aspen HYSYS and the impact of key input parameters on the performance was systematically evaluated. Under open loop operation, the effect of catalyst circulation rate (F_C) and regenerator inlet air flow rate (F_A) on the performance were plotted in terms of conversion, product yields and other key output parameters. The steady state closed loop performance of FCC unit was evaluated by varying the key input parameters while fixing the oxygen mol % in the flue gas (x_{oxygen}) and reactor plenum temperature (T_R) both individually and combined. The interaction of regenerator and reactor is one way as reactor performance strongly influences the regenerator and not vice versa. At fixed x_{oxygen} and T_R, the conversion and Naphtha yield decreased for an increase in the feed flow rate and vice versa. The Naphtha yield and conversion can be restored by decreasing the feed oil inlet temperature (T_A) or by decreasing the x_{oxygen}.

Keywords: Aspen HYSYS, Fluid Catalytic Cracking Unit, 21-lump kinetic model

ENGINEERING & TECHNOLOGY-17 REG. No. 15801

A Study on Strength Behavior of Red Soil Stabilized with Different Additives

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Day by day a huge quantity of waste materials are been generated and their safe disposal is a major concern world-wide. Therefore, utilization of these waste materials for the stabilization of soils may helps in enhancing the engineering properties of weak soil as well solve the problem of waste disposal. This paper focuses on the stabilization of red soil with saw dust ash and lime for highway construction purpose. The soil was stabilized with different percentages of saw dust ash (SDA) and the effect of different dosages of lime on optimum SDA-soil mix was studied. Different laboratory test were conducted to study its strength characteristics. The results obtained from different tests indicated that the addition of SDA has shown better improvement on the soil property and CBR values were within the limits recommended by the asphalt institute for highway sub base and sub grade. Thus the effective utilization of SDA could yield better strength on soil, thereby increasing its geotechnical properties as well as provides an alternate solution for the disposal of waste materials.

Keyword: Saw dust ash, CBR, Lime, UCS

ENGINEERING & TECHNOLOGY-18 REG. No. 15810

Polydimethylsiloxane/Conducting Polymer Composites for Triboelectric Applications

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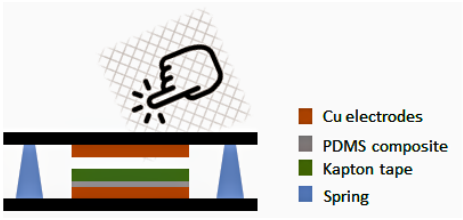
Triboelectric nanogenerators(TENG) is an emerging energy harvesting technique that converts small mechanical vibrations into electricity by the combined effect of contact electrification and electrostatic induction. A triboelectric nanogenerator can be fabricated by sandwiching a triboelectric material between two electrodes. The incorporation of positive triboelectric materials can enhance the efficiency of a negative triboelectric material.

This work focuses on the synthesis, fabrication, and triboproperty evaluation of Polydimethyl siloxane(PDMS)/ Polyaniline(PANI) and Polydimethylsiloxane/Poly(o-anisidine) (POA) composites. The CSA doped conducting polymers were prepared by oxidative chemical polymerization and were characterized using FTIR and UV analysis. The PDMS/conducting polymer composites were prepared by ultrasonication-assisted mixing followed by room temperature curing of the material using tetraethylorthosilane as curing agent and Dibutyl tin dilaurate as an accelerator in the ratio 100:10:1. A triboelectric nanogenerator of 2cm* 2cm frictional area was fabricated by sandwiching the developed composites between two copper electrodes attached to a substrate separated by rubber springs. A maximum short circuit current of 23 μA and an open circuit voltage of 141 V were observed for PDMS/POA(4wt%) composite on finger tapping While PDMS/PANI(5wt%) composite exhibited short circuit current of 17 μA and an open circuit voltage of 113 V, which are higher than the open-circuit voltage (70 V) and short circuit current (2 μA) of bare PDMS. The enhanced output of the composites can be attributed to the increased dielectric property of the materials due to the formation of micro capacitors. The

TENG with a frictional area of 2cm * 2cm is able to light up 120 blue LEDs simultaneously, making it useful for real-life applications.



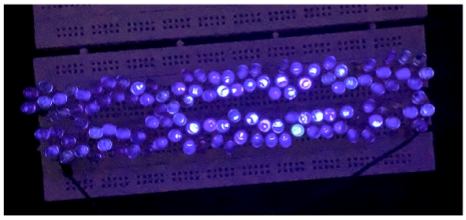


Figure. Schematic representation of the TENG and blue LED arrays lighted by TENG

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Thermal Performance Investigation on Corrugated Plate Heat Exchangers

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Background: Compact heat exchangers have become an essential necessity for power production and other purposes on a daily basis. The corrugated plate exchangers (CPHE) are well known for their high thermal performance. The overall tests have been conducted on CPHEs for two symmetric chevron angles (β) of 50o/50o , 60o/60o and 70o/70o . Data are obtained for steady state, single phase (water-water), counter arrangements, and for Reynolds number (Re) ranges from 500 to 2500, sophisticated mesh technique have been adopted to develop the mesh for the plates and the fluid between the plates. An appropriate grid refinement test has been carried out for the accuracy of the numerical results. The result has been validated through numerical data. A realizable k – ε turbulence model with scalable wall treatment found to provide the most consistent and accurate prediction of the thermal performance of CPHE. The numerical result showed that the effectiveness of the CPHE 50o/50o is higher than both 60o/60o and 70o/70o but the CPHE 70o/70o shows higher Nusselt value than other two.

Method: The present study introduces a new modification in CPHE flow mechanism as described in the following section, which could enhance convective heat transfer

significantly between the cold and the hot fluids, and consequently the fuel consumption can be reduced [19]. The numerical thermohydraulic performance tests carried out on counter-current flow arrangement, for two symmetric β = 30o/30o, and 60o/60o. Nu is employed as an indicator for heat transfer improvement, and CPHE effectiveness (E) is employed to compare the thermal performance between the basic and the new CPHE design. The CPHE comprised of four channels (five plates), two of them are pertaining to the cold side, which represent the utility fluid, and the other two pertaining to the hot side, which represent the product fluid. Therefore, the present study is performed on the hot side of CPHE. The corrugations shape have been considered for all cases in order to get as closer as possible to simulate thermal-hydraulic performance in real CPHE.

Results: The CFD results showed that,the thermal performance of the CPHE β 50o/50o is significantly higher than that of CPHE β 60o/60o and β 70o/70o. For the CPHE β 70o/70o, the calculated Nu is 22% higher where as CPHE β 60o/60o is 10% higher than that of CPHE β 50o/50o. The effectiveness for the CPHE β 50o/50o is 4% and 9% higher than that of CPHE β 60o/60o and β 70o/70o respectively.

Conclusions: This study would increase the understanding of the thermal behavior of the CPHE at higher turbulency conditions. The finding of the present study suggests that the use of CPHE β 50o/50o is more applicable and efficient in industries especially in industries where a high heat recovery is needed. Further studies can be done on the present study by either changing the geometrical dimensions of the CPHE or changing other factors in order to get maximum efficiency for heat exchangers.

Keywords: Corrugated plate heat exchanger, Thermal performance, Nusselt number, Chevron, Computational fluid dynamics.

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Terrain Adaptive Position Changing E-Bike

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Background: The terrain adaptive position changing E-Bike is a custom designed electric lite bike that can be used for various purposes. The

main intention of the development of this bike is to integrate the use of bikes of multiple categories into one. . Each motorcycle in each categories has its own capabilities and purpose. For example, a sports bike which is designed to be perform track oriented can preferably be used in track or smooth tarmac surfaces. When considering a naked street bike, it is designed for using in city traffic with comfort riding posture. When it comes to an average motorcycle enthusiasts or users, it is not practical to own multiple bikes for every purposes. Our project objective is to combine the use of multiple bikes into a single one by adding an option to change the positions of handlebar, seat and footrest without compromising the strength factor of the motorcycle. By this, a single motorcycle can be used in various terrains and purposes.

Method: The project consists of a chassis on which the front and rear suspensions, rear swingarm, seat, handle unit etc. are mounted. This project allows the rider to adjust the seating position according to the terrain on which the bike is used so that maximum comfort can be attained by the rider. The motorcycle is powered by battery pack which powers the drive DC motor and other motors used for the actuation of the mechanisms used for adjusting the position of the handle, foot pegs, and the seat. The change in riding position is attained by adjusting the position of the handle bar, seat and the foot pegs. The riding triangle is determined by the 3 crucial points. The adjustments are done using different mechanisms for each part. Each of them are electrically controlled by switches and relays.

Results: Fabrication of terrain adaptive position changing e-bike is completed and the rider can select required riding posture conveniently according to the riding terrain. Three riding positions are available for selection. The positions of handle bar, seat and footrest can be changed accordingly. The objective of this project is to combine the use of multiple bikes into a single one by adding an option to change the positions of handlebar, seat and footrest without compromising the strength factor of the motorcycle. By this, a single motorcycle can be used in various terrains and purposes. The movements of the handlebar, footrest and seating position are synchronized to an extend to get preferred riding posture of a sports bike, an adventure bike and a street bike having a standard position. Driving fatigue is related to maintaining a specific body posture, absorbing the impact of the road, and generating the necessary forces to control the motorcycle. The mechanisms for the quantification of fatigue are varied. Health problems such as back and finger pain, as well

as shoulder afflictions, have been identified. Additionally, health problems can result in a significant increase in medical costs for motorcyclists. Physical fatigue due to improper riding posture can be minimized by choosing the riding posture according to the terrain.

Conclusions: Motorcycles are an excellent alternative to cars and public transport. Bikes give you the flexibility to navigate around a traffic jam, making it a great way to get around. They are cheaper to maintain compared to a regular car and they also use less fuel. Finding the perfect motorcycle takes an extensive amount of research and shopping. There are a variety of bikes for sale, from off-road farm quad bikes to laid back cruisers. Ergonomics plays an important role in this. From the physiological point of view, a motorcyclist performs a monotonous task in an almost static posture affected by various physical parameters, causing rigidity and decreased blood flow in the muscles. Our project objective is to combine the use of multiple bikes into a single one by adding an option to change the positions of handlebar, seat and footrest without compromising the strength factor of the motorcycle. By this, a single motorcycle can be used in various terrains and purposes. The movements of the handlebar, footrest and seating position are synchronized to an extend to get preferred riding posture of a sports bike, an adventure bike, and a street bike having a standard position.

Keywords: Ergonomics, Electric Bike, Terrain Adaptive, Motorcycle, Riding Posture.

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Energy Optimization on Electricity and Transport Usage in Seafood Processing Units

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Background: Carbon footprint has become an important parameter in the era of industrial world and can potentially be incorporated into sustainability. This study investigates the carbon footprint from post harbor to the seafood processing units. Electricity usage was found to be the biggest contributing factor in the processing phase and fuel usage for

transportation was found to be the biggest contributing factor in the supply chain from post harbor to seafood processing units.

Method: This work focused to make an energy conserving framework through life cycle assessment studies on three seafood processing units and in three fishing harbors in Kochi. The process of seafood processing unit must be relatively energy efficient in the case of electricity and fuel consumption. Carbon footprint which indicates the CO_2 (carbon dioxide) emissions generated by a product system or supply chain on a life cycle basis**.** The study focused on CO_2 emission resulting from various activities in the fish supply chain in the land area from the harbor to the exit gate of seafood processing units. It includes carbon emission due to transportation, labour, and use of electricity in seafood processing units etc. CO_2 is chosen because, it was the most important greenhouse gas and its concentration is observed to be very high in the seafood processing units. The carbon footprint was calculated using the life cycle assessment method with a standard emission factor, observation covering post-harbor and processing.

Results: The carbon foot prints of individual and collective activities in the seafood supply chain have been computed with respect to three fishing harbours and three seafood processing firms of varying capapcity. In case of electricity usage the energy optimization can be done by managing working time of machines operation in seafood processing units. At the peak hours the electricity consumption is more so managing the time period and can reduce the energy consumption. Effective minimization in energy consumption in supply chain can be achieved through proper energy auditing of the seafood units, turn off machines after use, automation of existing process line, equipment up gradation, replacement of out-dated equipment, do energy auditing regarding the use of efficient energy, use energy star appliances, use green industry concept, Use of renewable energy, use low or zero carbon vehicle, regular maintenance of vehicle, ensure well inflated tires, install energy efficient machines, sensitize the labour about energy conservation.

Conclusions: This study attempt to provide a perspective on fuel and energy use across the supply chain and also how to minimizing the energy consumption. Its original focus had been on estimating fuel use in fishing vessels and electricity usage in various levels of seafood processing units and in fishing harbors.

Keywords: Carbon footprint, Energy optimization, LCA, Seafood, Post harbor, Kochi

ENGINEERING & TECHNOLOGY-22 REG. No. 15886

Evaluation of the Scope of Microalgae Based Wastewater Bioremediation in A Polluted Urban Canal

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Background: Microalgae, unicellular species which exists naturally as individuals or in groups, have been identified as a promising and long-term solution for wastewater treatment and also, for generation of valuable products. Conventional treatment techniques sags behind in various aspects and thus, new microalgae based bioremediation techniques become promising due to its viability and possibilities. In recent years, algal bioremediation have emerged as a strategic research front. The basic mechanism behind is inherent to the algal metabolism; nevertheless, the removal of pollutants will be variable accordingly to different microalgae used and effluent characteristics to be addressed.

Method: This work explores the scope of employing microalgae for bioremediation of wastewater as an environmentally sustainable treatment strategy. To investigate the role and applicability of algae in wastewater treatment, the pollution status of Parvathy Puthanar, an urban wastewater canal in Thiruvananthapuram was studied and a synthetic version of same was prepared. The microalgal strain, *Chlorella Vulgaris* was selected and inoculated in synthetic municipal wastewater so as to evaluate the growth conditions. A laboratory scale bioremediation setup was developed. Samples were periodically analysed for physicochemical parameters such as pH, BOD, COD, phosphate and nitrate, and compared with control to identify the changes that occurred during the retention period.

Results: The samples from selected 13 locations indicated that in some regions it is highly polluted with high concentration of nutrients (nitrate up to 4.3092mg/L, phosphate up to 964.59μg/L) and lower dissolved oxygen (up to 0.023mg/l). And also the obtained BOD and COD concentration were ranged from up to 143.64 mg/L and up to 432.64mg/L respectively. The optimal results from bioremediation showed that the removal

efficiency for BOD, COD, nitrate and phosphate were 47.31%, 52.06%, 94.58% and 48.24% respectively.

Conclusion: This study was observed to be encouraging to suggest that bioremediation using microalgae is a promising technology for wastewater treatment to improve its quality.

Keywords: *Wastewater, Physicochemical, Bioremediation, Microalgae, Chlorella Vulgaris*

ENGINEERING & TECHNOLOGY-23 REG. No. 15917

An Introduction to the Advancement of Conventional Chatbots in Malayalam Using Hybrid Approaches for Delivering the Social Security Schemes of Kerala Government

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Background: Government of Kerala provides a lot of social security schemes to the public. But majority of the people are unaware of these schemes and if they know some of the schemes, they are not sure what are the eligibility criteria to avail it or what are the procedures to follow. The existing information system of the State Government is through a printed catalogue with various Schemes and its benefits and searching information through this system is very difficult. To overcome this, a Chatbot in is developed in Malayalam which provides all the necessary information regarding the scheme. The usual technologies used to develop a chatbot include Machine learning or syntactic rule-based approaches. We have used a hybrid methodology that uses both machine learning and syntactic approaches.

Method: In this chatbot, the user can ask for the various social security schemes of Kerala Government in Malayalam. For user-friendliness phonetic Malayalam keyboard and auto-complete of user queries are integrated with it. If the user finds the exact scheme in the auto-complete list, he can click it and see the details. There are situations where, a user may ask queries outside the database. To provide a relevant response, rule-based approach is not enough

and thus comes the need for hybrid technology. In this methodology, the user query undergoes pre-processing stages like tokenization, stop word removal and root word extraction to get the required keyword. Then these keywords are searched in a corpus, that contains the keywords related with schemes. If any of the keywords in the user query matches with them, then the corresponding questions will be fetched and displayed as the response. In some scenarios, the user query does not contain the keywords that are included in the corpus. To handle this, similarity measurement tool, Jaccard Indexing is used that finds the most relevant similar keyword and the schemes associated with this keyword will be the bot's reply. If the bot still cannot get the exact scheme, then it will be moved to another table, from which the admin can provide the sufficient reply.

Results: When a user asks queries regarding social security schemes of Kerala Government, the bot generally categorizes it into four (a) exact scheme found in the database, (b) if exact scheme not found, then search for the keywords in it, (c) if exact keyword is not found then use Jaccard indexing, (d) if anyone of the above cases fail, then the bot sends this to the unanswered section in the dashboard, and the concerned person answers them.

Conclusion: Developing a chatbot in Malayalam is a tedious process due to lack of supporting modules. With the hybrid chatbot the users can get the required schemes anytime from anywhere, which helps the Government to make their schemes common among the public.

Keywords: Malayalam, Chatbot, Hybrid Methodology, Jaccard Indexing.

ENGINEERING & TECHNOLOGY-24 REG. No. 15925

Electric Vehicles - Opportunities and Future for Kerala

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Background: With geopolitical transitions, digital transformation, automobile industry crisis, global warming & its adverse effects, hike in fuel prices and increase in oil demand – there is rapid adoption of electric vehicles (EV) in India in recent times. Transport sector being the second largest contributor to greenhouse gases globally and Kerala known for its environmental

sensitiveness, biodiversity, and tourist attraction, the Government has already started to look for alternative options for sustainable transportation, and subsequently, they view electric vehicles as one of the viable options and formulated electric vehicle (EV) policy for the state in 2019.

Method: This paper revolves around the opportunities, the electric vehicle (EV) industry can offer for Kerala in the coming years. The data and information collated in this paper is obtained from industry experts, strategy papers, research papers, journals, blogs & articles.

Results: The driving factors of electric mobility is studied and the strategic opportunities for manufacturing EV subsystems & components in Kerala was visualised as an ecosystem of hubs namely energy storage hubs, drive train hubs and electronics hub.

Conclusions: Electric mobility in Kerala is inevitable and an integrated policy with special focus on financial health of the industry, revenue to the government and employment opportunities is critical for making the vehicle mission mobility plan of Kerala, a reality.

Keywords: Electric Vehicle (EV), Kerala EV Policy 2019, EV ecosystem, Energy storage, Drivetrain, Electronics.

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Automatic Generation of Text from Indian Sign Language Static Images for Communication and Research

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Background: Indian Sign Language (ISL) is a communication medium for hearing impaired people in India. Translation of ISL videos into text is one of the solutions for research as well as the development of the hearing community. HamNosys notations system is one of the best solutions which helps in translating a visual spatial language into textual or writing format. This also helps in translating text to its corresponding video signs. A Text-HamNo corpus along with an image–HamNo corpus will be a core resource for text-to-sign and sign-to-text communication systems.

Method: Glow based and vision based approaches are the two commonly used for sign-to-text translation. Here, we are using an object detection method for sign detection. An image corpus is created by tagging the sign image with HamNo notations and also created a text-HamNo corpus for mapping the text. Single Shot Multi-Box Detector (SSD) object detection algorithm is used for identifying the sigml tag from the ISL images.

Results: The system takes ISL images as input and identifies the sigml tags corresponding to the sign images. The signs it identifies are micro signs whose single location represents more than two sigml tags. We have collected and arranged the sigml tags in a prescribed format and identified the corresponding text from text - HamNocorpus.

Conclusion: The system successfully translates an Indian Sign Language sign to its corresponding text format. Object detection, image - to- sigml generation and sigml-to-text identification are the core areas of this image to text translation system.

Keywords: Indian Sign Language, ISL, Object detection, Sign-to-text translation

ENGINEERING & TECHNOLOGY-26 REG. No. 15937

Assessing the Role of Feeder Service for Encouraging Public Transport Patronage – A Review

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Introduction

Across the globe, public transportation is undergoing radical transformations. Public transportation plays a vital role in the economic development of a country. Public transportation includes various modes such as bus, rail, metro, suburban rail, water metro, jetty, etc. Public transport provides a facility to the commuters to reach their desired destination. The demand for public transportation grows fast as cities grow as a result of urbanisation. In recent days various infrastructure projects are implemented to meet the public transport demand. India also witnessing major infrastructure devel-

opment in terms of various public transport systems like metro, water metro, etc. The last-mile connectivity is also available to commuters who take public transit. Last-mile public transportation connectivity to a major transit line expands commuters access to more industrial zones and places of interest(Chandra et al., 2013).

The majority of modern public transportation systems are not being used to their full potential because of various issues with public transportation include operational efficiency, poor operating speeds, and longer journey times. This issue is frequently regarded as a lack of last-mile transportation connectivity to the transit stop(Chandra et al., 2013). The lack of connectivity to the public transport system increases the use of private transport modes. Investing much in transportation infrastructure without improving the quality of public transportation leads to the adoption of more personal forms of transportation. Involvement of more private modes have negative influence such as increased congestion, increase in travel time, air pollution leads to health issues, loss of economic productivity due to more road fatalities.

Intermodal transport services, such as a feeder system to offer last-mile connectivity, are needed to improve the efficiency of public transit. A good public transportation performance with feeder services has been identified as one of the potential ways to minimise air pollution, reduce energy consumption, and improve mobility and traffic congestion(Almasi et al., 2014). Feeder services are provided to assure last-mile connectivity and to enhance the number of riders who availing public transport. Most of the feeder services are provided on a shift basis. Various feeder service modes of transport already exist in different metro cities such as Bi-cycle, feeder buses, minibuses, shared auto, etc. We review some of the literature in this paper to identify the parameters that directly influence feeder service for encouraging public transport patronage.

Variables influencing the feeder service assessment – review

In the city of Bangkok, Thailand, a case study on the integration of paratransit as a feeder system into urban transportation and its effect on mode choice behaviour is done. The survey was divided into four sections: (1) their present travel patterns, for which they were questioned about the method and frequency of their travel, the expense and time, and use of public transit in the last two months, (2) travel choice consideration consists of the most preferred mode of transportation, (3) individual attitudes and preferences include the car use, safety and security, risks, environmental concerns

and view on the public transport and paratransit (4) general information. Among this Vehicle ownership, Safety and comfort, waiting time and age are seen to be the explanatory variable. Among these first three was having a negative influence on the model. Structural Equation Model (SEM) was used to design the model. As the study was restricted they suggested collecting variation samples and commuter demographics to getter a more accurate conclusion(Tangphaisankun et al., 2010).

In another study, the feeder mode choice selection behaviour of commuters travelling via KTM Komuter was studied The purpose of this study was to determine how passengers of a Malaysian rail service felt about feeder buses, the factors that influenced their decisions, and recommendations to encourage KTM Komuter customers to utilise feeder buses instead of driving their cars to and from stations. Gender, origin and destination, distance, vehicle ownership, education, income, trip characteristics and origin/destination waiting facilities are the variables considered. Linear regression analysis was used to model the data (Dependent variable: Feeder preferences; Independent variables: Sociodemographic factors, trip characteristics etc). It was seen that travel time and travel distance had a negative influence on the model while age and travel frequency have a positive influence. After the study, it was found out that buses received less proportionate demand as feeder vehicles, access and egress modes to stations determined the mode choice(Bachok & Zin, 2017).

A study has been conducted on combining public bicycles and rail transit opens up new possibilities for sustainable transportation(Ji et al., 2017). An intercept survey of rail transport users' feeder mode choice near rail stations in Nanjing, China was done to investigate the reasons for public bicycle utilisation for rail transit access. Feeder mode alternatives, including car, bus, walk, private bike and public bike were used for estimating the mode choice model. The study reveals the influence of personal demographics, trip characteristics, and station surroundings on public bicycle utilisation for rail transport access by distinguishing between public and private bicycle modes in the mode choice models. It was found out that travel time and age had a negative influence on the model while income class and travel cost had a positive influence. Rail commuters who have experienced bicycle theft and are travelling for school or jobs are more likely to use public bicycles to access rail transit. Except for density, which indicates a positive link with walking, land use characteristics are mainly negligible in this study.

In an SPSS environment, a case study

was conducted in the Ahmedabad City Bus Rapid Transit System corridor(Balya & Kumar, 2017). The proposed feeder mode service choice of walking with three service categories: Exclusive Footpath Service (EFS), Special Shoulder Treatment for Pedestrian Only (SSTP), and Pedestrian Allow in Mixed Traffic (PMT) was studied. The parameters considered are mode of transportation, trip purpose, origin and destination, journey time, travel cost, travel distance, traveller characteristics such as age, occupation, car ownership, household size, and travel behaviour. Multinominal logit was used to model the data. While travel distance and travel time have a negative influence, vehicle ownership, income class and household size have a positive influence on the model.

The feeder system between the Bus Rapid Transit System (BRTS) and the proposed Ahmedabad metro station was assessed(Trivedi, 2020). A primary survey was undertaken to collect data on the location as well as passenger attitudes about public transportation and the existing feeder system. Travel time, travel cost, safety and comfort and trip purpose are the explanatory variable used for the model. Travel cost and safety comfort had a positive effect while travel time had a negative effect on the model. Secondary data from the BRTS and metro was used to develop a proposal to improve the current system. They discovered that the current feeder system does not meet the needs of regular commuters after a thorough investigation and input from the community. From the analysis, electric rickshaws will be the most suitable medium of feeder between BRTS and the metro.

Table 1: Explanatory Variables

Paper	Travel Time	Travel Cost	Vehicle Ownership	Safety and Comfort	Income class	Travel distance	Household size	Waiting time	Age	Trip Purpose	Travel Frequency
(Tangphaisankun *et al*., 2010)			✓	✓					✓		
(Bachok & Zin, 2017)	✓					✓			✓		✓
(Ji *et al*., 2017)	✓	✓			✓				✓		
(Balya & Kumar, 2017)	✓		✓		✓	✓	✓				
(Trivedi, 2020)	✓	✓		✓						✓	
(Gkiotsalitis, 2021)	✓							✓			

Table 1 lists the explanatory variables that have been addressed in previous studies of feeder services analysis. From the detailed literature review, the most influencing explanatory variables for the feeder service consists of age, trip purpose, income class, household size, travel frequency, travel time, travel distance, travel cost, vehicle ownership, safety and comfort, waiting time.

Simulation evaluation was used to examine the existing feeder bus route 302 in Singapore and construct a model. Mobility-as-a-service (MaaS) schemes enable travellers to book a single ticket that covers all of their trip legs, thanks to advancements in smart mobility(Gkiotsalitis, 2021). In this travel time and distance are considered as the explanatory variable and both are having a negative influence on the model. This work suggests a mathematical approach for lowering the door-to-door travel durations of passengers who complete their origin-destination journey using up to two public transit modes.

Conclusion

This paper assessed the variables that influence the feeder system for encouraging public transport

patronage. Based on the literature review following impacts of variables are identified: i) Safety and Comfort, waiting time, vehicle ownership has a negative influence on the feeder system i.e. less safety, more waiting time and availability of personal vehicle reduces the use of public transport, ii) Similarly travel time and travel distance are having a negative influence, iii) Travel time and travel cost considered as a most important variable, iv) All other variables are having mixed effect, v) Household size considered as a least important variable. From the study, feeder services provide a greater role in developing public transportation utilization. Feeder service modes may vary depending on the land use characteristics, type of public transport mode availability and demand of the public. To enhance the participation of communities in public transportation, there is a need for intermodal transport facilities like feeder services.

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ENGINEERING & TECHNOLOGY-27 REG. No. 15948

Mobility Pattern Variations Due to Covid-19 Travel Restrictions

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Background: Travel restrictions imposed as part of the lockdown policy have resulted in a considerable reduction in movement of people and commodities. The mobility pattern of vehicles and its changes due to the travel limitations imposed from March to May 2020 in the State of Kerala during the year 2020 was analyzed in this paper.

Method: In this study, secondary data on mobility was employed to conduct the analysis. The mobility data was divided into three phases, namely Phase I (Pre-lockdown period), Phase II (Lockdown period) and Phase III (Post-lockdown period). The Two Standard Deviation Band Statistical Analysis was carried out to measure the degree of changes in mobility between the phases and the visual analysis was supported by Mann-Whitney U-test.

Results: The changes in visitors to Retail and Recreation, Transit stations and Workplace showed a similar trend that is, in all the category the change from baseline falls outside band in Phase II and either fell within the band or tended to the band towards the end of Phase III. In Grocery and Pharmacy category and Park category the change from baseline fell outside the band in Phase II, but returned to band in Phase II itself and more or less stayed in the band. In Residential category the change from baseline is positive unlike the rest. The mobility change falls outside the band during Phase II and remains outside the band in Phase III while tending towards the band.

Conclusions: Due to the introduction of travel restrictions during the Covid -19, there is a significant change in mobility from the regular pattern. Unlike the retail and recreation, grocery and pharmacy, parks, to transit stations and workplace categories, which saw a drop in mobility during the lockdown, the residential category saw an increase in mobility.

Keywords: Covid-19, Lockdown, Mobility

06

Environmental Sciences Forestry & Wildlife

Oral Presentation

ENVIRONMENTAL SCIENCE, FORESTRY & WILDLIFE-01 REG. No. 15445

Open Burning of Municipal Solid Wastes and Human Health Impacts – A Critical Study in Indian Context

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Background: Open burning of municipal solid wastes (MSW) has been identified as the largest source of dioxin-like POPs emission (29 compounds) in developing countries. In India, about 68 million tons of MSW is openly burned in households, streets and dumpyards, which could pose serious threat to human health & environment. It is the first experimental study in Indian subcontinent to determine the emission factors of dioxin-like POPs from open burning of MSW and have generated the annual emission data for the country. In addition, the human health risk associated with street waste burning and massive dumpyard fire breakout incidents are also studied.

Method: A customized Open Burn Test Facility (OBTF) was constructed inside NIIST campus and carried out simulated MSW combustion studies using original MSW obtained through state wide sampling. The OBTF enabled quantitative sampling of the emitted air as well as residual ash generated and the collected samples were analyzed using state of the art GC-MS/MS to estimate the levels of dioxin-like POPs. Further to validate the simulated study results, the carcinogenic and non-carcinogenic health risk at the open burning sites were also estimated as per ATSDR guidelines.

Results: The estimated national default emission factor for dioxin-like POPs from open burning of MSW was found to be 180 ug TEQ/ton. The annual emission of dioxin-like POPs in India was calculated to be 12.3 kgTEQ, which is quite high considering the fact that the tolerable monthly intake for humans is only 70 pg TEQ/kg/b.w. The study revealed considerable carcinogenic & non-carcinogenic health risk to the exposed community.

Conclusion: The study generated national inventory of dioxin-like POPs from MSW open burning sector and the associated incremental lifetime carcinogenic risk for humans. The findings of the study are under the consideration of KSPCB, CPCB & National Green Tribunal, which could instigate future policy decisions on scientific solid waste management.

Keywords: Dioxins, MSW open burning, carcinogenic risk, emission factor, annual inventory.

ENVIRONMENTAL SCIENCE, FORESTRY & WILDLIFE-02 REG. No. 15672

Conservation and Management Studies of Selected NTFP Plants of Western Ghats:A Participatory Approach

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Background: NTFP plants are passing under fast depletion due to overexploitation and unscientific harvesting. This had large impact on reduction of growing stock and livelihoods of the dependent communities. A participatory stakeholder level field activity on development of propagation protocols, augment seedling planting *in situ* along with knowledge imparting ensure the success of conservation, management and utilization efforts of these resources.

Method: Vegetative, seed propagation and storage practices were developed as per standard nursery and seed technological methods. The seedlings produced as outcome of propagation study used for enrichment activity by keeping in *situ* requirements of the species. Factors affected seedling survival was recorded through monitoring in half year basis. Knowledge imparted through training Manual.

Results: Developed propagation protocols of ten targeted species. Augment planting of 15000 seedlings of 10 target species were carried out at Vazhachal forest division. Post planting monitoring recorded 35% survival rate. Training manual prepared enabled aware ness and knowledge imparting on sustainable conservation and management practices.

Conclusion: Conservation and management activities of NTFP plants carried out through participation of tribal VSS Members act as a model to foresee availability of plants *ex situ*, viable seeds for long term supply, enhancement in populations and overall sustainable utilization of resources.

Key words: NTFPs, propagation protocols, enrichment planting, knowledge imparting, conservation, Management.

ENVIRONMENTAL SCIENCE, FORESTRY & WILDLIFE-03 REG. No. 15636

Diversity and Seasonality of Odonates in Kole Wetlands

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A two-year study was conducted to understand the diversity and seasonality of odonates (dragonflies and damselflies) in Kole wetlands, spread over Thrissur and Malappuram districts. A total of 63 species of odonates (39 dragonflies and 24 damselflies) belonging to 10 families were recorded during the study, out of which three species are endemic to the Western Ghats region and two to India. Odonate diversity, as measured using Shannon-Wiener Index, was maximum at Thottipal, an uncultivated area. It showed a peak during the early Monsoon season and dipped in winter.

ENVIRONMENTAL SCIENCE, FORESTRY & WILDLIFE-04 REG. No. 15749

ATR-FTIR and HRMS Analysis of Dust from Different Indoor Environments in A Tropical Metropolitan Area

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Background: Indoor dust is a major matrix that exposes people to a wide range of contaminants. Because the indoor environment is exposed to a wide range of chemicals from personal care items, furniture, construction materials, machinery, and cooking/cleaning goods, there is a significant risk of harmful compounds being present in indoor dust. However, there is a scarcity of data on the presence of contaminants of emerging con-

cern (CECs), their metabolites, and re-emerging contaminants in indoor dust across different micro-environments in Kerala.

Method: Dust samples were collected from four distinct micro indoor spaces (photocopying centres, residential residences, schools, and ATM cabins) in Greater Cochin Area, Ernakulam for this investigation. The collected samples were subjected to ATR – FTIR and LC-Q-ToF-MS analyses.

Results: The ATR – FTIR analysis indicated the presence of aldehydes, anhydrides, carboxylic acids, esters, sulphonic acids, and asbestos – a re-emerging contaminant. The HRMS analysis revealed the presence of 19 compounds. These compounds belonged to various classes plasticisers, plasticiser metabolites, photoinitiators, personal care products, pharmaceutical intermediates, surfactants, insecticides, and fungal metabolites.

Conclusions: To the best of our knowledge, this is the first report regarding the presence of CECs in indoor environments in Kerala and also the suspected occurrence of pesticides (metaldehyde and ethofumesate) in classroom dust in India.

Keywords: Micro indoor environments, indoor dust, contaminants of emerging concern (CEC), ATR-FTIR, HRMS.

ENVIRONMENTAL SCIENCE, FORESTRY & WILDLIFE-05 REG. No. 15733

Assessment of Environmental Conditions and Determination of Ecosystem Health Score of an Urban Wetland in Kerala

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Background: Wetlands are unique ecosystems that provide ecological, economic, and cultural services to humans. Healthy wetlands are necessary for human survival and sustainable development. Rapid land use conversions in an unplanned manner with the least considerations of environmental consequences can exert huge stress on sensitive ecosystems like urban wetlands. Despite the ecological functions it performs, urban wetlands are under great threats like extension of built-up areas, waste disposal and landfilling. Even though many legal frameworks are there for the protection of such ecologically significant areas, they are not much

strictly followed. This study focuses on the prevailing environmental conditions and ecosystem health score of Kattampally wetland, a natural coastal wetland in the Kannur district of Kerala. The study area belongs to the Kattampally-Valapattanam-Kuppam wetland complex, which is under consideration, to be notified by Govt of Kerala.

Method: Since the Kattampally wetland is located in the township area, the pollution exposure will be very high. Water and sediment samples were collected and analyzed for understanding the environmental quality and pollution status of the wetland area. Many field visits were conducted to observe the threats faced by the wetland ecosystem such as landfilling, solid waste dumping, and effluents from both domestic and industrial areas. The ecosystem health score of the Kattampally wetland was determined using indicators such as extent, water regimes, biodiversity, and governance. Each of these indicators has sub-indicators, which are further classified into 6 categories. Based on the rank and values of these categories the health score has been calculated. Primary data collected from the field and remote sensing images were also used.

Results: High values of TDS in water samples indicate the effect of sea water or presence of contaminates. Trace metal concentration was detected in the sediment samples of Kattampally wetland. Land encroachment, mangrove deforestation, waste dumping are the major anthropogenic pressures reported in the Kattampally wetland area. The ecosystem health score of the Kattampally wetland is '0.86' representing *the Ecosystem health rank 'B+'* and *the Good health category.* External pressures from the human-dominated environment may balanced by the wetland itself to maintain its integrity.

Conclusion: It is important to evaluate the current environmental conditions and threats to the wetland ecosystem for its wise management. If the prevailing destructive practices have not been regulated properly, it will impair the structure and functioning of the wetland ecosystem. Hence it is the need of the hour to implement suitable conservation strategies. The focus should be given to proper waste management practices, sustainable tourism activities, promotion of kaipad farming and fishery. Sustainable use of wetland resources is mandatory to conserve the ecosystem. The scientific operation of the Kattampally regulator cum bridge is another challenge faced by the wetland system. A management action plan is suggested for the conservation and management of the wetland.

Keywords: Wetland, environmental quality, health score, threats

ENVIRONMENTAL SCIENCE, FORESTRY & WILDLIFE-06 REG. No. 15574

Thermal Sensitivity of Soil Organic Carbon Under Continuous Teak Rotations in the Midland Laterites of Kerala

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Background: Global warming due to increased concentration of greenhouse gases is one of the most important concerns of mankind today. Kerala has a rich forest cover of which 10% is occupied by forest plantations. Objective of the study was to assess the changes in carbon fractions and carbon stability under continuous teak rotations.

Method: Total organic carbon, passive carbon and active carbon was analysed. Soil carbon stocks were estimated up to 1m depth. The decomposition rate and activation energies of soil carbon were investigated by an incubation experiment of 45 days duration. The carbon lost during the period was estimated by subtracting the amount lost during the period from the initial carbon content (at 0th day) and was used for determining the first order rate kinetics.

Result and discussion: The carbon stocks in the plantations varied from 0.8622 Mg/m^3 at 30 - 40 year class which was considerably higher than that at 100 -110 year class (0.5634 Mg/m^3). With continuous cultivation, the active carbon content was found to decrease. On the other hand the passive fractions were found to be increasing indicating that with continuous teak rotations there will be a large conversion of the active carbon pools to passive thereby seriously impairing the ecosystem health and productivity. Thermal stability studies shows that macro aggregates have higher levels of activation energy than micro aggregates in these soils.

Conclusion: There was only a weak correlation between mean weight diameter and organic carbon. With temperature, there was an increased conversion of active carbon to passive forms and this conversion could lead to higher carbon dioxide evolution once the threshold energy levels are attained. The study concludes that continuous teak rotation destabilizes carbon in soil and shows the potential to revert to a carbon source than sink if not managed sustainably.

Keywords: Carbon dynamics, Thermal stability, Soil carbon sequestration

ENVIRONMENTAL SCIENCE, FORESTRY & WILDLIFE-07 REG. No. 15865

Occurrence, Distribution and Ecological Risk Assessment of Microplastics in the Ashtamudi Wetland, Kerala

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Background: Microplastic (MPs) is a rising global pollutant that has attracted a good deal of attention from researchers and therefore the public. In the environment due to physical and mechanical abrasion, biofouling and effects of natural radiations plastics break into smaller particles known as Microplastics. These small particles are transferred via the food chain, creating vulnerabilities for both prey and predator through microplastics bioaccumulation, disturbing ecosystem functions (i.e., physiological functions, prey-predator populations, trophic transfers, etc.). Human beings also face various risks including oxidative stress, inflammation, fecundity and cell damage due to seafood contamination.

Method: The occurrence, abundance and distribution of microplastics (MPs) were studied in sediments and surface waters of Ashtamudi wetland. Bulk sampling method was adopted for recovering microplastics from water due to their low concentrations in aqueous samples compared to those in sediments. At each sampling station, 5L of water is collected in stainless steel container and nearly 500 gm of surface sediment was obtained and transferred to aluminium pouches. Samples are then filtered, dried and are subjected to Microscopic and FTIR (Fourier Transform Infrared Spectroscopy) examination for characterization and identification. The combined use of PHI (Pollution Hazard Index) and PLI (Pollution Load Index) provided the preliminary ecological risk assessment caused by MP contamination in surface water and sediments along the wetland.

Results: MPs were recovered from all the samples, indicating their in-depth distribution within the Ashtamudi wetland. Microplastic pollution risk in each surface water and sediments of the Wetland was explored with supporting risk assessment models. The abundance of MPs recorded from the water samples was within the vary of 15.2 ± 2.2 MP/L and from sediments was 5200 ± 300 MP/kg. >2 mm sized particle and black coloured MPs were

predominant in water and sediment of the wetland. MPs of various shapes like fragments, fibres, films and beads accounted for many collected samples. The Attenuated Total Reflectance-Fourier Transform Infrared Spectroscopy (ATR-FTIR) based chemical analysis identified eight types of polymers of that Polypropylene was the dominant polymer.

Conclusions: The present study provides the baseline data on abundance of MPs, their distribution, composition, and types in Ashtamudi wetland. The mean abundance of MPs in the wetland shows that the ecosystem is suffering from high Microplastic pollution. Proper solid waste management, development of adaptable policies and awareness creation about the negative impact of microplastics on the environment should be executed as soon as possible.

Keywords: Microplastics, Water, Sediment, Risk Assessment, Pollution Load Index, Coastal Wetland system.

ENVIRONMENTAL SCIENCE, FORESTRY & WILDLIFE-08 REG. No. 15832

Are We Exposed to Emerging Contaminants Through Drinking Water?

A Study of Rooftop Plastic Drinking Water Storage Units

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Background: Rooftop plastic tanks are common drinking water storage units in our state. The present study focus on the analysis of water from rooftop plastic tanks in Ernakulam district. The source of feed water is municipal water supply of Ernakulam District. The storage time of water in the tank varies between 12-24 hours.

Method: This study is focused on the presence of phthalates in drinking water collected from household rooftop storage tanks. The water samples collected from 20 different houses of Ernakulam district were subjected to the analysis of routine water quality parameters and Ion chromatography. Samples were particularly scanned for Total organic carbon (TOC), Total dissolved solids (TDS), pH etc. The samples with high TOC content than the allowed standard limit (< 2 mg/L, US *EPA*) were further subjected for the analysis by Liquid Chromatography with Quadrupole Time of Flight

Mass Spectrometry (LC-Q-ToF-MS). The water samples were concentrated by solid phase extraction.

Results: The water quality parameters along with their standard limit is presented. Similarly the detected cations and anions are also tabulated. Dibutyl phthalate, Bis (2-ethylhexyl) phthalate, and 3,6-dimethyl phthalic anhydride were identified in the water samples. These compounds were present in almost all the sample s analysed for the present study.

Conclusions: The presence of compounds of emerging concern in drinking water samples are reported in this study. All these water samples also presented high TOC values. Toxicity reports of phthalates indicate their role in health problems, including endocrine disruption, cancer, developmental abnormalities, and polyneuropathy. Phthalates are easily migrated to water media and it is highly necessary to upgrade the drinking water treatment units for their removal. More study is presently carried out to understand its transport as per the residence time, response to temperature and other key parameters.

Key words: Phthalates, ions, water storage tanks, LC-Q-ToF-MS

ENVIRONMENTAL SCIENCE, FORESTRY & WILDLIFE-09 REG. No. 15497

Development of Thermally Stable Coir Fibre Using Eco-Friendly Bio Extracts of *Spinacia oleracea*

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Background: As far as the value addition of coir is concerned, flame retardancy is one of the most important properties for industries as well as academic researchers. At present, coir industry accepts halogenated, phospho-halogenated and heavy metals containing halogens to impart fire retardancy. But these are toxic, non-eco-friendly and very expensive affecting the tensile strength of the fibres. This research investigates the fire resisting property that was imparted to coir by the application of bio-enriched extracts of spinach juice (*Spinacia oleracea*).

Method: Coir fibre is mercerized and one portion of the fibre is needle

punched to obtain coir needle felt for easy conduction of flammability tests. Fire retardant liquor of spinach juice and its bio enriched formulation was applied to mercerized coir fibre by soaking method and needled felt by spraying method. Various flammability tests and fundamental properties of the treated and raw coir has been evaluated.

Results: From flammability tests burning rate of the control coir increases 1.6 times as fire retardant (FR) treatment. From NPK analysis elements like potassium, nitrogen, phosphorous etc are present in FR liquors and it was confirmed by EDAX analysis of fibre.

Conclusion: Green techniques using sustainable bio sourced materials provide better alternatives to chemical methods of treatment for development of flame retardant fibres.

Key words: Horizontal flammability, Tablet test, Limiting oxygen index, Breaking stress.

ENVIRONMENTAL SCIENCE, FORESTRY & WILDLIFE-10 REG. No. 10369

Development of Neutral and Adaptive Genomic Markers for Management of *Santalum album* Linn.

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Background: Over exploitation without any strategies for sustainable management of sandal has resulted in diminution of available natural and genetic resources. It is not possible to adopt an appropriate conservation strategy for effective management without having an understanding of the current genetic status of sandal populations. Absence of genome wide markers with the ability to assess neutral and adaptive genetic diversity in sandal paves way for studies based on developing markers to understand local adaptation.

Method: The whole genome draft of sandalwood could be potentially used to mine genome wide SSR markers with the high degree of polymorphism that could assess the current genetic status including information on private alleles or rare alleles. EST-SSR markers linked to stress response, developed from the transcriptome sequencing could be used to analyse parameters linked to adaptive genetic diversity.

Results: Out of the total mined 89,849 SSR and 5241 EST-SSRs, we could identify a total of 54 primers, including 12 EST-SSRs that exhibit polymorphism among populations. The 12 microsatellite loci linked to stress responsive genes could be used to assess the adaptive potential of the resources and the genome wide SSR could assess the effect of gene flow, migration, selection or any evolutionary bottlenecks on the current sandal population.

Conclusions: Knowledge about allelic richness of various populations along with the influence of evolutionary factors in shaping the genetic structure is important to select elite genotypes for breeding and genetic improvement programs. Diverse sandal populations having unique/adaptive alleles with greater adaptive potential to combat climate change alterations needs to be looked forward for future management efforts.

Keywords: Transcriptome sequencing, Evolutionary bottlenecks, Polymorphism

ENVIRONMENTAL SCIENCE, FORESTRY & WILDLIFE-11 REG. No. 15470

Design and Development of Innovative Batch and Flow Based Sorbent Systems for Bromate Removal from Water

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Background: Worldwide, the rapid industrialisation and urbanisation exert huge stress on the water resources in terms of availability and safety of drinking water. Among, the oxyanions, bromate (BrO_3^-) is the most potent disinfection by-product and is classified as a "possible human" carcinogen. The present study was under taken to develop novel low cost clay based sorbent systems for the effective removal of bromate from water, which utilize simpler chemistries thereby enabling easier regeneration, custom fabrication and reusability.

Methods: Three different modified montmorillonite (Mt) clay adsorbents (Mt-H, Mt-CTS and Mt-H-CTS) with cationic surfactant (Hexadecyltrimethyl ammonium bromide) and biopolymer (Chitosan) were synthesised and used to adsorb the bromate ions in water. The bromate removal study was carried out in a batch and two innovative methods such as

adsorbent-cartridges and adsorbent imprinted carbon cloth (floating sorbent) systems. The modified Mt's were characterised by XRD, FTIR, and BET analysis. The influence of various parameters such as pH, composition of sorbents, extent of functionalization, sorption kinetics, and effect of coexisting anions on adsorption efficiency was studied. The regeneration (with NaCl) and reusability of sorbent materials were found to be highly encouraging.

Results: The higher adsorption attained by the modified adsorbents was associated with the generation of positive surface electric charge with the surfactant loading, which increased the efficiency of surface interaction with the bromate ions. The customized 'point of use' cartridge modules as well as floating adsorbent (adsorbent imprinted carbon cloth) developed using modified Mt systems, showed excellent removal efficiencies suitable for practical applications. All the three developed adsorbents systems could effectively reduce bromate from natural water sources from 100 μgL^{-1} to less than 1 μgL^{-1}, with an efficiency of >99%. Mt-H-CTS was found to be the superior sorbent among the three (Mt-H and Mt-CTS). The bromate adsorption was possible in wide range of pH, in presence of competing ions and applicable in different water samples.

Conclusion: The developed advanced sorbent system could be a promising process for the removal of toxic anions such as bromate. The smart reusable clean-up cartridge modules can be excellent tools for domestic drinking water outlets, while the adsorbent imprinted carbon cloths, can be of great use as "floating sorbents" in drinking water reservoirs and natural water reservoirs such as pond, lake and pools. The regeneration and reusability of the developed cartridges and floating adsorbents was found to be highly promising.

Keywords: Bromate, clay, Montmorillonite, adsorption, Cartridge, floating sorbent

ENVIRONMENTAL SCIENCE, FORESTRY & WILDLIFE-12 REG. No. 15698

The Inevitable Role of *Rhizophora* Species in Carbon Sequestration: A Case Study from Kannur District, Kerala

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Background: Mangrove vegetations provide a valuable service to the global population by storing vast amounts of carbon and are one of the most efficient and cost effective solution for offsetting carbon emissions. The preliminary aim of the study was to evaluate the carbon sequestration potential of *Rhizophora* species and a comparative analysis of aboveground and belowground carbon content in *Rhizophora* species distributed in the selected study stations of Kannur district, Kerala.

Methods: The selected stations of Kannur district for the study include Cherukunnu (S1), Edakkad (S2) and Kunjimangalam (S3). Quadrant study was carried out for the non destructive estimation of biomass of *Rhizophora* species. Existing general allometric equations were applied for computing biomass and carbon content of *Rhizophora* species.

Results: Mean total aboveground biomass (AGB) of *Rhizophora* species in S1, S2 and S3 was estimated to be 442.10 kg/ plot (m^2), 326.65 kg/ Plot (m^2) and 464.10 kg/ Plot (m^2) respectively. Mean total belowground biomass (BGB) was highest in S3 (177.07 kg/ m^2) and lower in S2 (140.97 kg/ m^2). The average carbon content/ plot (m^2) of S1, S2 and S3 was estimated to be 251.36 kg C/ m^2, 226.70 kg C/ m^2 and 315.08 kg C/ m^2 respectively. The total carbon content sequestered in *Rhizophora* species at S3 (94.52 ton C/ ha) had the highest value compared to S1 and S2.

Conclusions: *Rhizophora* species distributed in the undisturbed area of the study stations exhibit high biomass and carbon content. It signifies the potential of *Rhizophora* species in carbon sequestration and thereby plays a vital role in climate change mitigation by reducing atmospheric CO_2 emissions.

Keywords: *Rhizophora*, Carbon sequestration, Carbon dioxide, Carbon content, Aboveground biomass, Belowground biomass.

ENVIRONMENTAL SCIENCE, FORESTRY & WILDLIFE-13 REG. No. 15510

Heavy Metal Scavenging of Carbon Nano Tubes Deciphered from Forest Floor Humic Acid

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Introduction: Invention of carbon nano tubular(CNT) structures had created an unprecedented hype in material science.However, bulk production of this material have led to an over exploition of graphite sources and demands exploration of natural sources for CNT.Humification process in soil has much similarities to the coalification process and was hypothesed to be a natural source of CNT. The present study probed the core structure of extracted, purified and nano converted humic acid and conclusively establishes the presence of multiwalled CNTs in these natural materials. Studies were undertaken to delineate the heavy metal scavenging potential of these nano materials vis – a vis their raw forms.

Method: Humic acids were extracted from teak plantations in Idukki district (Kerala) by acid precipitation and purified by standard protocols.From the purified forms, a subsample set was converted to nano forms by ball milling.Spectrochemical , microscopic and laboratory analysis were performed to reveal its structure and properties. Adsorption studies were conducted using lead ion as a representative heavy metal at specific temperature and pH.Isotherms and kinetic models were plotted to explain the mechanism of adsorption and characterized the ensuing surface modification of nano converted humic acids .

Results: Spectroscopic characterization confirmed the CNT structures and graphene layers in nano humic acid with a layer spacing 0.28 nm.Nano conversion enhanced the surface area and acidic groups and enhanced the lead ion adsorption by nearly two fold compared to raw humic acids. Entrapping of lead ion inbetween the walls of CNTs in nano humic acid was a salient observation and multilayered adsorption was confirmed with the better fit of Freundlich isotherm. Further, intra-particle diffusion kinetic model supported the pore filling of lead ion.

Conclusion: This work summarized the presence of carbon nano tubular structures in humic acid and establishes its heavy metal scavenging potential The increased performance

of this natural adsorbent was attributed to the CNTs, enhanced surface area and acidic carbon functional moieties in the purified and nano converted humic acids.

Keywords: Carbon nano tube, Humic acid, Isotherm modeling, Kinetics

ENVIRONMENTAL SCIENCE, FORESTRY & WILDLIFE-14 REG. No. 15111

Diurnal Flux in CO_2 Associated with Growth Response of *Terminalia cuneata* Roth. And *Mimusops elengi* L. Under Controlled Growth Conditions

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Background: Global warming and climate change, attributed by greenhouse gases (GHGs), are the most serious environmental concerns of the present millennium. Carbon sequestration is the long term removal, capture or sequestration of CO_2 from the atmosphere to mitigate or reverse climate change. Carbon offset planting is suggested as one among the means to check the unprecedented levels of CO_2 in the atmosphere. *Terminalia cuneata* and *Mimusops elengi* can be suggested as excellent candidates for CO_2 mitigation programs.

Method: Present study evaluated CO_2 flux inside a microclimatic environment with tree species *Terminalia cuneata* Roth. and *Mimuosops elengi* L. They were brought to experimentation in two growth chambers having controlled supply of air (Control) and air- CO_2 mixture (Treated), for a period of 15 days. CO_2 flux was measured using automated CO_2 gas analyser. Growth parameters such as Plant height, stem thickness, leaf area of plants before and after CO_2 treatment were compared.

Results: Day flux inside treated chamber is higher than that of control. Percentage day and night flux of CO_2 inside treated chamber with Terminalia is higher than Mimusops. Growth parameters such as plant height, stem thickness and leaf area of both the plants increased under elevated CO_2.

Conclusion: Higher accumulation and resultant day flux of CO_2 in treated chamber can be attributed to the plants growing within it. Uptake and assimilation of CO_2 by Terminalia and Mimusops are evident from the increased morphological attributes

of growth like plant height, stem thickness and leaf area. Present study confirms that Terminalia is more efficient and can acclimatize in an elevated CO_2 condition much better than Mimusops.

Keywords: *Terminalia cuneata, Mimusops elengi*, CO_2 flux, elevated CO_2, growth chambers

ENVIRONMENTAL SCIENCE, FORESTRY & WILDLIFE-15 REG. No. 15758

Impact Evaluation of Renovated Ponds in Palakkad District

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Background: Ponds are among the most diverse and yet threatened components of fresh water diversity. Palakkad district is blessed with more than 14800 private and public ponds. But most of them are silted up and have collapsed side walls. The Department of Soil Survey and Soil Conservation has undertaken renovation of 56 ponds in the district. In this paper, the impact evaluation of renovation of ponds implemented under RIDF XX is conducted for 13 ponds only.

Method: The ponds were selected in consultation with the department and the main works carried out as per the renovation programmes include: desilting and sediment removal, increasing the depth of existing ponds, giving side wall protection, construction of ramps and steps etc. A socio-economic survey was conducted among the stakeholders / beneficiaries of the scheme, to know their perceptions of the project with the help of questionnaires prepared for the same.

Results: Majority (90%) of the respondents reported that the primary benefit of pond renovation was for meeting daily needs like washing, bathing etc. The remaining 10% used the ponds mainly for recreation. There was a considerable increase in the grass yield and greenery (canopy) of the area as a result of pond renovation. All the respondents (100%) reported that the overall vegetation of the surrounding area flourished after the project implementation. As a result of renovation programme, an increase in water table of nearby wells was noticed by all the respondents.

Conclusions: For the ponds to become

more water use efficient, catchment area treatments will have to be provided in the near surrounding area, to harvest the rain water for recharging the water body. Awareness to that level and a sense of ownership should be created among the stakeholders living nearby.

Keywords: Renovation of ponds, increase in water table, perception of beneficiaries, benefits of renovation, evaluation.

ENVIRONMENTAL SCIENCE, FORESTRY & WILDLIFE-16 REG. No. 15365

Causes and Consequences of Intensive Climate Change on Kerala During the Recent Decades

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Background: Globally, changes in rainfall have been drastic during the past few decades and the consequent hydroclimatic hazards especially in the tropical monsoon regions has been attributed to the global warming.

Methods: The present study aims to decode the spatio-temporal evolution of the rainfall from 1901-2020 in the state of Kerala and determine the epochs of intensive changes in rainfall and establish the association with global climate indices using advanced analytical tools. The study further examines the grounds of recently accelerated changes of rainfall in terms of its seasonality, dry spell, wet spells and intensity.

Results: The monthly rainfall trend analysis using an expanding-sliding window with Kendall's Taub, revealed a long-term declining trend of the two peak rainfall months June and July while the August and September shows an increasing trend in rainfall. Also, a declining seasonality index was observed during 1991-2018 pointing to 'markedly seasonal with a long drier season' indicating that the rainfall is being distributed to other months of the year. The analysis of rainfall characteristics during recent decades indicates that the monsoon droughts are becoming more predominant throughout Kerala. This is evident from the decreasing trend in the total number of wet days, prolonged

wet spells and the total rainfall from the wet days and increasing trends in the total number of the dry days, prolonged dry spells and the total rainfall from dry days in the case of annual rainfall and monsoon rainfall. The total rainfall from moderate and heavy rainfall events showed a decreasing trend, while the rainfall from low rainfall events showed an increasing trend.

Conclusions: The observed increasing positive rainfall anomaly during the subset 1991-2020 were analogous to increasing positive Dipole Mode Index indicating the influence of warming sea. From the gathered information on the recent intensification of the changes in the climatological and hydrological variables, the study stresses the need for a revised outlook for the water management sector and agricultural practices of the state.

Keywords: Trend analysis, Kerala Rainfall, Dry Spell, Wet Spell, Seasonality

ENVIRONMENTAL SCIENCE, FORESTRY & WILDLIFE-17 REG. No. 15522

Specimen Matters for Diagnosis-Tackling The Menace of Elephant Endotheliotropic Herpes Virus Infection

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Background: Elephant endotheliotropic herpes virus (EEHV) infection is a serious health concern for elephants with more than 90% case fatality rate in young animals. Adult elephants act as carriers and sustain the transmissibility among herds. Trunk washes and blood samples are the samples collected for the diagnosis of EEHV by PCR, though their effectiveness in detecting infected and carrier is debatable. A case study was done in the EEHV affected-rescued elephant calves at Elephant rehabilitation centre, Kottor to settle this debate.

Method: Continued monitoring of the affected elephants was done through real time PCR relative quantification method using trunk washes and blood samples based on which treatment was initiated.

Results: Blood samples turned negative for EEHV during convalescence.

But trunk wash samples gave positive results for EEHV till complete recovery of the animal and also indicated carrier status with shedding of the virus.

Conclusions: Screening of trunk wash samples not only aids in prompt diagnosis and effective treatment but also a procedure for detecting carriers with or without viral shedding. This case study along with the previous pilot studies satisfies that trunk wash samples are the preferred specimen for accurate detection of EEHV and preventing the transmission of this fatal disease in young elephants.

Keywords: EEHV, trunk wash, real time PCR

ENVIRONMENTAL SCIENCE, FORESTRY & WILDLIFE-18 REG. No. 15757

Assessment of Biochemical Composition and Organic Matter Quality of Beypore Estuary, South West India

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Background: Estuaries are unique geographical environments and in these shallow transitional aquatic systems, sediments play a major role in the aquatic productivity by acting as a sink as well as source of organic matter and nutrients. Hence an integrated tool involving the labile and refractory fractions of sediment is essential for the assessment of biogeochemistry and trophic nature of coastal systems. Chaliyar River, the fourth longest river in Kerala, with a total drainage area of 2933 km^2, joins the Arabian Sea at Beypore. The Beypore estuary had a long history of chemical pollution through untreated or poorly treated effluents from the Rayons factory.

Method: Surface and bottom water samples and surface sediments were collected from 10 stations in the Beypore estuary during December 2020 and February 2021 representing the post and pre monsoon seasons, respectively. The assessment of various physicochemical parameterswas carried out as per the standard methods (Grassoff et al., 1983). Carbohydrates in sediments were estimated using phenol-sulphuric acid method. Protein in dissolved phase was measured using copper reagent and Folin-ciocalteus reagent (Lowry et al 1951) and Total lipids (LPD) were extracted according to Bligh and Dyer (1959) and estimated according to Barnes and Blackstock (1973).

Results: The non-conservative nature of dissolved nutrients suggests that local inputs are the major sources of nutrients into the estuary. During the present study N: P ratio varied between 0.27 and 8.29 and was well below the Redfield ratio, suggesting phosphorus enrichment in the estuary. Analysis of trophic index of water column using total nitrogen and total phosphate indicates eutrophic nature. Total organic carbon of the surface sediments ranged widely in the study region (0.01– 3.8 %); Sedimentary biopolymeric carbon accounted for 32-80% of TOC and ranged from 133 to 12534 μg/g during post-monsoon season and from 413.92 to 12243.18 μg/g during pre-monsoon season, respectively. Biochemical assessment showed the dominance of carbohydrates over lipids and proteins.

Conclusions: Lower proteins to carbohydrates and lipids to carbohydrates ratio indicate a lower nutritive quality of organic matter in the sediments, suggesting significant allochthonous contribution and the heterotrophic nature. The accumulation of detrital organic matter in sediments degrades the quality of organic matter; limiting the benthic ecology and acting as a potential carrier of toxic chemicals and heavy metals. Hence it is highly imperative to develop a sustainable management strategy to prevent further degradation of this fragile ecosystem.

Keywords: Estuary, Organic matter, Biogeochemistry, Biopolymeric Carbon, Trophic status.

ENVIRONMENTAL SCIENCE, FORESTRY & WILDLIFE-19 REG. No. 15947

Landfill Site Suitability Analysis Using Geospatial Techniques and Analytical Hierarchy Process in Pudussery Panchayat, Palakkad District, Kerala, India

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Background: Solid waste management is one of the acute environmental problems in today's world due to enhanced human interactions, rapid urbanization, and industrialization. The main intention of solid waste management is to take out the waste materials to support the economic development and well-being of humans most efficiently at reasonable costs by using spatial techniques like Geographic Information System (GIS) and Remote Sensing. The main objective of the present study was to identify and locate a suitable site at Pudussery Panchayat in Palakkad district, Kerala, for waste disposal, which is economically feasible, environmentally friendly, and socially acceptable manner.

Method: The important nine criteria that have been taken into consideration for the landfill site selection included transportation network, waterbodies, drainage, slope, public assets, settlements, geomorphology, land use/land cover, and depth to groundwater. Geospatial technology and the Analytical Hierarchy Process (AHP) model were used for analysis. Various scores were assigned to different criteria based on their importance in site suitability.

Result: From the study, it was found that out of the total 65.14 km^2 of the study area, 0.14 km^2 (0.21%) area as highly suitable, 0.18 km^2 (0.28%) area as moderately suitable, 25.85 km^2 (39.68%) area as less suitable, 38.97 km^2 (59.83%) area as unsuitable for waste disposal. The resultant map has shown two possible sites for waste disposal within the Panchayat boundary.

Conclusion: The study revealed the efficiency of geospatial technology integrated with the AHP for decision-making and the identification of suitable landfill sites.

Keywords: Solid Waste Management, Geographic Information System, Remote Sensing, Landfill Site suitability, Analytical Hierarchy Process

ENVIRONMENTAL SCIENCE, FORESTRY & WILDLIFE-20 REG. No. 15508

Monitoring the Soil Phytolith and its Dynamics in Natural and Manmade Ecosystems

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Among the various approaches to securely reduce carbon emissions and atmospheric build-up, sequestration of carbon in terrestrial systems is considered the most promising technique to offset unbalanced carbon in the atmosphere. Carbon biogeochemically sequestrated within the silica presents an extremely stable form of carbon in terrestrial systems. The present study concentrates on phytoliths abiogenic siliceous carbon in the plant systems. Phytoliths in forested and cultivated systems were explored in Wayanad plateau and Granite syenite of Kerala part of Southern Western Ghats. Results indicate Wayanad plateau and Granite syenite contain Trapeziform corniculate shaped Phytoliths and in the vertical distribution of soil average PhytOC content were estimated as 2.837%(B_1 horizon)and 0.02% in O and B horizon. Based on the experimental results, selection of high PhytOC-yielding cultivars and standardization of soil management strategies under different ecosystems offer an opportunity to enhance terrestrial carbon sequestration.

Keywords: CO_2 Sequestration, Phytolith, Soil carbon dynamics

06

Environmental Sciences Forestry & Wildlife

Poster Presentation

Genome Wide and Genic Markers to Study Adaptive Genetics in *Korthalsia laciniosa*

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Korthalsia laciniosa (Griff.). is one of the eight major rattan genera in the subfamily Calamoideae under the palm family Arecaceae. In India, the genus is restricted to Andaman and Nicobar Islands with two species viz. K. laciniosa and K. rogersii. Both species are extensively harvested as raw materials for rattan industry. Along with constrains of insular habitat to maintain viable population, the extensive extraction has led to genetic erosion and endangerment of natural resources in this rattan genus. Resource depletion of insular populations of Korthalsia may trigger the vulnerability of species' by reducing the ability to adapt to the changing climate. Hence, proper conservation strategies need to be initiated by identifying the adaptive potential of the species, to sustain the genetic resource, especially in the climate change scenario. Our study intends to focus on the development of neutral and adaptive molecular markers for landscape genomic approach. Data generated via draft genome was used to construct cDNA library of K. Laciniosa. Polymorphic microsatellite markers linked to stress response and plant development were retrieved from the library using MISA. We could identify a total of 3303 EST-SSR. Highly polymorphic 12 molecular markers were identified of which five markers were linked to stress response. These markers could be used to identify the genetic diversity and adaptive potential of the species. The data generated using the markers would provide appropriate information to design and implement conservation strategies.

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-22 REG. No. 12871

Cost Effective Treatment of Chloride Contaminated Effluent from Gelatin Industries Via Friedel's Layered Double Hydroxide Formation

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Background: Gelatin industries play an important role in the production of protein rich foods. But the effluents from such industries are of much environmental concerns. They expel large quantity of wastewater, of which the putrescible fractions are generally managed by anaerobic bioprocesses. However, the final ETP discharge often contain excess chloride, along with other oxy anions like sulfate, phosphate etc. The discharge within exceeding levels of chloride is not advisable as per the guidelines or could create scale formation during recycling. Hence it is highly imperative to developa cost reductive process tobring downthe chloride levels in the effluent and to enhance the recyclability of the discharged water.

Method: The effluent from the gelatin industrywas subjected an innovative Ultrahigh Lime with Aluminium process (UHLA) by which the excess chloride was precipitated as calcium chloroaluminate with the addition of sodium aluminate and calcium hydroxide.

$$4Ca^{2+} + 2Al^{3+} + 2Cl^{-} + 12OH^{-} \rightarrow Ca_4Al_2Cl_2(OH)_{12}$$

Thesupernatant chloride free water can be reused without any scale formation issues and reduce the water consumption in such industries.

Results: The optimum chloride concentration was found to be0.02 M and experimental results revealed that the Cl^{-}: Al^{3+}: Ca^{2+}needs tobe maintained in the range 1: 4: 6for better removal. Other experimental parameters such as pH, reaction time, effect of interferentsetc were optimized.. From the XRD analysis data the formation of layered double hydroxide during the UHLA process can be inferred. The FTIR data confirms the LDH(Freidel salt) formation. Further, reusability-studies with the calcinedLDH were also carried out.

Conclusion: Ultra High Lime with Aluminium (UHLA) process was custom designed for the removal of chloride from the gelatin effluent and

an efficiency of 88% is reported. The obtained bench scale experiment procedure can be scaled up easily.. In addition, thegenerated calcium chloro aluminate (LDH) byproduct of UHLA process has a lot of industrial applications such as anion sorbents.

Keywords: UHLA Process, Friedel's Salt, Coprecipitation, Layered Double Hydroxides

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-23 REG. No. 15774

High Energy Faceted Superhydrophilic Anatase TiO_2 for Self-Cleaned Anti-Fog Wind Shields

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Background: Self-cleaning coatings being a labor-saving technique perceived to be a boon to many a field like in anti-reflective coatings, in paints, and so on. Its application in enormous facades and windshields could bring down frequent accidents besides saving energy and time. Hydrophilic and hydrophobic coatings are commercially available. However, hydrophilic coatings are more desirable for windshield applications. Titania is widely known to be a better choice. Nevertheless, their wettability and photocatalytic activity are not well appreciable in practical terms.

Method: This work brings about the crafting of a reliable superhydrophilic titania photocatalytic self-cleaning coating material through a sustainable and green synthetic strategy. This high energy faceted morphologically engineered titania (TiO_2) nanoparticles which are greatly exposed via a modified hydrothermal route with the assistance of the surfactant polyethylene glycol (PEG) contribute immensely on the self-cleaning property, were analysed using XRD, TEM, and SAED; while UV-Vis spectroscopy is used to study their optical behaviour.

Results: TiO_2 synthesized with the relative concentration of PEG: TTIP ratio equal to 1:1, exhibited superior photo-

catalytic self-cleaning behaviour with 98.82% photocatalytic degradation ($k = 23.25 \times 10\text{-}3\ min^{-1}$) of Methylene Blue as the model dye, with a zero water contact angle within just 5 min of UV irradiation. The photocatalytic and self-cleaning behaviour of the materials can be correlated with the crystallinity and exposed percentage of high-energy facets. Moreover, when PEG: TTIP is 1:1, TiO_2 crystal seems to be enriched with more nanocuboids than spindle-shaped when compared with titania synthesised with lower PEG concentrations and the presence of PEG clearly encourages superhydrophilicity of the material, encompassing the feasibility as an active coating material for a promising practical realization.

Conclusion: This work explores the green synthesis of high-energy faceted titania photocatalysts with superb wettability along with the possibility of commercialising it for self-cleaning coating applications.

Keywords: Titania Photocatalyst, Self-Cleaning Coatings, High-Energy Facets, Zero Wettability

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-24 REG. No. 15807

Ecosystem Based Approach in Aquaculture can be Adopted by Regulating Three Critical Environmental Processes

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Background: There is a growing concern on sustainability in aquaculture sector due to the increased pressure on environment. In this background FAO introduced the concept of Ecosystem Based Approach in aquaculture in 2006 defined as the "strategy for the integration of aquaculture with the wider ecosystem such that it promotes sustainable development, equity and resilience of interlinked social-ecological systems" (FAO 2010). Environment and Ecosystem service is included as one of the key principles of the concept.

Methodology: Water and sediment quality including physico- chemical and biological parameters from a selected zero water- exchange, brackish water grow out system in Alappuzha District of Kerala were analyzed. A total of 23 parameters were estimated. The obtained values were subjected to Principal Component Analysis (PCA)

to elucidate critical components regulating stability of the system.

Results: The three principal components extracted from PCA analysis govern three ecosystem processes .The critical components are a) Phytoplankton Growth Component b) Oxygen Component and c) Decomposition Component.

Conclusion: This study suggested the importance of three processes in the environment in maintaining ecosystem sustainability of the culture system. The Ecosystem Based Approach in Aquaculture can be implemented by proper regulation of primary production, oxygen availability and decomposition and mineralization processes with or without human intervention depending on the required biomass production.

Key words: Ecosystem Based Approach in Aquaculture, Principal Components, Ecosystem Processes

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-25 REG. No. 15775

Groundwater Quality in Coastal Regions of Northern Kerala with Special Reference to Saline Water Intrusion

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Background: Water quality has much importance in our life because it is essential to support physiological activities of any biological cell. The present study focus on the ground water quality analysis of coastal regions of Kozhikode, Kannur and Kasaragod, Kerala, with special reference to saline water intrusion.

Method: 137 samples were collected from different coastal areas wells in Kozhikode, Kannur and Kasaragod districts. Sampling and analysis were carried out as per the standard procedures given in the standard methods for the examination of water and waste water (APHA, 2017). Each sample is collected with 3-5km horizontally distance. The study is conducted in post-monsoon season.

Results: The samples near the sea shore (100-200m from HTL) showed the high rate of saline intrusion. In some extent salt water intrusion is the reason behind deterioration of ground water in private wells near coastal area. The results showed significant correlation with salinity and anions

like chloride, and sulfate. Cations like magnesium and calcium were also significantly correlated with salinity of ground water. More than 90°/o samples showed the presence of Total coliforms, E.coli and Fecal coliform.

Conclusion: The results showed that, only shoreline well water samples (100-200m from high tide line) were affected by the salinity. But samples taken from 1km and 5 km distance from HTL were not affected by salinity. Around 90% of the samples where bacteriologically contaminated. Some of the samples taken from agricultural areas were turbid and contaminated with iron. In 137 samples, around 100 well water is used for drinking purpose. Traditional treatment techniques were used in houses like boiling and chlorination.

Keywords: Water quality, Saline intrusion, Ground water pollution.

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-26 REG. No. 15806

Population Dynamics and Histopathological Effects of Potentially Toxic Bloom Forming Cyanobacterium *Microcystis aeruginosa* from Aquatic Ecosystems of Central Kerala (South India)

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Background: The prevalence and development of blooms by cyanobacterium *Microcystis* sp. that can produce hepatotoxin Microcystin is raising serious threats in the freshwater ecosystems around the globe. Eutrophication is considered to be the significant factor favouring these blooms, and the possible toxic effects to the aquatic systems resulting from the bloom events mark the species as an important research topic worldwide and well documented. Even then, the bloom physiology, population structure, and toxicity studies of *Microcystis* are very little in the Indian aquatic systems scenario.

Method: Routine monitoring of *Microcystis* population and bloom development was conducted along the freshwater ponds of central Kerala from May 2019 to February 2020. Physicochemical and biological parameters (temperature, pH, dissolved oxygen,

and major nutrients such as nitrate, phosphate, silicate, and chlorophyll *a*) were estimated. Qualitative and quantitative analysis of the bloom samples were performed following the standard procedures. Histopathological changes on the organs such as liver, gills, and heart of fish, *Oreochromis mossambicus* exposed to *Microcystis* bloom were studied.

Results: From the present study, the abundance of *M. aeruginosa* was more prevalent during the periods characterised by high surface water temperature (~ 31°C) and nutrient concentrations. Maximum nitrate and phosphate concentrations were 96.7 µmol L^{-1} and 19.88 µmol $L^{-1,}$ respectively. 100% mortality of the candidate fish species was observed within 15 days of exposure to *M. aeruginosa* bloom during the toxicity study. Histological examination revealed severe deterioration, predominantly in the liver cells, indicating the hepatotoxicity of Microcystin. Severe structural impairment in gills and heart were also observed.

Conclusion: The present study accounts for the significant hydrographical parameters conducive for *M. aeruginosa* blooms and their toxicity effects. Considering the impacts and toxicological effects of such blooms, regular monitoring of the freshwater ecosystem is necessary to preserve and maintain the stability of aquatic systems.

Keywords: CyanoHABs, *Microcystis aeruginosa*, Histopathology, Hepatotoxin, South India

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-27 REG. No. 15802

Anthropogenic Impact on Carbon Neutrality Towards the Interaction Between Socio Economic Sectors and Climate

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Background: Strong evidences exist towards the large contribution of anthropogenic warming due to Green House Gases (GHGs) for extreme event occurrences globally and probability of rise in 2°C with uncurbing carbon emission with same rate as of now (Bonfils et al., 2020; Horton et al., 2016; Lu et al., 2016; Meehl et al., 2007; Mishra et al., 2015; Mukherjee & Mishra, 2018; Perkins-Kirkpatrick & Gibson, 2017; Stott et al., 2010). Also, The State, Kerala has been hit by a series of natural disasters, including

the cyclone Ockhi in 2017, tauktae, 2021, and severe floods resulting from extreme rainfall events related landslides in 2018, 2019 and 2021 and the fatalities. In this background, a regional assessment of carbon emission from different anthropogenic intervene sector has estimated in Kattakada GP which will cater to the need of prioritizing the climate action points / carbon sequestration implementation at state level, facilitate more informed deliberations on state/ national level climate policy priorities.

Method: Regional estimation of the major GHGs flux profile of CO_2, CH_4 and NO_2 in socio economic sectors of energy, transport, Agriculture, Forest & Other Land Uses (AFOLU), livestock and waste sectors of Kattakada Gramapanchayat (GP) were performed, Trivandrum, Kerala State. IPCC, 2006 guidelines for National Greenhouse Gas inventories with all anthropogenic sources of GHGs emissions will be applied for the estimation of carbon neutral status of selected sectors (IPCC, 2006, 2019).

Results: Kattakada GP exhibited an excess carbon emission of 23780.6 eq. CO_2 tonne. Highest Carbon footprint was observed from Energy Sector (17956.8 eq. CO_2 tonne). Emission profile of Kattakada GP in different sectors is found to be as follows: Energy > Waste > Transport> Livestock> Agriculture, Forestry and Other Land Use (AFOLU).

Conclusion: The major findings of the investigation reveals that an excess emission of carbon for Kattakada GPs which needs to be nullified. More investigation is needed to nullify the carbon emission from Energy and Waste sector. The carbon sequestration in terms of croplands, soils need to be improved. Detailed intervention plan is formulated for key emission sectors to control the emission of GHGs to the atmosphere to achieve the carbon neutrality status.

Callitriche L., Unveiling an Unrecognized Genus from Kerala

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The genus *Callitriche* L. (Callitrichaceae) includes 30 species of very delicate herbs, growing in shallow lakes and river margins, wetlands, ditches and temporary pools from freshwater to brackish waters. The genus is mostly monoecious, with axillary naked flowers and schizocarpic fruits which separates into four mericarps. *Callitriche* is almost cosmopolitan in distribution with most species found in temperate zones of both the hemispheres but mostly in northern hemisphere. Landsdown (2007) reported thirteen species from Asia. Till now there are only seven species recorded from India.

While documenting the angiosperm diversity of Idukki district, some remarkable specimens of *Callitriche* were collected from different parts of the district. Upon detailed examination, the specimens were recognized as *C. wightiana* Wall. ex Wight & Arn., which has never been recorded from Kerala state and *C. idukkiana* Vishnu & Nampy, a species new to science. Therefore, this paper unveils a hitherto unknown genus *Callitriche* to the state of Kerala. The species are recognized here based on morphological and molecular data. A detailed description, illustration, colour photoplates and SEM photographs of seeds are provided for easy identification.

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-29 REG. No. 15699

Assessment of Total Carbon Content of Pneumatophores from Selected Mangrove Wetlands of Kannur District

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Background: Mangrove ecosystems are highly productive and carbon rich biomes distributed in tropical and sub-tropical regions of the world. Mangroves having different types of special root systems such as pneumatophores, stilt roots, knee roots etc. Pneumatophores are found in the true mangroves like *Avicennia, Bruguiera*, and *Sonneratia* etc. Pneumatophores are efficient in carbon storage and the epiphytic algal association on pneumatophores enhances the carbon sequestration capacity.

Method: The present study was carried out in selected mangrove wetlands such as Payangadi, Cherukunnu and Kunhimangalam. Frequent field visits and quadrat study were conducted. Number of pneumatophores were counted, collected and analysed for biomass and carbon content. Fresh weight and dry weight of pneumatophores with epiphytes and pneumatophores alone (devoid of epiphytes) were also taken. From the observation, biomass and carbon content were calculated (Kauffman and Donato, 2011).

Results : Pneumatophores from the collected study stations were analysed for the biomass and carbon content. Total biomass of all counted pneumatophores from the quadrants were 0.9637 kg, 1.857 kg and 2.5306 kg for the study sites Payangadi, Cherukunnu and Kunhimangalam respectively. The average carbon content obtained from the quadrant sampling at Payangadi was 75.168 kg C/m^2 and at Cherukunnu and Kunhimangalam the carbon content observed as 144.401 kg C/ m^2 and 197.387 kg C/m^2. The total carbon content in the study area calculated were 330.66 kg/ha,75.22 kg/ha and 1094.35 kg/ha for the three study stations Payangadi, Cherukunnu and Kunhimangalam respectively. The difference in the total carbon content of pneumatophores with epiphytes and pneumatophores alone were

calculated. This signifies the contribution of epiphytic biomass in carbon sequestration.

Conclusion : The study reveals total carbon content of pneumatophores from selected mangrove wetlands such as Payangadi, Cherukunnu and Kunhimanglam of Kannur District. From the result it was clear that pneumatophores of mangroves serve as a carbon reservoir and the association of epiphytic algae adds the carbon sequestration capacity of mangrove ecosystem.

Key words : Mangrove, pneumatophore, biomass, carbon content.

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-30 REG. No. 15805

Short Term Variability of Benthic Diatoms of Cochin Estuary-Southwest Coast of India

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Background: Microphytobenthos are the chief primary producers in illuminated benthic substrates of tropical estuaries. Among microphytobenthos, benthic diatoms are a significant community, which in association with bacteria produce extracellular polysaccharides (EPS) that helps in the biostabilization of sediments. The present study describes the short-term variability in the diversity and distribution of benthic diatoms in the Cochin estuary, southwest coast of India.

Method: Benthic diatoms in the Cochin estuary were examined monthly from July 2021 to December 2021. The sediment samples were collected from the top 6 cm using a hand-glass corer of 2cm diameter. The parameters such as sediment temperature, pore water salinity, sediment pH, dissolved oxygen, pore water nutrients (nitrate, phosphate and silicate), organic carbon (OC), organic matter (OM), sediment texture and sediment chlorophyll were analyzed. Statistical analysis was carried out using PRIMER V6.

Results: Benthic diatoms of 38 species belonging to 13 genera were identified, of which pennate diatoms contributed 62%. Major diatoms include *Actinocyclus* sp., *Cyclotella striata, Cyclotella*

stylorum, Gyrosigma wansbeckii, Navicula erifuga, Nitzschia clausii, and *Thalassiosira eccentrica*. The average nutrient concentration of Nitrate, Phosphate and Silicate was 28.32 ± 6.31µmol L^{-1}, 6.18 ± 2.45µmol L^{-1} and 45.14 ± 17.32µmol L^{-1}, respectively. The average sediment chlorophyll *a* was 24.55 ± 8.17 µg cm^{-3} and highest during July (40.97µg cm^{-3}) and lowest during November (19.64 µg cm^{-3}). In the principal component analysis, sediment chlorophyll *a* and dissolved oxygen in pore water was positively correlated with benthic diatom diversity and cell density. Diatom cell density was higher during July (5605 cells cm^{-3}) and lowest during September (2887 cells cm^{-3}). Intensified monsoonal influx negatively affects the density and diversity of benthic diatoms.

Conclusions: The results provide significant insights into the biotic and abiotic factors affecting the structure of the benthic diatom community in the tropical Cochin estuary. The study reveals the species composition of benthic diatoms with its environmental variables. Pennate diatoms are primarily encountered in the surficial sediment because of raphae. Benthic diatoms have a vital role in the nutrient remineralization in the tropical estuary, and benthic biofilm produced by benthic diatoms can prevent coastal erosion globally.

Keywords: Microphytobenthos, Benthic diatoms, Sediment chlorophyll, Cochin estuary, Southwest coast of India.

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-31 REG. No. 15949

Assessment of Spatio-Temporal Variation of Urban Heat Island in Palakkad Municipal Area Using Various Remote Sensing Indices

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Background: Urban Heat Island (UHI) is the phenomenon in which the Land Surface Temperature (LST) rises over the urban areas rather than the surrounding rural areas. The spatiotemporal variation of Urban Heat Island over a period of 2 decades was analyzed using Remote sensing indices in an area of 78.5 sq.km. falling with in Palakkad Municipal area and

the adjoining panchayaths, by utilizing Remote Sensing and GIS techniques.

Method: Determined the changes in land use/land cover pattern and urban heat variation over the study area for a period of 20 years from 2000 to 2020. Various Remote sensing indices were derived from the satellite image. Besides, the relationship of Indices with LST was extracted using the linear regression method.

Results: 7.70% of built-up area was increased in 2020, as compared to 2000. Due to this urban sprawl the LST in 2020 became 3.89˚C higher than LST in 2000. The Linear Regression analysis between LST and Remote sensing indices viz. NDBI, NDVI, NDWI, and MNDWI were done and results showed a positive correlation between NDBI and LST with R^2 values 0.62 and 0.63 in 2000 and 2020 respectively. A high negative correlation between NDWI and LST with R^2 values 0.62 in 2000 and 0.64 in 2020. Further, the MNDWI showed a weak negative correlation with LST in the study area in 2000 and 2020, R^2 values 0.22 and 0.28 respectively. NDVI and LST with R^2 values 0.38 and 0.40 in 2000 and 2020 respectively. Correlation between NDWI and NDVI was also verified which showed a negative correlation and R^2 values of 0.45 and 0.59 in 2000 and 2020 respectively.

Conclusion: As compared to 2000 an increment of 7.70% of built-up area was determined in 2020. This is the reason for the variation of UHI. From the study, it was found that the Palakkad urban area needs more attention in future urban development to reduce the UHI.

Keywords: Urban Heat Island; Land Use/Land Cover; Remote Sensing Indices; Remote Sensing; Linear Regression.

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-32 REG. No. 10026

A Green Bio-Economy Through Microalga - *Scenedesmus* Spp. Potential Species for Biodiesel Production, Bioactive Molecule and Bioremediation

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Background: In the current decades, microalgae are treated as the most promising source for biological applications such as production of biofuel, value-added biomolecules and also used in wastewater treatment. Microalgal culturing practices for bioactive compounds and biofuel are very less in India, when compared to other countries. Even though, Kerala is well known for its water bodies and wetlands, microalgal diversity is least explored and valorised in terms of economic aspects.

Method: The present study focused on the isolation and cultivation of commercially important genera of green algae, *Scenedesmus* from Cochin estuary. Biochemical characteristics, antioxidant properties, and various bioactive compounds like carotenoids, Extracellular polysaccharides and different phytochemical compounds were estimated. Biodiesel production was checked through Nile red staining, transesterification of algal oil and quality assessment of biodiesel. In addition, the strains were cultivated in different concentrations of fish silage as feasible cultivation media.

Results: *Desmodesmus subspicatus*, *Acutodesmus acuminatus*, and *Pectinodesmus pectinatus* are the various *Scenedesmus* species isolated from Cochin estuary. All the unialgal cultures showed a significant amount of protein, carbohydrates, lipids, and various carotenoids, also exhibited high antioxidant activities by DPPH and ABTS assays with rich phenolic compounds. The cultures varied in the concentration of alkaloids, tannins, flavonoids, glycosides, saponins, and EPS production. Quality biodiesel were produced by *D. subspicatus* and *P. pectinatus*. Lower concentrations of fish silage were used for high algal biomass production with effective nutrient removal.The algal biomass with silage medium after biodiesel production can be used as a good fertilizer for plants.

Conclusions: *Scenedesmus* spp. is one of the important genera for microalga

used for biodiesel production, bioactive molecule and wastewater bioremediation. The current study establishes a zero-waste culture practice with microalgae for nutraceutical and biofuel applications. The native species isolated has higher growth potential, more tolerance, adaptation to the local environment; thus it can be recommend for the commercially viable for industrial production and application.

Keywords: Microalgae, Kerala, Cochin Estuary, *Scenedesmus*, Bioactive Molecules, Biofuel

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-33 REG. No. 15916

Effect of Substrate Inoculum Ratio on the Anaerobic Degradation of Sugarcane Bagasse for Biogas Production and Natural Fibre Extraction

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Background: In India, nearly 100 million tonnes of sugarcane bagasse (SB) is generated in a year. Most of it is being wasted by burning for power generation. Anaerobic degradation (AD) can be applied as a biological pre-treatment method for extracting natural fibre and biogas from SB. AD is a complex process which involves multiple steps and microbial groups; association of different microbial group is critical for AD process. Substrate to inoculum ratio (S/I) is one of such factors which govern the amount of microbial load in AD process. If the S/I are high, the more amount of substrate can be loaded into the reactor, but if it goes beyond the critical level it will adversely affect AD process.

Method: In the current experiment, four different S/I ratio 2.33, 3.08, 4.72, and 9.02 were tried for the AD of SB. Cumulative Methane Yield (CMY), pH and substrate degradation is taken for studying the effect of different S/I ratio on the AD of SB.

Results: When S/I ratio at 2.33, 3.08, 4.72, and 9.02 the corresponding CMY was 597 mL, 403 mL, 92 mL and 19 mL/ g VS_{added}. Instability in the pH and souring of digestate was observed when S/I ratio increased above 3.08. A strong negative correlation between the S/I ratio and the degradation of SB was observed; as the ratio of S/I increases, the degradation rate of the SB reduces proportionally.

Conclusion: S/I ratio upto 4 can be used for pretreatment of SB by AD process without much instability. The theoretical reduction of CMY calculated from current experiment at S/I of 4 was about 50%, which is ideal for pretreatment of SB because almost twice the amount of SB can be loaded when S/I ratio increased from 2 to 4, without changing working volume of reactor. But the ideal condition is at S/I = 3, where substrate loading can increase by 150% and 70% CMY can be recovered. The overall results from the experiment conclude that for AD of SB, a S/I ratio of 3 was most appropriate, but it can be extended to 4 without much instability with the AD process.

Key words: Anaerobic Degradation, Substrate Inoculum Ratio, Sugarcane Bagasse, Cumulative Methane Yield

Acknowledgement: The study was funded by CSIR-NIIST, Thiruvananthapuram, Kerala, India.

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-34 REG. No. 15820

Extraction and Enumeration of Microplastics from the Soils of Mangalavanam Bird Sanctuary – A Protected Mangrove Forest in Kerala, India

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Microplastics are considered to be plastics of size less than 5 mm by the scientific community. The havoc caused by microplastics has emerged only two decades ago. The researchers are still discovering the ecological, social, and economic impacts of these tiny particles. The behaviour, fate, and impacts of microplastics in various environmental compartments are still a topic of research. Microplastics have shown their presence almost everywhere from food items to pristine locations on the earth. Here, an investigation is done on the soil microplastics present in an ecologically sensitive protected mangrove situated amidst the hustles of Kochi city. Urban mangroves are one of the least studied ecosystems in the context of microplasticsand this is the first study of microplastics in a mangrove in Kerala. The microplastics in the soil samples were categorized based on their abundance, colour, size, and shape/type. We have identified six

colours; red, green, blue, black, yellow, and transparent. The collected microplastics contained four different types/ shapes - spheres, foams, fragments, and fibres.

Keywords – microplastics pollution, soil microplastics, urban mangrove ecosystem

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-35 REG. No. 15613

Geo Chemical Variations in Contrasting Ecosystems of the Southern Western Ghats

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Background: Minerals, more specifically the clay minerals, endow the soils with unique surface charge chemistry and provide chemical homeostasis to the terrestrial biogeochemical cycles. The ions released from the clay minerals are gradually removed from the system by plant uptake, leaching and harvesting regimes. Ion extraction over long continuous cycles of plant growth renders the soils chemically degraded and reduces its productivity.

Methods: Clay mineral were extracted from soils different ecosystems such as forest, plantation and open land. Soil chemical properties such as pH and EC were analysed. XRD analyses of the clay fractions were done using randomly oriented thin film samples

Results: At surface soil of forest ecosystem quartz (36.74%), kaolinite (29.37%), smectite (22.04%), gibbsite (5.04%), feldspars (12.33%), and kaolin minerals (5.43%) were found. Minerals such as quartz (15.71%), kaolinite (53.55%), smectite (16.59%), gibbsite (4.11%), feldspars (12.33%), illite and micas (3.35%) and kaolin minerals (5.32%) were found in surface soils of open land. At surface soil of plantation quartz (7%), kaolinite (31.53%), smectite (14.83%), gibbsite (22.06%), illite and micas (10 %), vermiculite (5.16%), chlorites (1.2%) and kaolin minerals (5.06%) were found.

Conclusion: 2:1 minerals such as smectite and illite and micas were found to be higher in plantation moderate in forest and low in open land. 1:1 mineral such as kaolinite was found to be higher in open land (53.55%) compared to forest (29.37%) and plantation (31.53%). Mineral variations were high in plantation compared forest system and open land.

Keywords : Clay, 1:1 mineral, 2:1 mineral

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-36 REG. No. 14101

Effect of Bio Control Agents on Post-Harvest Disease Management and Organoleptic Properties of Banana

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Background: Banana is an integral fruit component of most farming systems in Kerala and it is also an important commercial fruit crop of the country next to mango. Since it is a highly perishable fruit it is very much susceptible to the post-harvest diseases. Crown rot, incited by *Lasiodiplodia theobromae*, *Colletotrichum musae* and *Fusarium* sp. is a major threat for growers causing losses during storage and by reducing its fruit quality, shelf life and marketability. It is very much essential to develop the stable biocontrol strategies efficient for the post harvest management.

Method: A study was done at College of Agriculture, Vellayani, Kerala Agricultural University to observe the effect of selected biocontrol agents on the post harvest disease suppression and organoleptic properties of the treated fruits. Selected biocontrol agents *Trichoderma harzianum*, *Aspergillus aculeatus* and *Aspergillus niger;* essential oils cinnamon oil 0.05%, clove oil 0.1% and basil oil 0.1% and the combination of biocontrol agents and essential oils were tested against the major pathogen *L. theobromae*.

Result: The study revealed that among the biocontrol agents, KAU isolate *T. harzianum* (KAU T_2) showed maximum inhibition of the disease (66.67 % PDI); Only less than 50 per cent reduction in control was observed for cinnamon oil (0.05. At higher concentrations of cinnamon oil tested i.e., at 0.8%, 99.67 per cent disease reduction was recorded over the pathogen inoculated control. An increase in shelf life was noticed in case of fruits treated with *T. harzianum* (3.25 days). Mean of ranks and mean score value for overall acceptability was analysed for all the treatments. It was found that best treatment was cinnamon oil (0.8 %). Among the biocontrol agents used, *T. harzianum* treated fruits had higher rank.

Conclusion: The study revealed that shelf life was enhanced and organoleptic properties were improved by the application of biocontrol agent T. harzianum and essential oil on banana

fruits along with disease control.

Key words: Crown rot, *Lasiodiplodia* sp. postharvest rot, organoleptic property, banana

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-37 REG. No. 15750

Cyanobacteria as Indicators of Water Quality, A Case Study in Chaliyar River, Kerala

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Background: The study analyzed water quality parameters and cyanobacterial diversity from thirteen different sites in Chaliyar River, Kerala. The cyanobacterial diversity and density indicating that the river was eutrophicated and affect the water quality.

Method: Thirteen water samples were collected from Chaliyar River. All the water quality parameters were analyzed as per the standard procedure proposed by APHA (2017). Phytoplankton samples were collected by passing water through plankton net of mesh size 60um (microns). The identification of cyanobacteria and other phytoplankton was carried out by using a microscope and monographs of G. W. Prescott (1962).

Results: The physico-chemical analysis of the water revealed that the pH range from 6.68 to 9.2 (mean 7.90), nitrate from 0.0 to 3.41 mg/l (mean= 1.10), Water Temperature from 30.7 to 34.9 ^{0}C (mean= 32.23), Phosphate from 0.0 to 0.04 mg/l (mean= 0.014), dissolved oxygen from 3.10 to 8.25 mg/l (mean= 6.18). *Anabaena sp.* dominates and reaches 35600 cells /ml at the level of pH 6.68. There is a high variation in the density of cyanobacteria with different time and locations. *Microcystis* are present in all the samples and followed by *Anabaena* (85%), *Oscillatoria* (62%), *Kirchneriella* (46%), *Spirulina* (38%), *Chroococcus* (0.15%) and *Merismopedia* (0.08%). Microcystis is positively correlated to Nitrate (r= 0.3) and Anabaena is not associated to nitrate (r= -0.003). There is a positive correlation between biochemical oxygen demand (BOD) and anabaena density (r = 0.71)

Conclusion: Density and diversity of cyanobacteria of Chaliyar River are related with parameters of water quality. The dominance of a single cyanobacteria species indicating low water quality in that region and one

of the significant factors that affect the cyanobacteria development is nutrients. Here it shows nitrate and ammonium are the key nutrients that triggers the algal bloom.

Keywords: Cyanobacteria, Chaliyar River, Water quality, Algal bloom

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-38 REG. No. 15581

Miyawaki Afforestation, A Solution at Local Level?

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Background: The global demand of increasing green cover has come up with may ecosystem restoration activities, many of which are unscientific like growing monoculture plantations and converting open grassland and savanna ecosystem into forests. Miyawaki method of afforestation is a 50 years old practice developed and scientifically proven by the Japanese botanist, Akira Miyawaki using the principles of Potential Natural Vegetation and ecological succession.

Method: This article give insight into the implications of Miyawaki method based on the studies across the globe and its trial events in India. All the 15 relevant articles obtained only from Google Scholar database and 20 newspaper reports from reputed Indian newspapers have been reviewed in the article.

Results: The Miyawaki forests maintained physical and biological attributes of near natural forests in temperate regions. However, in tropical countries like India, the efficacy is not scientifically reported since it is slowly gaining momentum only since last few years. Albeit the trials were successful considering the plantation density which is thirty times denser than regular forests, comparison of photosynthetic rate and carbon sequestration capacity have not been done.

Conclusion: Establishment cost of the method is high, but is helpful in increasing the green cover and enriching biodiversity in shortest time with minimal maintenance except for the first few years. Assistance from voluntary organizations and corporate firms can be made use of in meeting the financial requirements and monitoring activities.

Keywords: Miyawaki afforestation, ecosystem restoration

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-39 REG. No. 15482

An Evaluation of Lejeuneaceae on Phorophytes

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Background: Bryophytes are the simplest and most primitive group of land plants, it occupy almost all kind of habitats. Epiphytic bryophytes constitute an important and integral part of communities. *Lejeunea* Lib. species is one of the largest genera of the family Lejeuneaceae (Marchantiophyta). They are mainly phorophytes growing on tree trunks, branches of trees or shrubs, leaves, and some on rotten logs.

Method: Random selection of conserved forest and plantation areas of Kannur district of Kerala is selected as the study site. Sample growing firmly adhered to their substrata were scraped with the help of a knife or cut along with the substratum with a chisel. Morphological characters were studied using Leica stereo microscope and anatomical studies were carried out using Magnus camera. The herbarium specimens were kept in Herbaria of Sir Syed College Taliparamba. Host species specificity and its interaction were studied.

Results: The study revealed that Lejeuneaceae grows well in slight acidic to neutral pH and it favours a rough textured bark. Eight species of Lejeuneaceae were observed on different host plant, which include both angiosperm and gymnosperm. Among the angiosperm host Anacardiaceae family were dominating over other families. Significant host specificity was not seen among these group.

Conclusions: This study showed the importance of conservation of phorophyte since it serves as the shelter for many species. The climate and geography do play an important role in deterring the makeup of epiphytic communities. Maximum growth and spread was observed during the monsoon. Often neglected agricultural environments showed species richness.

Keywords: Lejeuneaceae, Phorophytes, Leica stereo microscope, Host species

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-40 REG. No. 15485

Phylogrouping and Determination of Antimicrobial Resistance of *Escherichia coli* Isolates from Faeces of Sloth Bears (*Melursus ursinus*) in Wayanad Wildlife Sanctuary, Kerala.

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Background: The sloth bear (*Melursus ursinus)* of the Ursidae family native to the Indian subcontinent is listed as vulnerable by the IUCN and protected under schedule I of India's wildlife protection act. Ursidae has a complex gut microbiota that varies depending on the dynamic interplay among diet, host, and commensal bacteria. *Escherichia coli* are gram-negative bacteria that are present as part of the normal bowel flora of humans and animals.

Method: Phylogrouping and determination of antimicrobial resistance of Escherichia coli isolates from faeces of sloth bear (Melursus ursinus) in Wayanad, Kerala was done from March to July 2019. Fresh fecal samples were collected from different areas of Wayanad Wildlife Sanctuary (not older than 7 day old and characterized by an outermost layer stained with intestinal exfoliated cells, a slightly glossy mucus layer). The study was conducted to isolate and phylo-group E. coli by Polymerase chain reaction (PCR) from the faecal samples and also to assess the antimicrobial susceptibility pattern of the isolates by disc diffusion method.

Results: The faecal samples collected were cultured on agar media to isolate E. coli. The bacteria were characterized based on the Grams staining and biochemical characteristics. The phylogrouping was then carried out employing the quadruplex PCR method. Fourteen isolates of E. coli were obtained from the 31 samples collected. Out of the 8 phylogroups A, B1, B2, C, D, E and F that could be detected by the quadruplex PCR methods, isolates of phylogroup A, B1, B2, C and D could be detected. The identity of one isolate was unknown.

The antibiotic susceptibility testing were also carried out for the isolates of *E. coli* from the faecal samples. The

bacterial isolates were subjected to disc diffusion assay. The antibiotic susceptibility testing of *E. coli* isolates from 14 samples to 6 antimicrobial agents shows that all isolates are 100 per cent resistance to Ciprofloxacin and Clindamycin.

Conclusions: *E. coli*, especially of human origin, is a common contaminant of water. Contaminated water, when consumed, could spread the infection to wild animals sharing the water source and could potentially lead to disease condition. There is a high chance of faecal contamination of the lentic and lotic water sources near the human settlements which are in the fringe areas of the forest and could cause infection to other wild animals.

Kerwords: *E.coli*, Sloth Bear, Phylogrouping, Wildlife, Antimicrobial Resistance

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-41 REG. No. 15509

Effect of Sub-Micromolar Concentrations of Cadmium and Lead on the Diversity and Carbon Utilization Pattern of Bacteria in the Water Column of Cochin Estuary

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Cadmium (Cd) and lead (Pb) are the most harmful heavy metals in coastal ecosystems because of their higher affinity with organic matter and induce toxicity at the lowest concentration to all organisms. Microbial response to cadmium and lead varies depending on their concentrations and bioavailability. Some bacteria may die at lower concentrations of Cd and Pb, but there are bacteria which can enter into a viable but non-culturable status (VBNC) or even active in the presence of higher concentrations of these metals. In the current study, we investigated the effect of Cd and Pb on the diversity and carbon utilization pattern of bacteria present in the water column of the Cochin estuary. Water samples collected from the estuary were spiked with submicromolar (0.2 to 1 µM) concentrations of $CdCl_2$ and $Pb(NO_3)_2$ and incubated for 24 hr. The community strcture and carbon substrate utilization pattern of bacteria in the sample were studied using

denaturing gradient gel electrophoresis (DGGE) and Biolog EcoPlate™ respectively.. We observed no significant difference in the Shannon Diversity Index (H'), calculated based on the DGGE profile, between different samples exposed to different concentrations of Cd and Pb. However, the carbon substrate utilization was significantly reduced with the increasing concentration of Cd and Pb. The H' of carbon substrate utilization of bacteria (3.1- 3.2 in the control) decreased with increasing concentrations of heavy metals and reached a minimum of 0.7 to 0.8 in the flasks treated with 1 **µM of Pb and Cd respectively.** Results of the current study indicate that the sub-micromolar concentrations of Cd and Pb can arrest microbial metabolism in the estuaries, which may induce deleterious effects on the biogeochemical cycling of nutrients.

Keywords: heavy metal pollution, substrate utilization, diversity, cadmium and lead, sub-micromolar concentrations

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-42 REG. No. 15867

Investigation on Temporal Dynamics of Two Populations of *Hopea racophloea* Dyer of the Western Ghats

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Background: The Dipterocarp forests are at the brink of disappearance as their logging has been increased at alarming rates in many regions of the Western Ghats. The species like *Hopea erosa*, H. *Jacobi*, and *H. racophloea* are known only from limited localities, and their high degree of habitat specificity makes them rare. Most of the Dipterocarpaceae are economically important, and these are undergoing a high level of human exploitation.

Methods: This study has been conductedin 1 ha (100m*100m) permanent plots established by Kerala Forest Research Institute in two patches of tropical wet evergreen forests, namely Nadukani (NK) and Palaruvi (PV).The

field survey was carried on September 2002, June 2014 and September 2021. A comparison of the Biomass, Basal area, Density and IVI of *H. racophloea* in three censuses were done to evaluate the temporal dynamics in stand and structure in the population of two-study sites.

Results: Stand structure analysis of two population of *H. racophloea* from 2002 to 2021 revealed a healthy population dynamics of *H. racophloea*. Populations of both the Nadukani and Palaruvi were contributing prominently for the total basal area and biomass of both forest stand and we are reporting a positive relationship between all demographic parameters and time. A comparison of density distribution across different girth class between the two studied populations revealed the population of species *H. racophloea* of Nadukani forest is more stable than that of the Palaruvi forest.

Conclusions: Based on the dynamics of the above parameters we can conclude that in both the study areas *H. racophloea* population is improving its dominance over 20 years. The contribution of *H. racophloea* towards the basal area and biomass of the study sites were very prominent and has a critical role in carbon cycling in the studied community.

Keywords: Basal area, Biomass, Density, Population Dynamics, Girth class

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-43 REG. No. 15887

Distribution Pattern of Marine Seaweeds in the Coastal Region of Kannur District, Kerala

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Background: Seaweeds are important macroscopic algae which forms a major biotic component of shallow coastal ecosystem. They are mainly distributed in the rocky intertidal regions and hence play a major role in maintaining the coastal diversity and also forms one of the key environmental resources. Seaweeds, the primary producers give nutrients and energy for higher trophic groups. Seaweeds are widely utilized as a source of food, feed, fertilizer and medicine. Luxuriant growth of seaweeds found in the along the coastline of Andaman-Nicobar Islands, Lakshadweep

islands, Gujarat, Tamil Nadu, Maharashtra, Goa, Kerala, Orissa etc. Even though seaweeds were widely studied in India, there are many regions rich in seaweeds which are not investigated yet. The present survey is designed to understand the species diversity, distribution, abundance of seaweeds in the northern Kerala coast and also recognize its economic potential.

Method: The present study was conducted from November 2019 to January 2020, collection was made during once in each site. Field collections were made from coastal regions of Kannur district. Random sampling method was used for seaweeds collection. The collected samples were preserved in 4% formalin. Standing stock of seaweeds were also estimated.

Results: A total of 13 species of seaweeds were collected from the 9 study areas. From the total species, 5 species were from Chlorophyceae, 6 species from Rhodophyceae and 2 species from Phaeophyceae. Among the seaweed biomass distribution *Gracilaria corticata* contributed 24% followed by *Gelidium* (17%), *Hypnea esperi* (12%) and *Caulerpa sertularioides* (11%). From the total collected species, 10 species were economically important- *Ulva, Enteromorpha, Cladophora, Caulerpa, Padina, Gelidium, Gracillaria, Hypnea esperi, Hypnea musciformis,* and *Coralline officinalis*. Most of these seaweeds are edible and can be used as fodder, manure, and also used for medicinal, industrial purposes (agar, carrageenan, etc). In the present investigation *Gracilaria corticata* contributed the major share of biomass among other seaweeds.

Conclusions: In this context, the present study emphasiz that large scale cultivation of seaweeds support rural employment and this could make a key role in strengthening the rural economy in the coastal region.

Keywords: Seaweeds, Kannur coast

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-44 REG. No. 15883

Impact of Climate Change on Hydrology in Karamana- Neyyar River Basin

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Climate change is recognized to be one of the most severe problems in future. In this study, the impact of climate change on the streamflow of Karamana-Neyyar river basin, Kerala is investigated. The Soil and Water Assessment Tool (SWAT) model is used to find the impact of climate change on streamflow. For assessing the change in hydrology, five Global Climate Models (GCM) such as BNU, CANESM, CNRM, MPI ESM LR, MPI ESM MR and two critical scenarios like Representative Concentration Pathway(RCP) 4.5 and RCP 8.5 are used. Modelling is done using SWAT for the historic data and the model is calibrated using Sequential Uncertainty Fitting Algorithm (SUFI2) in SWAT-CUP, which showed results with coefficient of determination (R2) and Nash-Sutcliff Efficiency as 0.65 & 0.72 for calibration and 0.52 & 0.68 for validation. The model parameters are fitted using the calibration results and models are framed with future climate data. The outputs from GCMs for future periods are aggregated into three time slices T1(2011-2040), T2(2041-2070), T3(2071-2100) for both emission scenarios. The model results demonstrated an increase in precipitation. It is also observed that the runoff is increasing as +3.54 %, +9.71 %, and +8.99 % for near, mid and far periods respectively of RCP 4.5 and by +21.80 %, +11.96%, and +44.99% for near, mid and far time periods of RCP 8.5 which is a very significant impact..

Keywords: Climate change, SWAT, Hydrological model, Global Climate Models

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-45 REG. No. 13154

Germplasm Conservation of Wild Relatives of Cultivars from the Andaman Archipelago Outside the Islands

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Wild Relatives of Cultivars (WRC) has a key role in food security of the mankind and economic developments of countries. The wild relatives of cultivars occurring in Andaman-Nicobar Islands seem to be a lesser-known group even now in the Indian context. This potential group encompasses quite a lot of endemics and other extra Indian Malaysian taxa with potential economic values. The Plant Genetic Resources (PGR) of the Andaman-Nicobar is remarkable with wide range of lesser-known Wild Relatives of Popular Cultivars such as spice plants, fruit plants, plantains, tubers, aroids, yams, cereals and a few popular cash crops. The Andaman - Nicobar Islands in the Bay of Bengal is far off from the Coromandel Coast of the Peninsular India between the latitudes 6° 45′ to 13° 41′ N and longitudes 92° 12′ to 93° 57′ E. This Archipelago covers an area of around 8249 sq. km stretching in north south direction and comprises around 306 major islands and 206 islets. These islands are mostly uninhabited and with sandy or rocky seascapes merging into dense littoral forests. According to current enumeration, the insular floristic composition consists of 2314 Angiosperm species circumscribed under 1011 genera belonging to 181 families, within the limited fragmented land masses of 8,249 sq km, representing high degree of plant diversity and fragile ecological equilibrium. This Andaman- Nicobar region is susceptible towards catastrophic events like cyclones, volcanic eruptions, earthquakes, tsunamis etc. Various ecological, climatological and anthropogenic attributes found to prevalent upon the insular flora highlighting the mandatory requisite of insular germplasm conservation outside the Islands. The current poster exhibits details on ex-situ conservation of insular WRC at JNTBGRI Field Gene Bank.

ENVIRONMENTAL SCIENCE, FORESTRY & WILDLIFE-46 REG. No. 15707

Isolation and Characterization of Bioluminescent Bacteria andits Application in Mercuric Chloride Toxicity Testing in Soil

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Background: Bioluminescence is a natural phenomenon in which living organisms produce light as a result of their biochemical and enzymatic activities. Bioluminescence is produced by bacteria, algae, squid, and fishes. Among these bacteria are the most abundant bioluminescent organisms and can emit a blue/green light for communication purposes provoked by the enzyme luciferase. The application of these bacteria in Environmental Science as contaminant biosensors is gaining attention recently. In this study, we sought to search for novel bioluminescencebacterial species to test their potential use as bioindicators of pollutants and their application in mercuric chloride ($HgCl_2$) toxicity testing in soil.

Materials and Methods: The samples used were Indian Mackerel, Anchovy, Raja Rani, and Squid. The portions taken from the eye, fin, gut, gills, scale, and ink were suspended overnight in sterile sea salt saline and screened for bioluminescence production by using media such as Photo Bacterium Agar, SWCA, LA, BOSS agar, and TCBS. Only bioluminescent organisms were usedfor further study. Morphological and biochemical characterization was carried out with the help of ABIS software and based on Bergey's Manual of determinative Bacteriology and molecular identification by amplifying 16srDNA.Mercuric chloride toxicity was tested by inoculating *Pseudomonas fluorescens* to solutions with soil containing mercuric chloride at varying concentrations (0.5,1,1.5, 2, and 2.5g). After 12 hours of incubation in a shaker at room temperature, the organisms were subcultured on Photo Bacterium Agar.

Result: Out of 140 organisms isolated from different parts of the fish, 45 organisms showed bioluminescence property. Bioluminescent bacteria were identified as *Pseudomonas fluorescens biovar, Pseudomonas cichorii, Pseudomonas salomonii* , and *Vibrio vulnificus*. *Pseudomonas fluorescens* used for the detection of metal toxic-

ity in soil. It loses its luminescence in the presence of mercuric chloride at 1mg/l, not at 0.5mg/l.

Conclusion: The loss of bioluminescence shows the soil is contaminated with toxic metal. The presence of chemical pollutants and toxins disturbs their cell metabolism, leads to the loss of bioluminescence. *Pseudomonas fluorescens* bacteria can be used as contaminant biosensors for the detection of the toxic level of acute and cumulative poisons like mercuric chloride in soil. This rapid, simple, and sensitive test, can also be used to find out the concentration of other pollutants in soil and water such as fluoride, chromium, zinc, lead acetate, ferrous sulphate.

Keywords: Bioluminescent bacteria, Mercuric chloride toxicity

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-47 REG. No. 15930

Taxonomic and Functional Heavy Metal Resistome Profiling of Mangalavanam Mangrove Ecosystem and Comparative Analysis Across Other Tropical Ecosystems

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Background: Rapid urbanization and ensuing anthropogenic pollution has led to extensive heavy metal accumulation in mangrove ecosystems, especially in developing countries like India. Consequently, the resident microbial population develop the ability to resist/tolerate high metal concentrations. In this context, a metagenomic investigation of Mangalavanam mangrove in Kerala undertaken to discern diversity and ecological function of its microbial consortia. Mangalavanam mangrove, often dubbed as 'the green lung of Cochin, is a non-tidal part of Vembanad-Kol wetland and one among 26 Ramsar sites in India.

Method: Metagenomic DNA was extracted from the surface sediments of Mangalavanam mangroves and *de novo* whole metagenome shotgun sequencing was performed on the Illumina HiSeq 2000 platform. Analysis of the sequencing data was performed on MG-RAST server.

Results: Whole metagenome shotgun sequencing of the mangrove sediment

identified functional and taxonomic attributes of contigs related to arsenic, cadmium, chromium, cobalt, copper, mercury and zinc resistance. Among the functional categories, Cobalt-zinc-cadmium-resistance was predominant, followed by Copper homeostasis, Zinc resistance, Arsenic resistance, Resistance to chromium compounds, Copper homeostasis: copper tolerance, Mercuric reductase, Mercury resistance operon, and Cadmium resistance. Taxonomic annotation of contigs involved in heavy metal resistance displayed a high abundance of phylum *Proteobacteria*. Comparative taxonomic and functional analysis enabled an understanding of global prevalence of heavy metal resistome profiles across comparable or related tropical niches. Mangalavanam mangrove sample showed strict correlation to oil/anthropogenic impacted Brazilian mangrove sample.

Conclusion: Identification of heavy metal resistant/tolerant bacterial species and their genetic determinants will help to understand ecological implications of heavy metal pollution and identify potential bacteria for bioremediation. These observations can aid strategies to control/regulate anthropogenic activity mediated increase of heavy metal resistance. This approach can be the mainstay for continuous evaluation of heavy metal impacted environmental niches by monitoring selected metal resistance contigs.

Keywords: Metal resistome profiling; heavy metals; mangroves

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-48 REG. No. 15480

Effective Adsorption and Removal of Phosphate from Aqueous Solutions by Calcined Friedel Salt

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Background: Pollution by phosphates has become a global environmental problem with the increasing discharges from human industrial activities and urbanization. Although it is an essential nutrient for growth of microorganisms in aquatic environments, excess concentration can stimulate plant growth, resulting in eutrophication. In the present study, the performance of Friedel's salt (FS) as an adsorbent for phosphate removal

from aqueous solution was investigated. In recent years, exploration for new low-cost & high-efficiency adsorbents have been a hot topic. The developed process utilizes the FS waste byproduct generated during chloride removal from chemical industries and is a classic illustration of emerging circular economy concept in waste management.

Method: The experiment on phosphate adsorption by FS (Friedel's Salt) and CFS (Friedel's Salt calcined at 550^0C) was performed and compared using batch experiment technique. The characterization of synthesized adsorbents was carried out using SEM EDX, XRD and FTIR methods. The effect of pH, temperature, contact time, amount of adsorbent and concentration of adsorbate for maximum adsorption, were evaluated. The interference effect of common anions was also studied. Spiking experiments were conducted with river, tap and mineral water samples inorder to underline the application potential of the material.

Results: The studies proved that FS calcined at 550^0C exhibited better adsorption characteristics than un-calcined system. However, lower pH and higher temperature was found to have detrimental effect. As low as 0.1 g of CFS was sufficient to remove 98% vis-à-vis 51.34 % for FS from 500 ppm phosphate solution. The isotherm data of FS was found to be well fitted with Langmuir while sorption kinetics was best fitted with pseudo first order kinetic model. Thermodynamic study confirmed the spontaneity and exothermic behaviour of the process. Excellent results were obtained for all the real water samples collected.

Conclusion: The studies proved that the calcined layered double hydroxides of Friedel's salt are a potent candidate for phosphate removal.

Keywords: Friedel's Salt, Phosphate, Adsorption, Calcination

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-49 REG. No. 15895

Deep Learning-Based Landslide Hazard Prediction in Southern Kerala

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Landslides are of the frequent natural hazard affecting the Western ghats of Kerala. The present study aimed to develop accurate and reliable landslide susceptibility map for the southern Kerala viz., Idukki, Kottayam, Pathanamthitta, Kollam and Thiruvananthapuram using deep neural networks. For this a total of 1907 landslides are collected and nine geo-environmental variables such as lithology, soil texture, land use/land cover, slope angle, slope aspect, distance from roads, distance from streams, distance from lineaments and topographic wetness index are selected for modelling. The model is validated with ROC-AUC and other confusion matrix-based measures. The generated landslide susceptibility map is further classified into five categories such as least susceptibility area, low susceptibility area, moderate susceptibility area, high susceptibility area and extreme susceptibility area. About 78.64% of the study area falling under least susceptibility followed by 8.55% in low susceptibility, 7.73% in moderate susceptibility, 1.39 percentage in high susceptibility and 3.69% in extreme susceptibility. The model obtained 91% accuracy in training section (AUC-0.91) and 90% accuracy in testing sections shows the ability of DNN in classifying landslides and non-landslides correctly. Besides the generated landslide susceptibility map is trust worthy and can be used for future hazard mitigation.

ENVIRONMENTAL SCIENCES, FORESTRY & WILDLIFE-50 REG. No. 15782

Seasonal Variations in Physico Chemical Parameters and Nutrient Dynamics in Ashtamudi Estuary, A Ramsar Site, South West Coast, India.

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Background: Ashtamudi Estuary has been designated as Ramsar Site in November 2002. The Lake is exposed to pollution from human as well as non- human interferences like urban and sewage pollution, coconut husk retting, land reclamation etc. In the present study, the nature and degree of pollution and its influence on the backwater environment have been discussed. The major objective of the study is to acquire a better understanding of the seasonal variation in the general hydrography and nutrient concentration of Ashtamudi Estuary.

Method: Samples of water and sediments were taken from fifteen locations during Non-monsoon and Monsoon Seasons of 2021, using a boat as sampling platform. Surface water samples were collected using Niskin sampler (GO FLO, USA). General hydrographical parameters and nutrients of the surface waters were analysed using standard methods (Grasshoff et al., 1999; APHA,2005).

Results: pH is one of the most important water quality indices. The pH of the water samples exhibited variations from 7.45 (S13) to 8.18 (S4) in non-monsoon. Similarly in monsoon, the pH of the samples varied from 5.5(S5) to 7.9 (S14). EC is a measure of the ability of a water sample to convey electrical current related to the concentration of ionized substances in water. Values of EC in water samples collected from Ashtamudi estuary in non-monsoon varied from 12.69mS/cm (S12) to 46.87mS/cm (S5). In monsoon, the Electrical Conductivity varied from 0.11mS/cm (S12) to 17.09mS/cm (S5). The oxygen dissolved in the water is often referred to as dissolved oxygen and its measurement can be used to indicate the degree of pollution by organic matter and the level of self-purification of the water. In the present investigation, minimum concentration of DO was noticed at S12 (5.52 mg/L) and maximum at S13 (9.2mg/L) in the non-monsoon. In monsoon, minimum concentration of DO was noticed at

S1 (6.24 mg/L) and maximum at S10 (8.6mg/L). Biological oxygen demand is the amount of oxygen required for microorganisms to degrade the oxidisable organic matter present in waste water. BOD of the collected water samples exhibited variation from 1.10mg/L (S5) to 9.93 mg/L Kureepuzha (S2) in the non-monsoon season and in monsoon season the BOD varied from 2.3 mg/L (S8) to 14 mg/L (S12). Dissolved inorganic phosphate concentration shows a minimum of 0.01 ppm and maximum of 0.2 ppm (S15) in non-monsoon and in monsoon, the phosphate concentration exhibited variation from 0.03ppm (S8) to a maximum of 0.19ppm (S2). The nitrite concentration shows variation from 0.1 ppm (S5) to 0.14 ppm (S1) in the non-monsoon and in the monsoon, it varies from 0.1ppm(S10) to 0.6ppm (S2). In the present investigation, sulphate concentration in samples varied from 3.52ppm(S12) to 22.29 ppm(S2) in the non-monsoon. In monsoon, the sulphate concentration varied from 2.06ppm(S12) to 16.76ppm(S2). The concentration of urea in water sample varied from 0.81 ppb (S11) to 56.64 ppb (S10) ppb in non-monsoon. In monsoon, the urea concentration varied from 12.16ppb (S15) to 110.91ppb (S4). the concentration of silicate in surface water sample ranged from 0.27ppm(S5) to 2.39ppm(S14) in non-monsoon and in monsoon, the concentration varied from 0.06ppm (S4) to 0.12ppm (S12,S13,S14) .High concentration of silicate was noticed riverine area.

Conclusions: Seasonal variation in pH, electrical conductivity and concentration of nutrients such as nitrite, phosphate, urea, silicate and sulphate was recorded. The results shows seasonal variations in the wetland is due to the exposure to pollution from sewage, coconut husk retting, land reclamation etc. Several industries such as clay factory, cashew factory, coir retting factory were also located near the wetland which serve as point sources of pollution.

Keywords: Ashtamudi Lake, Physicochemical Parameters, Monsoon, Non-Monsoon.

07
Fisheries & Veterinary Sciences

Oral Presentation

Molecular and Functional Characterization of a Histone H2A-Derived Antimicrobial Peptide, Hipposin from Milk Fish *Chanos chanos*

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Background: Antimicrobial peptides (AMPs) are evolutionarily conserved host defense peptides, distributed widely in nature as an innate immune molecule. The aquatic environment contains wide variety of pathogens and hence the innate immune system, the first line of defence in fish is highly significant. Histone derived peptides play an important role in the innate immunity of fishes. The present study deals with the characterisation of the potential antimicrobial peptide, Hipposin from the histone H2A of Milk fish, *Chanos chanos*.

Method: - Total RNA was isolated from gills using TRI® reagent (Sigma) following manufacturer's protocol. First-strand cDNA was generated. PCR amplification of the cDNA was done using Hipposin primer with 60^0C as annealing temperature. PCR products were cloned into pGEMT Easy Vector, and transformed into DH5 alpha *E.coli* competent cells. Positive recombinant clones were selected for plasmid isolation. Recombinant plasmids were sequenced. Molecular characterization and functional predictions were done using different *in silico* tools.

Results: A 243 base pair fragment encoding 81 amino acid residues was amplified from complementary DNA termed as *Cc*-Hip. Homologous sequence analysis showed that *Cc*-Hip belongs to the Histone H2A super family and shares sequence identity with other fish histone derived AMPs. Secondary structural analysis showed α-helical, random coiled with prominent proline hinge. Physicochemical properties and molecular structure of *Cc*-Hip is in agreement with the characteristic features of antimicrobial peptides. *In silico* functional characterisation of active peptide using various bioinformatics tools revealed antibacterial, anticancer and antibiofilm activity making *Cc*-Hip a promising candidate for further exploration.

Conclusions: An antimicrobial pep-

tide was identified from the histone H2A of *Chanos chanos* and named as *Cc*-Hip. Sequence similarity of *Cc*-Hip to previously reported histone H2A derived AMPs along with physicochemical and functional properties strongly indicate *Cc*-Hip to be antimicrobial, anticancer and antibiofilm peptide with potential applications. This study also illustrate the importance of H2A derived AMP in the innate immune system of Osteichthyes.

Keywords: - Innate immunity; Antimicrobial peptide; Histone H2A; Hipposin

FISHERIES & VETERINARY SCIENCES-02 REG. No. 14311

In vitro Culture and Characterization of A Cell Line from the Spinecheek Anemone Fish *Premnas biaculeatus* (Bloch, 1790)

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Background: The importance and necessity of *in vitro* cell culture systems are expanding for the isolation and characterization of viruses, testing of therapeutics and for the production of materials for immunological and vaccination studies. Fish cell lines serve as useful tools for carrying out toxicological, carcinogenic, cellular physiology and also in gene regulation and expression studies. The spinecheek anemone/maroon clown fish *Premnas biaculeatus* (Bloch, 1790) is one of the popular species of clown fishes which fetches high value in the international ornamental fish trade. A new continuous cell line designated as PB1BrTr was established and characterized from the trypsinised brain tissue of *P. biaculeatus.*

Method: Primary culture was done by trypsinisation method using Leibovitz's-15 (L15) medium supplemented with 20% fetal bovine serum (FBS) and confluent monolayers obtained were subcultured, passaged and and cryopreserved at different passage levels. Seeding and plating efficiency as well as doubling time of this cell line were determined. To optimize the

growth conditions, cell densities were evaluated at different temperatures and serum concentrations using a haemocytometer. Mitochondrial COI gene sequence analysis was carried out to authenticate the cell line. Cell line sequence was compared with the fish tissue sequence and gene sequences were submitted in NCBI GenBank. The cells were also characterized by chromosome analysis. Cell morphology and cell type were determined using Giemsa and immunofluorescence staining respectively. Cytotoxicity assay were performed to evaluate the susceptibility of the cell line to bacterial extracellular product (ECP) from *Vibrio alginolyticus.*

Results: The *in vitro* cell culture system derived has crossed 60 passages. The optimum growth conditions were found to be at temperature of 28±2°C, and the growth of cells increased as the FBS supplementation increased from 2% to 20% and 5% was found sufficient to get good monolayers within 5 days of incubation. Cryopreserved cells showed 85-90% viability at passages 20, 30 & 45 on revival. The seeding efficiency for an initial inoculum density of 1 x 10^5 cells mL^{-1} was 80% and the plating efficiency of cells seeded at a density of 1000 cells was 85% with no significant differences between replicates. The population-doubling time of PB1BrTr cells at passage 45 was 36h. CO1 gene sequence analysis authenticated purity of the cell line and matched with the tissue sequences. Chromosome analysis indicated that the cells are aneuploid. Cells were found to be bipolar in nature and showed strong immunoreactivity to the antibodies directed against fibroblast marker. Cytotoxicity assay of the cell line showed a dose-dependent decline in cell viability after 48 h of exposure. The initial observations were vacuolation in the cells exposed to ECP from the least (1 μg mL^{-1}) to the highest concentration (11μg mL^{-1}).

Conclusions: This study established a new continuous cell line PB1BrTr from the brain tissue of the maroon clown fish *P. biaculeaus*. Optimization of the conditions for growth of the cell line as well as characterization and authentication of the new cell line PB1BrTr developed was accomplished.

Keywords: *In vitro* cell culture, PB1BrTr, Maroon clownfish, Primary culture, Trypsinisation

FISHERIES & VETERINARY SCIENCES-03 REG. No. 15401

The Genomic Dissection of Diversity among Native Goats of Kerala Farmed under Small Holder Production System

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Background: A growing concern in small holder goat production is the decline in genetic diversity and concomitant surge of inbreeding. Being the future livestock of choice for the marginal peasants in Kerala, periodic assessment and proper management of genetic diversity in goats is called for in order to avoid the risks of inbreeding on fitness to ensure their long term survival. In the era of genomics, utilisation of genomic information is called for to manage the genetic diversity and unfavourable inbreeding in farm animal populations.

Method: The genomic inbreeding was estimated based on runs of homozygosity (ROH) and linkage disequilibrium was used to determine effective population size (Ne) of the studied population. Genome-wide single nucleotide polymorphism (SNP) marker data obtained by Illumina SNP50 goat BeadChip genotyping of 48 goats (24 each of Attappady Black and Malabari) was utilised for the estimation of ROH and LD.

Results: The proportion of goats lacking ROH (per cent) was 66.67 in Attappady Black and 39.13 in Malabari goats. The mean number and length of ROH of 1 Mb or more was higher in Malabari goats (2.1304±0.6369 and 6.0016±0.5271Mb) compared to Attappady Black goats (0.4583±0.1343 and 4.0197±0.3755Mb). Mean ± S.E of genomic inbreeding coefficient ($F_{ROH\geq 1Mb)}$ in per cent was 0.519±0.19 and 0.07480±0.0243 in Malabari goats and Attappady Black goats respectively and differed among the two breeds significantly ($p\leq 0.05$). The LD between adjacent SNPs across all autosomes measured as correlation coefficient (r^2) was low and mean ± standard deviation of LD were 0.0657±0.09 and 0.0661±0.09 for Attappady Black and Malabari goats respectively. Based on genomic data, Ne was estimated as 512.8198 in Malabari and 371.22 in Attappady Black goats at 17 generations back.

Conclusions: Exceptionally low genomic inbreeding and high Ne indicate that adequate genomic diversity

exists among native goats of Kerala to avoid immediate risks of reduced fitness and production due to inbreeding depression.

FISHERIES & VETERINARY SCIENCES-04 REG. No. 15468

Genetic Evaluation of Crossbred Cattle of Kerala for Fertility and Production Performances

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Background : Genetic evaluation of dairy animals for major performance traits is necessary for maintaining high level of productivity, improvement of genetic gain and to develop a genetic evaluation system for overall improvement in performances of crossbred cattle of Kerala. It also helps to find out the relative importance of genetic and environmental components of each trait.

Methods: Data pertaining to 1180 crossbred cattle sired by 208 Frieswal bulls from 2003 to 2019, maintained at different farms of Kerala Veterinary and Animal Sciences University and field centres of ICAR- Filed Progeny Testing Scheme were analysed. Estimates of covariance components and genetic parameters were obtained using restricted maximum likelihood (REML) approach using average information (AI) algorithm. Major fertility trait considered was Daughters pregnancy rate and service period while production traits were milk yield and fat percent.

Results: Daughters Pregnancy Rate had low heritability (0.092±0.03), compared to 305 days milk yield (0.170±0.094) and fat percent (0.173±0.072). Phenotypic (r_p), genetic (r_g) and permanent environmental (r_c) correlation indicated unfavourable association of fertility with production traits. DPR was having lower direct additive (σ^2a) and permanent environmental variance (σ^2c) compared to other traits. Highest additive genetic variance (σ^2a) was obtained for 305 days milk yield.

Conclusions: The study estimates the magnitude of correlations and covariances of fertility and production traits and also emphasis the importance of fertility i.e. pregnancy rate in the evaluation and breeding programmes of crossbred cattle of Kerala.

Keywords: genetic evaluation, fertility, production, crossbred cattle

FISHERIES & VETERINARY SCIENCES-05 REG. No. 15531

Viral Disease Profile of Fish Culture in Kerala: Molecular Epidemiology During 2019-21

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Background: Kerala has an abundant aquatic resource potential. Aquaculture in the State has been getting accelerated with scaled - up production systems. This expansion demands heightened trans-boundary movements of seed for intensification. Such a situation invites diseases at different stages of culture operations, and among them viruses are the principal pathogens affecting the aquaculture industry globally, and over the years, six finfish viruses have been detected in India. In this context, the present study was undertaken to analyze the viral disease profile in the aquaculture sector in Kerala using molecular epidemiology tools.

Methods: Live or moribund fishes were collected, aseptically dissected and organs were preserved for nucleic acid extraction for molecular epidemiology, virus isolation, and microscopy using standard protocols. DNA extraction, RNA extraction and reverse transcription were the methods. Accordingly, molecular screening for 21 selected fish viruses has been accomplished by using specific oligo nucleotide primers. When positive amplicons were obtained, they were sequenced and analyzed based on NCBI database employing BLAST search algorithm. Phylogenetic analysis of the sequence data was obtained using MEGA.

Results: Altogether screened 128 fish samples under groups and species such as Tilapia (45%), Cyprinids (24% Rohu, Catla, Grass carp, Gold fish, and Koi carp), *Etroplus suratensis (16%)*, Seabass (6%), different species of ornamental fishes (10%) for viral pathogens after recording species wise clinical signs. Surprisingly, among the 21 fish viral pathogens screened Cyprinid Herpusvirus 2 alone could be detected, that too in nine samples of cyprinids, representing 24% of the total samples.

Conclusions: The results provide an insight in to the epidemiology of finfish viruses in the culture environment of Kerala having Cyprinid herpesvirus 2 (CyHV2) prevalent covering 29% of

cyprinids in both food and ornamental fish sector. This implies that appropriate containment measures have to be adopted to prevent spread of the virus further, which must include effective quarantine and seed quality assurance in place to attain sustainable growth in fish production. Needless to say, prophylactic measures including vaccination have to be adopted to eradicate the pathogen from the system.

Keywords: Aquaculture diseases, fish virology, fish disease surveillance

FISHERIES & VETERINARY SCIENCES-06 REG. No. 15573

Post- Mortem Diagnosis of Rabies in Animals Using Microchip-Based RT-PCR on Nuchal Skin Specimens for Scaling up Rabies Surveillance

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Background: Brain tissue is the preferred specimen for post-mortem diagnosis of rabies in both humans and animals. Higher biosecurity requirements, skill and transportation facilities required for collection and transport of brain or whole carcass to the laboratory is one of the reasons for the poor rabies surveillance in animals. Point of care testing with simple, reliable and easy to operate devices would be an ideal approach for providing rapid results. The present study was undertaken to define a reliable protocol for diagnosing animal rabies using skin specimen, a superficial tissue sample which is collected in a non-invasive manner for post-mortem diagnosis. Our aim was to design a protocol to replace the classical post-mortem diagnostic method that uses brain biopsy with an ultimate target of stepping up rabies surveillance in animals.

Methods: The study evaluated

diagnostic performance of Microchip based RT-PCR on nuchal skin specimen for rabies surveillance and , to assess its suitability as an alternative of brain tissue for post mortem rabies diagnosis in animals. Nuchal skin specimens were collected from 25 animals of different species which were tested positive for rabies on Direct Fluorescent Antibody Test (DFAT) of their brain tissues . Brain tissues and skin specimens collected at necropsy were compared using (DFAT) an internationally approved methods for rabies diagnosis and Microchip based RT PCR.

Results: Validation of Microchip based RT-PCR on skin and DFAT on skin in comparison with DFAT on brain as gold standard gave a sensitivity of 96% and 80% respectively.

C**onclusion**: The study established that Microchip based RT PCR on skin specimens is rapid, sensitive and specific, opening its potential as an ideal rabies surveillance tool overcoming the logistical challenges of carcass transportation to reference laboratories and alleviating biosafety concerns associated with brain collection. The findings highlight the potential of skin specimen for improving rabies surveillance in animals, especially in resource-poor countries.

FISHERIES & VETERINARY SCIENCES-07 REG. No. 15604

Primary Hemocyte Culture of *Penaeus monodon:* An *In vitro* Model for Shrimp Virus Investigations and Development of Antiviral Chemotherapy

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Background: In vitro cell culture systems are exceptionally important tools for research in viral diseases. In the absence of an established crustacean cell-line, primary cell cultures are effective platforms for shrimp virus isolation and characterization. Development of primary hemocyte culture in modified double strength Leibovitz-15 (L-15) growth medium and its application in WSSV isolation has been accomplished in this laboratory. This paper deals with the outcome of a study conducted to isolate two other major shrimp viruses such as Infectious Hypodermal Hematopoi-

etic Necrosis Virus (IHHNV) / *Penaeus stylirostris* penstyldensovirus (PstDV1) and Monodon baculo virus (MBV)/ *Penaeus monodon* nudi virus (PmNV) on shrimp hemocyte primary culture.

Method: Virus inoculum was prepared in modified double strength L-15 medium from a virus infected shrimp, infection confirmed through diagnostic PCR. Primary hemocyte culture was generated and the monolayer of cells was exposed to the infected tissue suspension, and examined for cytopathic effects supported with MTT assay. Expression of MBV genes (polyhedrin, lef4, DNA polymerase) and IHHNV genes (capsid and promoter) was determined through semi quantitative PCR. qPCR was carried out in StepOnePlus Real time PCR system (Applied Biosystems, USA) using Power SYBR green master mix (Applied Biosystems, UK) to determine the relative mRNA expression of virus infected hemocytes at different time intervals (6h, 24h, 48h, 72h). To check the release of virion to supernatant in-vivo studies were carried out in shrimp animal model.

Results: Cytopathic effects such as (a) granulation (b) vacuolization (c) detachment (d) rounding off of cells (e) shrinkage and disintegration of the hemocytes were observed in the primary hemocyte culture subsequent to the inoculation. Virus genes demonstrated confirmed replication of viruses in the hemocytes. The virions were found to get released into the culture supernatant as assessed by its infectivity in vivo and invitro.

Conclusion: This is the first report of isolation of IHHNV and MBV in primary hemocyte culture emphasizing it as a platform for research in virus-cell interaction, virus morphogenesis and also for the discovery of novel drugs to combat viruses in shrimp culture.

Keywords: Primary hemocyte culture, Monodon baculo virus (MBV), *P. monodon* nudivirus (PmNV) Infectious Hypodermal Hematopoietic Necrosis Virus (IHHNV), *Penaeus stylirostris* penstyldensovirus (PstDV1)

FISHERIES & VETERINARY SCIENCES-08 REG. No. 15677

Immobilized *Bacillus cereus* MCCB101 as a Bio-Augmentor Preparation to Support Ecosystem-Based Approach in Aquaculture

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Background: Detrodigest is a bioaugmentor preparation (*Bacillus* MCCB 101) of National Center for Aquatic Animal Health, CUSAT distributed to aquaculture sector in the Country for detritus degradation. Farmers brew it at farm site and apply to water once in 10 days to effect bioremediation of detritus and mineralization. Over the years, it has been noticed that the bio-augmentor that reaches the pond bottom is not adequate enough to bring forth the envisaged degradation of organic matter and improve E*h*. This realization paved the way to develop an application to the pond bottom as nodules prepared out of silica-based substratum to which the bio-augmenter is attached.

Methods: Detrodigest preparation was mixed with the silica-based substratum at 1:1 ratio (V/W) and converted into nodules of 3 cm diameter. This preparation was applied to the pond bottom gently at the rate of 2 Kg per acre water spread area. The process was continued for 12 months on continuous basis twice a month. During this period, evaluation of water quality parameters such as pH, salinity, alkalinity, hardness, ammonia, nitrite, nitrate, Hydrogen sulphide, Phosphates and phyto and zooplankton count, and the sediment quality parameters such as pH, E*h*, Hydrogen sulphide production potential and sediment oxygen demand were undertaken. Health of the fish stock in the system was assessed based on the survival of fishes and retrieval periodically. The Detrodigest preparation was subjected to SEM and total plate count to assess the status and number of cells in unit weight.

Results and Discussion: The striking observation was the control over E*h*, sediment Oxygen demand and hydrogen sulphide production potential of the pond with absolutely no mortality, as during the previous years there had been substantial loss of fish during summer months. Number of bacterial cells in unit weight of the preparation was 10^{9} cells/g. The Scanning electron microscope (SEM) images confirmed the retention and distribution of the immobilized bacterial cells on the substratum. At 4°C it exhibited a shelf life of 2 weeks.

Conclusion: The Detrodigest preparation immobilized in the silica-based substratum was found suitable for delivering the bioaugmentor *Bacillus* MCCB 101 to the pond bottom for detritus degradation and pond bottom management.

Keywords: Detrodigest, Bioaugmentor, Immobilization, SEM, E*h*

FISHERIES & VETERINARY SCIENCES-09 REG. No. 15871

Application of Endophytic *Penicillium citrinum* Extract to Control *Vibrio harveyi* in *Penaeus monodon* Culture System

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Endophytes are microbes that colonize living, internal tissues of plants without causing overt disease symptoms. Endophytes probably harvest a plethora of bioactive metabolites and serve as potential candidates for novel natural products to exploit in medicine, agriculture and industry.

The present study is focused on the isolation of endophytic *Penicillium citrinum* from macroalgae *Hypnea muciformis* from southwest coast of Kerala based on standard protocols. Screening of antimicrobial potential was done against bacterial pathogens by disc diffusion method. Considering its antimicrobial property, its application in *Penaeus monodon* larval culture system was planned to control microbial population especially the vibrios. Crude extract of *P. citrinum* was prepared and administered in larval rearing system via water (W) and via feed (F) and a control was kept without extract treatment. *Vibrio* count of rearing water was noted periodically up to 1 month. After that all the experimental animals were challenged with pathogenic *V. harveyi* and survival was noted for a period of 1 month.

The combined approach of morpho and molecular taxonomy revealed the taxonomic position of the endophytic fungus as *Penicillium citrinum*. Endophytic *P. citrinum* inhibited the growth of seven different pathogenic bacterial strains. Its application in *P. monodon* larval culture system significantly reduced the total *Vibrio* countin both

experimental groups and better result was observed in water treatment group. Survival rate was also higher in both the experimental groups compared to control.

Current study highlighted the efficacy of the crude fungal extract from *P. citrinum* to control microbial population and thereby the water quality in the *P. monodon* culture system. Besides, enhancing survival indicates its potential for application in aquaculture.

Keywords: Endophyte, Macroalgae, Antivibrio, Post larvae, Survival

07
Fisheries & Veterinary Sciences

Poster Presentation

FISHERIES & VETERINARY SCIENCES-10 REG. No. 11113

Growth Performance and Survival of Guppy (*Poecilia reticulata*) In Response to Chitosan Flocculated Marine Microalga *Picochlorum maculatum* MACC3 Supplemented Diets

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Background: Mortalities are very common in ornamental fishes rearing facilities mostly due to temperature fluctuations, associated stress and disease outbreaks which substantially leads to huge economic losses. An immunostimulant can be used to treat such unpredicted stress events as it generates resistance by activating innate immune system of the animals. The present study evaluates the significance of 10% supplementation of chitosan flocculated marine picoalga *Picochlorum maculatum* MACC3 on growth, stress response and survival of Silverado guppy (*Poecilia reticulata*) juveniles.

Methods: The test feed was prepared by the 10% incorporation of dried powder of chitosan flocculated *P. maculatum* MACC3 into blood worm powder using 1% gelatin as binder, whereas the test was devoid of the alga. The fishes were fed adlibitum two times daily for 120 days. At the end of the feeding period length, weight and survival rates were recorded. The fishes were challenged with the pathogen *Aeromonas salmonicida* MTCC 1945 and survival rates were recorded.

Results: There was significance difference ($p<.05$) on net weight gain (WG), specific growth rate (SGR), feed conversion ratio (FCR), survival and post challenge survival between control and 10 % chitosan flocculated *P. maculatum* MACC3 supplied groups.

Conclusion: As the results of the study 10 % incorporation of chitosan flocculated *P. maculatum* MACC3 had positive effects on the growth, immunity and survival of guppies (*P. reticulata*).

Key words:*Poecilia reticulata, Picochlorum maculatum*

FISHERIES & VETERINARY SCIENCES-11 REG. No. 13682

Influence of Designer Diet and Holy Basil (*Ocimum sanctum)* Leaves on Serum Lipid Profile of Layers

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Background: People want to consume cholesterol lower food items. Egg is the best vehicle to deliver the health promoting components to the humans at low cost, along with other nutrients already present in the egg. Poultry nutritionist tried to deliver the egg with human health promoting components.

Method: A biological experiment of six weeks duration, followed by laboratory investigations were carried out to study the effect of designer layer mash (DLM) containing full fat flaxseed, oil rich sardine fish, Holy Basil leaf meal (BLM), vitamin E and Organic selenium (Sel-plex), on serum lipid profile of layers. six dietary treatments are, T_1 - Control – standard layer mash, T2 - Standard layer mash + 1 g/ kg BLM (C-BLM 1g), T_3 - Standard layer mash + 2 g/ kg BLM (C-BLM 2g), T_4 - Designer egg layer mash (DLM), T_5 - DLM + 1 g/ kg BLM (DLM - BLM 1g), T_6 - DLM + 2 g/ kg BLM (DLM - BLM 2g). On the last day of the study, blood samples were collected from two layer for each replicate. The serum was separated and the serum samples were used to estimate the total cholesterol, HDL-C, LDL-C and VLDL-C and Triglycerides.

Results: Designer egg diet and Basil leaves feeding had resulted in significant reduction in serum TG (718 mg/dl), TC (140.2 mg/dl), VLDL-C (72.7mg/dl), LDL-C(23.9mg/dl) and significant increase in HDL-C(43.7 mg/dl), compared to the control. The synergistic effect of designer diets with BLM was prominently observed by favourably altering the serum lipid profile. BLM levels were independently capable of suppressing the bad TG, TC, LDL-C and VLDL-C levels in serum and increasing the HDL-C levels.

Conclusions: The synergistic effect of designer diets with Basil leaf meal was prominently altered the serum lipid profile of hens.

Key words: Designer layer mash, serum, Cholesterol, Triglyceride

FISHERIES & VETERINARY SCIENCES-12 REG. No. 15473

Molecular Characterization Demonstrates the Occurrence of Phylogenetic Similar Isolates of *V. alginolyticus* and *V. parahaemolyticus* in Aquatic Environment

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Background: *V. alginolyticus* is an opportunistic pathogen of fish and shell fishes which causes septicemia. It is associated with other *Vibrio* infections especially with *Vibrio parahaemolyticus*. The present study evaluated the biochemical and phylogenetic characteristics of *Vibrio alginolyticus* from different aquaculture farms in terms of its prevalence, hemolysin genes, genetic relatedness and antibiotic susceptibility.

Method: Conventional microbiological tests for screening *V. alginolyticus* from brackish water farm samples, molecular identification of species specific, pathogenic gene fragments, hemolysin genes, pulsed field gel electrophoresis, exoenzyme tests, and antimicrobial susceptibility tests

Results: The prevalence of *V. alginolyticus* in the screened samples was around 13.04%. A total of 12 isolates out of 68 isolates picked from Thiosulfate Citrate Bile salt sucrose (TCBS) agar plates were biochemically identified as *V. alginolyticus*. These isolates were further confirmed by Polymerase Chain Reaction (PCR) targeting collagenase gene. Molecularly confirmed isolates were checked for the presence of hemolysin genes viz, *tlh, trh*, and *tdh* targeted PCRs. The *tlh* gene was found in 8 isolates of *V. alginolyticus.* Further, Pulse field gel electrophoresis (PFGE) typing with *NotI* restriction enzyme successfully differentiated *tlh* positive *V. alginolyticus* from *tlh* negative *V. alginolyticus* isolates with 92% genetic similarity. *V. alginolyticus* isolates showed proteolytic, lipolytic and lecithinase activities. Intermediate resistance to most of the antibiotics tested explains that the isolates obtained locations are exposed to antimicrobial agents.

Conclusion: This study confirms the presence of phylogenetically similar isolates of *V. alginolyticus* and *V. parahaemolyticus* in the aquatic environments. The amplification of *tlh* gene in other *Vibrio* species may lead the inadequacy of the species-specific marker of *V. parahaemolyticus* in the

event of surveillance of epidemiological investigations. This will be of serious concern especially in case of rapid detection of *V. parahaemolyticus* by using direct enrichment PCR assay targeting *tlh* gene.

Keywords: Vibrio, Prevalence, Hemolysin Genes, Genetic Relatedness, Antimicrobial Susceptibility

FISHERIES & VETERINARY SCIENCES-13 REG. No. 15501

Multidrug Resistant *Edwardsiella tarda* in Goldfish, *Carassius auratus*: A Crisis for Concern in Ornamental Fish Industry

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Background: Goldfish (*Carassius auratus)* is one of the most important domesticated ornamental fishes in aquaria and are reported to be infected with diverse bacterial species thereby affecting the sustainable fish culture. *Edwardsiella tarda* is one of the serious pathogens affecting the worldwide aquaculture. The present study was focused to investigate the cause of disease outbreak in a goldfish farm. Further, the isolated pathogen was subjected to phenotypic and genotypic characterization for determining their virulence and antimicrobial resistance and the infectivity was confirmed through in-vivo study.

Methods: Goldfish (n=5) showing hemorrhagic septicemia and gill paleness were collected from Ernakulam farm with 60% cumulative mortality. The infected tissues *viz*. gills, kidney, liver and spleen were processed separately for bacterial isolation. The unique isolated colonies were subjected to various phenotypic and genotypic tests. The experimental challenge trials were done with all the representative isolates and LD50 was also calculated for the causative agent. Eleven virulent genes were tested using PCR for the identified pathogen and histopathological analysis was performed to determine their pathogenicity. Antimicrobial susceptibility tests with 46 antibiotics of 15 classes were done for the pathogen using disc diffusion method. To determine

the location of antimicrobial resistant genes, plasmid curing studies were also carried out employing acridine orange.

Results: Based on the phenotypic and genotypic analysis, the bacteria were identified as *Edwardsiella tarda*, *Citrobacter freundii, Acinetobacter junii* and *Comammonas testosteronii*. Experimental challenge studies using healthy goldfish revealed that among the four isolates, *E. tarda* alone leads to 100% mortality of experimental fish within 175 degree days and the pathogen could be successfully re-isolated from the moribund fish. The LD50 value of *E. tarda* was calculated as 9.9×10^5 CFU/fish. The histopathology of the infected tissues of goldfish had shown the typical features of *E .tarda* infection. The pathogen was found positive for the virulence genes *viz*. *hly*, *etfA*, *etfD* and *eseD* as detected using PCR. Thus *E. tarda* was confirmed as the real causative agent of the disease outbreak. Multiple antimicrobial resistance (AMR) exhibited by the pathogen towards 19 tested antibiotics with the multiple antibiotic resistance (MAR) index of 0.46 highlighted the exposure of antibiotics to the fish in the farm. The existence of antibiotic resistant genes within the plasmid as revealed through plasmid curing studies pointed out the possibility of rapid dissemination of AMR in aquaculture.

Conclusion: *E.tarda* was confirmed as the real causative agent of the disease outbreak in goldfish farm through experimental challenge studies. Identification of potential virulence and plasmid borne multi drug resistance in the studied pathogen challenges the effective antibiotic treatment and promotes the spread of AMR through horizontal gene transfer. Hence proper surveillance and appropriate diagnostic methods need to be implemented in fish farms at regular intervals to mitigate the menace.

Keywords: goldfish; *Edwardsiella tarda*; experimental challenge; virulence; antimicrobial resistance

FISHERIES & VETERINARY SCIENCES-14 REG. No. 15544

Improvisation of Seed Production Technology of Scampi Through Probiotic and Immunostimulant-Based Interventions

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Background: The Nationwide approved technology of Scampi (*Macrobrachium rosenbergii*) seed production consists of feeding the larvae with newly hatched *Artemia* nauplii to advanced nauplii from Mysis 1 to post larvae. Other than antibiotic application no more intervention is under practice in the country. May be because of the same reason the percent production of Scampi seed remains around 10 over three decades, which to a large extend make the hatchery operations unviable. Therefore, in order to upgrade the technology and to enhance the production a precise preventive health care strategy has been envisaged and executed. This consists of application of the probiotic preparation (Enterotrophotic) and the Marine yeast preparation (My-1) bioencapsulated in *Artemia* nauplii.

Method: Three dierent treatment plans with triplicates and three control tanks were set up. In test-1, PL were fed with MY-1 enriched *Artemia* nauplii, in test-2 PL were fed with Enterotrophotic enriched *Artemia* nauplii and in test – 3, PL were fed with yeast and Enterotrophotic enriched *Artemia* nauplii and PL in control tanks were fed with placibo *Artemia* nauplii. Length, weight and survival of PL were determined. After 15 days of treatment the post larvae were challenged with pathogenic *Vibrio alginolyticus* MRNL – 3 and the survival was recorded.

Results: The batches of post larvae fed on bioencapsulated My-1 and Enterotrophotic exhibited significantly higher survival, higher growth and resistance to the pathogen invasion. Considering the results obtained, this combination of treatment has been recommended for application in commercial hatcheries starting from Mysis 1 to advanced post larvae as it has been proven that all life stages of the animal are equally immunocompetent.

Conclusions: My-1 and Enterotrophotic together as a probiotic can be administered to the larvae incorporating them into their feed to give better

survival and growth improvising the seed production technology of Scampi.

Keywords: Probiotics, *Macrobrachium rosenbergii*, survival, growth.

FISHERIES & VETERINARY SCIENCES-15 REG. No. 15647

Feeding Habits of the Deep-Sea Pandalid Shrimp, *Plesionika semilaevis*, Spence Bate, 1888 from the Southwest Coast of India

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Background: Study of food and feeding is of fundamental importance in understanding the rate of growth, population concentration, gonadial maturation, metabolic activities, seasonal and distribution. *Plesionika semilaevis* is an economically important caridean deep-sea shrimp from the southwest coast of India. Information on food and feeding of this species is lacking globally. The present study details the qualitative and quantitative analysis of food and feeding in relation to season, gender, size and stage of maturity of *P. semilaevis*.

Method: The diet contents were studied using an aggregate number of 1227 individuals collected fortnightly from deep sea landing centre in Shaktikulangara, Kollam, Kerala. Feeding condition, feeding intensity, Index of Preponderance, frequency of occurrence, Gastrosomatic index (GaSI), Vacuity index in connection to the sex, maturity, size group and season were calculated for this species. One-way Analysis of Variance (ANOVA) was carried out to verify if the diet composition, percentage of stomach fullness and GSI varied according to sex, berried/non berried stages, size and season.

Results: The diet of *P. semilaevis* is composed mainly of benthic and benthopelagic organisms. Detritus was the most prevalent item in the gut, followed by crustaceans, foraminifera, fishes, sediment, and sponge parts. Considering stomach fullness, feeding intensity and food quality, the females were found to be more effective predators than males. Actively fed condition

was high during the pre-monsoon period. In males and non-berried females feeding intensity was higher for smaller individuals, while among berried females, larger sized individuals showed highest feeding intensity.

Conclusion: Presence of detritus, foraminifera, sediment and molluscan remains in the gut indicated a possible benthic feeding activity while the presence of broken parts of other smaller decapods and fishes suggests its swimming efficiency and scavenging nature evidencing its ability to feed on pelagic forms. Females shows higher feeding intensity than males because of sexual dimorphism and increased growth rates.

Keywords: Deep Sea shrimps, *Plesionika semilaevis*, Feeding behaviour, Arabian Sea.

FISHERIES & VETERINARY SCIENCES-16 REG. No. 15649

Food and Feeding of Deep Sea Penaeid Shrimp, *Metapenaeopsis andamanensis* Wood-Mason, 1891, Along the South West Coast of India

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Background: One of the most diverse genera in the family Penaeidea is *Metapenaeopsis* Bouvier, 1905 and consists of 76 species. *Metapenaeopsis andamanensis* is one of the most commonly available Deep Sea penaeid shrimp in Kerala, widely known as Rice velvet shrimp. While considering the biological and taxonomical studies of a species, the food and feeding habits plays a significant role. Feeding habit analysis also helps to quantify the food resource that are more extensively used by a species and provides more information on the preferred food of the species.

Method: The intensity of feeding was determined by the degree of distension of the stomach due to the presence of food inside the anterior and posterior chambers of the proventriculus. Stomachs were grouped into actively fed, moderately fed and poorly fed for analyzing the feeding condition. The gastro somatic index, feeding intensity and vacuity index

was done to analyze the feeding activity of *Metapenaeopsis andamanensis* and the relation with sex, season and size (small, medium, large). To know the relative importance of food contents, the Index of Preponderance was calculated.

Results: In relation with the season, feeding intensity was less during the pre-monsoon than the post monsoon in both the sexes and female has higher feeding intensity than the males, while the feeding intensity increases with size. Seasonal analysis of the gastro somatic index (GaSI) showed minor difference in both sex. Vacuity index (VI) showed distinct variation between the post monsoon and pre monsoon however it varied with size revealed higher values in males. Diet composition with regards to season, sex and size constituted of crustaceans, foraminifera, detritus, and the minor components included mollusc, fish remains, sediments and unidentified particles.

Conclusion: The food and feeding analysis provide the basis for understanding the major fauna, habitat and trophical interactions of the species and also in understanding its feeding patterns of the species, also provides knowledge on several ecological aspects of the species.

Keywords: *Metapenaeopsis andamanensis*, food and feeding, gastro somatic index, vacuity index, Index of Preponderance.

FISHERIES & VETERINARY SCIENCES-17 REG. No. 15725

Shell Grit as Free Choice Calcium Source for Gramasree Male Birds

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A feeding trail was conducted in 12 Gramasree male birds of 32nd weeks which were randomly distributed to three experimental groups (G1 and G2) with six birds in each group and housed separately in male cages for 91 days. During this experimental period, layer breeder ration (control) was prepared as per ICAR, (2013) recommendations and fed to all experimental male birds. Shell grit having more than 2 mm particle size was given as free choice after feeding to G2 birds, respectively to meet their

extra calcium requirement. The feed intake and body weight were significantly different ($p<0.01$) between the treatment groups. shell grit intake was 0.72 g/rooster/day, respectively. Total calcium intake was 3.20 and 3.55 g/rooster/day in G1 and G2 respectively. Semen was collected by abdominal massage at weekly intervals from 33rd to 44th weeks of age and analysed for semen volume, colour, sperm concentration and sperm motility and significantly no difference was found between the groups. The serum Ca and P content and tibial-ash were similar in all the treatment groups but the tibial calcium content was significantly ($p<0.01$) higher in shell grit group. It can be concluded that, calcium intake (3.20 g/rooster/day) through feed is sufficient for male birds to meet their calcium requirements and extra, shell grit given as free choice feeding had not influenced the semen qualities without any detrimental effects.

Keywords: Calcium, Shell grit, Chemical composition, Gramasree male birds, semen quality

FISHERIES & VETERINARY SCIENCES-18 REG. No. 15764

In Search of Anti-Vibrio Activity in Commonly Seen Plant Species in the Region

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Background: Shrimp farming is one of the major aquaculture endeavors which contribute to the global economy profoundly. However, its development was greatly hampered by disease outbreaks among which Vibriosis predominated. Decades of antibiotic therapy led to the development of antibiotic resistant bacterial strains besides the presence of residual antibiotic in meat inviting ban on their use in aquaculture. This has led to the dare requirement of searching for natural anti -vibrio molecules in lieu of conventional antibiotics used in human and veterinary medicines for aquaculture application. In this context anti-vibrio property of 20 plant species seen around was examined against 5 species of *Vibrio* along with 2 strains of *Vibrio harveyi*

Methods: Shade dried plant leaves were powdered and extracted in Soxhlet apparatus. The crude methanolic

extracts of 20 selected medicinal plants thus generated were used for bacterial growth inhibition studies. Bacterial growth medium along with 1mg/mL of plant extracts were prepared in microtiter plates inoculated with 2µl of 0.1Abs (at 600nm) bacterial cultures and incubated for 24 hours. Absorbance was measured at the initial and final stages. Potent fractions were further checked by disc diffusion assay also.

Results: Present study enumerates the promising effects of crude extracts from *Solanum tuberosum* (potato peel), *Myristica fragrans*, and *Citrus limon*in inhibiting the five species of *Vibrios* tested. Meanwhile, extract from *Ficus religiosa*, *Piper betle*, *Terminalia catappa*, *Nigella sativa*, and *Ocimum tenuiflorum* inhibited 4 species and the one from *Biophytum sensitivum*, and *Curcuma aromatic* inhibited 3 species of vibrios. *Camellia oleifera, Moringa oleifera, Mentha spicata, Coleus barbatus, Mimosa pudica*, and *Momordica charantia* exhibited activity towards 2 of the bacterial species. Rest of the plant extracts from *Rhizophora mucronata, Madhuka longifolia, Azadirachta indica,* and *Sesamum indicum* inhibited growth of only one *Vibrio* species. This result itself explicates the importance and great potency of terrestrial plants in inhibiting pathogenic vibrios.

Conclusion: The study demonstrated the importance of terrestrial plants as a source of bioactive natural compounds which can be efficiently used in the management of Vibriosis in aquaculture.

Keywords: Vibrio spp, anti- bacterial, plant extracts.

FISHERIES & VETERINARY SCIENCES-19 REG. No. 15796

First Report on *Streptococcus agalactiae* Involvement in the Mortality of Genetically Improved Farmed Tilapia (GIFT) In Kerala, India

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Background: Tilapia is the second most cultured species in the world. Recent intensification as well as unscientific mode of culture has led to the spread of pathogens to newer areas. Among the pathogens causing mass

mortalities in tilapia, *Streptococcus* sp. especially *S. agalactiae* is of paramount importance. The evidence of vertical transmission as well as the zoonotic nature of *S. agalactiae,* shows the catastrophic potential of the pathogen.

Method: The fishes showing clinical signs were brought to the laboratory in 4°C, dissected immediately and processed for microbiological investigations. The kidney was aseptically streaked onto the tryptic soy agar plates. The isolated colonies were subjected to morphological, biochemical characterization as well as molecular identification.

Results: The pathogen was presumptively identified as *Streptococcus* morphologically and confirmed as *Streptococcus agalactiae* after biochemical characterization as well as molecular identification.

Conclusions: This is the first report of the pathogen from the culture systems of Kerala cautioning its possible vertical transmission along with zoonosis. Appropriate preventive health care strategies including quarantine measures and quality assessment of seed being distributed to farmers have to be undertaken to prevent the entry of such pathogens to the aquaculture environment of Kerala.

Keywords: Aquaculture, Tilapia, Disease, Bacteria, *Streptococcus agalactiae*, Streptococcosis

FISHERIES & VETERINARY SCIENCES-20 REG. No. 15829

Environmental Impact Study of Aquaculture Systems Through Life Cycle Assessment

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Background: The sustainability challenges faced by the global aquaculture sector highlight the critical need to understand and quantify the environmental footprints of diverse production methods, as well as the importance of using environmentally friendly fish production practices. Life Cycle Assessment (LCA) is one of the efficient tools developed to evaluate the environmental impact of food production systems, and is a standard method (ISO 14040) for assessing the long-term viability of

various aquaculture systems quantitatively, from cradle to grave. LCA serves as a scientific foundation for examining system improvements, and developing certification and eco-labelling standards.

Method: LCA methodology is developed on the basis of the major life-cycle phases as specified in ISO 14040. The study is based on the peer reviewed articles published in the field of aquaculture, along with the case studies of various aquaculture systems in Kerala. Attempts were made to compare the reported results to field level observations and primary data collected through real-time investigations in aquaculture farms under real-world conditions.

Results: The impact factors which affect the life cycle of aquaculture systems vary depending on the micro climate, culture practices, type and use of fuel/energy, water quality and pollution, land use practices and general management practices. The primary analysis showed that the factors such as water quality, aquatic pollution, dependence on fossil fuels, inappropriate land uses, over dependence on abiotic inputs etc. are having significant impacts on the aquaculture systems in Kerala, coupled with climate change issues.

Conclusions: Concerns about the long-term sustainability of novel fish production techniques have grown, and the aquaculture industry's standards and criteria are becoming increasingly stringent. In the hunt for best practices, LCA has proved to be a useful method for identifying the environmental hotspots and comparing different production systems.

Keywords: Sustainable aquaculture, Life cycle assessment, Environmental impact, Eco-friendly practices

08

Health Sciences

Oral Presentation

HEALTH SCIENCES-01 REG. No. 14244

Evaluating the Diagnostic Potential of Liquid Biopsy by Next Generation Sequencing in Oral Tongue Carcinoma

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Background: Oral cancer is one of the most prevalent forms of cancer in the world. In India it ranks first among all cancers in men and second in women. The poor survival of this tumour is mainly due to lack of knowledge about its molecular background and dearth of good biomarkers for early detection and prognosis. Liquid biopsy is a revolutionary technique in cancer diagnosis. It consists of isolation and detection of circulating tumour cells, circulating tumour DNA, circulating RNA and tumour-derived exosomes, as a source of genomic and proteomic information in patients with cancer.

Method: Tissue DNA and circulating DNA was isolated from oral tongue cancer patients for Whole Exome Sequencing (WES). Two oral cancer cell lines (UM-SCC-83A (primary) and UM-SCC-83-B (metastatic) were also used for the validation studies. Bio-statistical tools like VarScan, GATK-Mutect2 and Strelka, are used for the data analysis and common variants are only selected for the downstream annotations. Later Sanger sequencing was employed to confirm the somatic mutations

Results: After annotation we observed 50 somatic mutations, among them most frequently observed genes are *CDX2, FLT3, NOTCH1, BRAF, HRAS,* and *TERT*. *BRAF* and *TERT* gene mutations were identified in circulating DNA of above 60% of sample populations and also in both primary and metastatic cell lines.

Conclusion: This present study was validated the diagnostic potential of liquid biopsy by analysing somatic mutations present in the circulating DNA of oral tongue cancer patients by comparing the mutational status of tissue sample and cell line samples.

Keywords: Liquid biopsy, Whole Exome Sequencing, Oral Tongue Cancer

HEALTH SCIENCES-02 REG. No. 15575

Glucose Oxidase – Peroxidase Incorporated Alginate Diamine Peg-G-Poly(PEGMA) Xerogels for Diabetic Wound Healing

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Background: Diabetic foot ulcers remain a major healthcare problem. Hyperglycemic state delays the wound healing process and results in stalled wounds. Glycemic control with sustained enzyme delivery towards the wound site is an emerging strategy for developing advanced wound care biomaterials. In this study we developed alginate based xerogel for the controlled delivery of glucose oxidase and peroxidase for promoting diabetic wound healing.

Method: Alginate was conjugated with Diamine PEG molecule and grafted with poly(PEGMA) chains by free radical polymerization. Chemical as well as ionic crosslinking was provided and final xerogel (ADPM2S) was characterized by various techniques. Physio-chemical properties such as FTIR, NMR, % swelling, mechanical strength and bioadhesion were studied. Glucose oxidase (GO) and peroxidase (POD) were loaded into the hydrogel and analysed its release profile. The production of H_2O_2 and lowering of glucose were monitored. The *in vitro* wound healing effects of GO-POD loaded xerogel was analysed by scratch wound assay. The collagen deposition and migratory effects were studied. The *in vitro* reactive oxygen was monitored by DCFDA assay.

Results: ADPM2S xerogel showed good physical properties as a wound care material. The overall % swelling was 1500% and had a tensile strength of 400 KPa. The material could able to deliver 57% GO and 76% POD within 24h in a controlled manner. There was significant increase in % wound closure observed in cells treated with hyperglyemic condition (20%) to GO-POD loaded hydrogel (57%) within 8h. A significant increase in collagen deposition was also observed.

Conclusions: GO-POD loaded ADPM2S hydrogels could be a promising advanced wound care material for diabetic wound management. This system controls the glucose and reactive oxygen level at the wound site and promote wound healing *in vitro*.

Keywords: Alginate, Glucose oxidase, peroxidase, Diabetic wound

HEALTH SCIENCES-03 REG. No. 15645

Is Kerala Treating Its Migrant Labourers Well?

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Background*:* A large population of migrants work in sectors demanding heavy physical labour. Such exertion needs to be supplemented with good food, good hygiene, and rest. Since these factors are in short supply, migrant labourers are always under the shadow of health and nutritional problems. The objective of this study was to assess the socioeconomic aspects, the influence of conducting nutritional education sessions on nutritional awareness and personal hygiene and the nutrient intake of migrant labourers.

Methods*:* The study was conducted on hundred migrant labourers in the Thiruvananthapuram district in Kerala. The data was obtained using a standardised interview schedule. To test the knowledge, attitude and practice, a set of questions were developed, validated and used to record data. Sessions were conducted for the target group to improve their awareness. Their nutrient intake was recorded using a three day 24-hour dietary recall method. The data obtained was then analysed using IBM SPSS Statistics. The mean and standard deviation, T- test and ANOVA were performed.

Results: The data revealed that the majority of the migrant labourers were from West Bengal, between 18 and 27 years (62%), receiving wages up to ₹10000 – ₹15000 per month (52%). For knowledge, attitude and practice, a positive change was observed immediately after the sessions. The scores after one and three months indicated that the level of retention reduced with time, indicating the need for providing regular awareness sessions. The data also revealed that the intake of the macronutrients was above the respective Recommended Dietary Allowance (National Institute of Nutrition 2020) values. The total calories contributed by these nutrients was satisfactory. Meanwhile, the micronutrients intake was below the respective RDA levels.

Conclusion*:* Since migrant labourers are a significant economic force, their health and well-being would influence the local economy and people. By giving proper awareness on various

nutritional aspects, positive changes could be brought up on the food consumption pattern, thereby improving their health.

Keywords: migrant labourers, macronutrients, micronutrients, nutrient intake, knowledge, attitude, practice, retention, nutritional awareness, hygiene

HEALTH SCIENCES-04 REG. No. 15830

Yoga Reduces Hypercholesterolemia by Down Regulating Pro-Inflammatory Cytokines and Immunophilins

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Introduction: Cyclophilin A (CyPA) is a proinflammatory immunophilin, abundantly expressed in activated macrophages, endothelial cells and vascular smooth muscle cells. CyPA is known to mediate atherogenesis by inducing endothelial dysfunction, inflammation in vessels, the production of foam cells, vascular smooth muscle cell migration/ proliferation and weakening of plaque stability. Plasma CyPA levels have been reported to be increased in patients with vascular inflammation. Yoga is a popular form of complementary and alternative medicine, comprising Asanas (postures), Pranayama (breathing exercises) and Dhyana (meditation). Although there is considerable evidence on the preventive and therapeutic outcomes of yoga on cardiovascular diseases and its risk factors, the scientific basis of these claims has not been evaluated.

Objectives:

To study the influence of yogic intervention on cholesterol levels

To understand how yoga improves biochemical profile and reduce clinical risk factors of atherosclerosis

To study the influence of yogic intervention on atherosclerotic and pro-inflammatory biomarkers.

Methods: Apparently healthy individuals (n=45) were recruited for a yoga intervention study for 90 days. Based on their lipid profile, the subjects were

grouped into hypercholesterolemic (≥200) and normocholesterolemic (<200). Individuals were subjected to yoga exercise for 5 days/ week (YI group). A control group without any yoga intervention (NYI group) was also included in the study. Parameters such as body mass composition, waist circumference, blood pressure, random blood sugar, HbA1C, lipid profile and cyclophilin A levels were analysed. Changes in the gene expression levels of hypercholesterolemia related gene markers (LDLR, PCSK9), cytokine and pro-inflammatory markers (NRF2, IL-1, TNF-alpha, Cyclophilin A) and adipocyte differentiator gene (PPARG) was analysed before and after the intervention. Serum levels of major inflammatory markers like TNF-α and Cyp A were analysed. Analyses were done before and after YI as a medium for comparison.

Results: Yoga intervention group showed a significant downregulation in the expression of CyPA compared to the control group in addition to other key pro-inflammatory markers. Also, YI group showed reduction in several risk factors of cardiovascular diseases such as waist circumference, blood pressure, blood sugar and lipid profile.

Conclusions: We conclude that yoga reduces pro-inflammatory conditions in plasma of hypercholesterolemic individuals by decreasing expression of immunophilin CyPA and thus reducing its circulatory levels.

Keywords: TNF alpha, CYP A, YOGA, Inflammation, proinflammatory markers, gene expression

HEALTH SCIENCES-05 REG. No. 15846

Immunohistochemical Profiling of p53 Mutation Status: A Propitious Approach for TNBC Prognostication

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Background: *TP53* gene encoding the tumor suppressor protein, p53 is reported to be the most frequently mutated gene in human neoplasia, including breast cancer. p53 mutation is often correlated with enhanced aggressiveness and worse overall survival. However, recent researches suggest that in breast cancer the incidence of mutation hinges on the molecular

subtype of the disease. Based on this conception, mutant p53 may perhaps be anticipated to be a biomarker for breast cancer, especially for the cryptic TNBC (Triple Negative Breast cancer) subtype.

Methods: The study was planned as a cross-sectional one with 551 randomly selected breast cancer tissue samples. The clinical and histopathological parameters of the patients were reviewed for their effects on clinical outcomes using univariate/multivariate Cox regression. Protein expression patterns and mutational status was analysed.

Results: Heterogeneous overexpression in p53 protein levels was detected among the TNBC samples. Both univariate and multivariate analysis showed that *TP53* expression levels were significant predictors of breast cancer survival and prognosis. The Kaplan-Meier plot illustrated a significant variation in survival between the different expression groups. Overexpression of the p53 protein is reported to be the result of mutations of the *TP53* gene. p53 mutation analysis using genome sequencing could supplement the immunohistochemistry data.

Conclusion: Even though heterogeneous, p53 is mutated in up to 80% of the TNBC patients. *TP53* mutation status and gene-expression are imperative survival markers of TNBC, and these molecular markers may provide prognostic information that harmonizes the clinical variables. The development of a novel integrated prognostic model that includes *TP53* mutation and gene expression groups could be expedient in the choosing of treatment.

Keywords: TNBC prognostication, p53 mutation, immunohistochemical scoring, targeted therapy

HEALTH SCIENCES-06 REG. No. 15852

Telomere Independent Nuclear and Mitochondrial Functions of Human Telomerase (h TERT) in the Regulation of Cell Cycle and Cell Death

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Background: Cancer is a multifactorial causative disorder characterised by broad molecular signatures. The important hallmark

of cancer immortality is the telomere length maintenance mechanisms of the cell. The human telomerase is the rate-limiting factor contributing to telomere length maintenance subsequent to its reactivation during transformation. Interestingly, recent studies have shown that the catalytic subunit of human telomerase, hTERT, is involved in various non- telomere related functions such as regulation of gene expression, interaction with growth factors, and cell proliferation. Even though several studies have identified the potential involvement of telomerase in the tumorigenesis process, complex diversifying mechanisms and the interacting partners that govern diverging functions such as apoptosis inhibition, invasion, and redox regulation by telomerase is not well defined. Recent studies have shown that during diverse stress conditions, telomerase undergoes mitochondrial translocation. The implication of this translocation to cell death is yet to ascertain. It is unclear whether mitochondrial translocation is signalling for mitochondrial oxidation or permeabilisation or it is protective in nature.

Method: Usually, telomere length shortening is a slow process. A challenge in dissecting telomere dependent and independent cancer progression events is the lack of a model system that supports the long time fate of the cell with respect to the telomere targeting. To understand this telomere independent nuclear and mitochondrial functions of human telomerase, real-time time analysis of mitochondrial oxidation and telomerase translocation have to be studied in cells after shRNA silencing and overexpression of telomerase**.**

Results: Overexpression of TERT show alteration in cellular ROS levels and desity of lysosome and mitochondria.

Conclusions: hTERT in mitochondria have a crucial role in the cell cycle, cell death and Redox regulation.

Keywords: Human telomerase reverse transcriptase (hTERT), Cell death, Cancer, Telomere.

HEALTH SCIENCES-07 REG. No. 15889

Wound healing and tissue regeneration activities by *Thottea siliquosa* leaf essential oil and its nanoparticles

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Background: *Thottea siliquosa* is used in traditional medicine to treat inflammation, non-healing wounds etc by tribal community of Kerala. They used leaves for steam bath to alleviate whole body inflammation by insect bites Essential oils have low shelf life and high volatility. Nano encapsulation of essential oil (TSNP) is an alternative way to circumvent this problem for the development of a stable therapeutic entity.

Method: Leaf of *T.siliquosa* was hydrodistilled and characterised by GC-FID and GC-MS analysis. TSNP was synthesized using chitosan alginate copolymer system and its physical characterisation was carried out. The keratinocytes (HaCaT) and fibroblast cells (L929) were treated with various doses of TSLO and TSNP to determine the cell proliferation by MTT assay and fluorescent microscopic evaluation. *In vitro* wound healing activity was assessed by scratch assay. Caudal fin regeneration test in Zebra fish (*Danio rerio*) with TSLO and TSNP was carried out. Expression of wound healing enhancer genes was studied using RT-PCR

Results: GC-FID and GC-MS analysis revealed the presence of 50 compounds (99.68%) in TSLO with bicyclogermacrene (29.33%) as the major compound. The encapsulation efficiency of the nanoparticle is 76.5% with a controlled release of TSLO is 63% in 3 hours. Among the tested doses in MTT assay, TSPN at 5µg/ml dose and above displayed significant cell proliferation. This result is in correlation with the results obtained from fluorescent microscopy, wherein both the TSLO and TSNP (5 and 100 µg/ml) showed potent cell viability in acridine orange-ethidium bromide staining. *In vitro* wound healing was assessed by scratch assay, in which TSPN showed significant cell migration better than TSLO. In caudal

fin regeneration test, TSNP exhibited significant caudal fin regeneration at 5 µg/ml concentration than TSLO in 21days treatment. Genes which enhance wound healing like KRT5, KRT17, TGF-β, and FIBRONECTIN were expressed.

Conclusion: TSNP is a promising nano-interface for wound healing and tissue regeneration activities.

Keywords: *Thottea siliquosa*, Nano-encapsulation, Wound healing, Fin regeneration.

HEALTH SCIENCES-08 REG. No. 15872

siRNA and Anti-Neoplastic Agent Tethered Gold Nanosystem: A Promising *in vivo* Co-Delivery System for Breast Cancer Management

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Background: *RNA interference* (*RNAi*) based *therapeutic* approaches are under vibrant scrutinization in cancer management. Small interfering RNA (siRNA) is an important RNAi tool which is sought to have significant application in cancer therapy owing to its potential to silence genes involved in tumour progression. However, encapsulation of siRNA in a safe and efficient nanocarrier is of high demand. In order to increase the therapeutic efficacy of monotherapy, combination therapy arises as a promising cancer therapeutic strategy. Herein, a green synthesis approach using polysaccharide (PSP001) isolated from the fruit rind of *Punica granatum* is employed for engineering stable gold nanoparticles for the combination therapy of HER2 siRNA along with doxorubicin for treating HER2 positive breast cancer cells.

Materials and Methods: PSP-Gold (PG), PSP-Gold-Dox (PGD), HER2 siRNA-PSP-Gold (HsiPG), siRNA-PSP-Gold-Dox (HsiPGD) NPs were synthesized via a green chemistry approach and characterized using DLS, TEM, UV Spec, FTIR and gel retardation assay. Biocompatibility, *in vitro* cytotoxicity, cellular uptake, apoptotic potential of nanoparticles and gene expression status were evaluated in breast cancer cells. *In vivo* tumor reduction as well as biodistri-

bution analysis was done in xenograft breast cancer model in immunocompromised mice.

Results: HsiPGD NPs underwent so many physical as well as biological characterisations. The results revealed an appealing biocompatibility, pH-sensitive cargo release kinetics, cytotoxicity as well as competent cancer cell internalization profile within limited span of time. The selective execution of programmed cell death in HER2 positive breast cancer cell was confirmed with multiple apoptosis studies like Annexin V, Caspase, live dead staining assays. The extensive toxicity evaluation of drug loaded NPs in BALB/c mice also substantiated the efficacy of PGNPs as a safe and efficient vector. Significant downregulation of HER2 expression was exposed via western blot both *in vitro* as well as *in vivo*. *In vivo* anti-tumor potential evaluation in xenograft breast cancer model revealed the tumor reduction property of HsiPGD NPs Tumor specific biodistribution was also confirmed via both *in vivo* as well as *ex vivo* animal imaging.

Conclusion: In summary, we have successfully fabricated a cost effective and versatile nanoplatform using novel anti-tumor, polysaccharide PSP001 for the combinatorial intervention of siRNA and chemotherapeutic drug facilitating efficacious treatment of HER2 positive breast cancer.

Keywords: Nanoparticle, polysaccharide, siRNA, doxorubicin., breast cancer

HEALTH SCIENCES-09 REG. No. 13563

Effect of the Anti-Fungal Agent, Fluconazole, on Reproduction in *Drosophila melanogaster*

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Introduction: Gut mycobiota is an important part in an organism's life. Currently there are no studies on effect of loss of mycobiota in general on any organism including *Drosophila melanogaster*. In this study we exposed *Drosophila melanogaster* to fluconazole, anti-fungal agent and examined its effect on development.

Method: In case of larvae six different concentrations of fluconazole (10µg/ml, 50µg/ml, 100µg/ml, 200µg/ml, 300µg/ml and 500µg/ml) were used for the treatment by incorporating in the medium. A control was also kept without fluconazole. For each experiment 25 larvae of different instars were used. In case of adult flies male and female flies were counted and transferred to bottles for the experiment. Fluconazole was feed to the adults by mixing with sugar solution at a concentration of (300µg / ml). Next day they were transferred to normal culture medium for egg laying. The treated larvae were surface sterilized and homogenized in bicarbonate buffer and centrifuge. The extract was plated in two types of plating medium one for bacteria (Luria Bertani Agar for bacteria and other fungi (Sabouraud Dextrose Agar for fungus).

Results: When the first instar larvae were treated with different concentrations of fluconazole and there was no mortality to the treated larvae but the number of pupae in F1 generation in found to be reduced. The concentration of fluconazole for 50% pupation in the F1 generation was found to be 300µg/ml. The MIC ranges were 0.125–≥64 µg/mL for fluconazole. The average steady state of serum concentration of a patient treated with 200mg of fluconazole is 23.9 mg/l. Treatment of adult flies with fluconazole resulted in only 53.2% pupation of the larvae. When the larvae were treated with fluconazole and the next generation larvae transferred to normal medium, all larvae pupated indicating that the reduction in pupation observed is not due to its direct effect on pupation but may be due to reduction in fecundity or hatchability of the eggs. Treated larvae showed 42.3% decrease in fungal population and simultaneous 27.7% increase in bacterial population indicating a competitive advantage for the bacteria on reduction of fungi in the gut. The observed decrease in pupation on treatment with fluconazole may be due

to decrease in fecundity or hatchability which needs to be examined.

Conclusions: This study indicates that the alteration in the gut micro biota may affect the reproductive capacity. This is the first report of effect of fluconazole on the larvae of *Drosophila melanogaster*. Studies need to be conducted in pests and higher organisms to understand the role of gut fungi. Identification of the fungi and bacteria in the gut of fluconazole treated and control larvae and adults are ongoing.

Keywords: Gut mycobiota, Anti-fungal, Fluconazole, *Drosophila melanogaster*

HEALTH SCIENCES-10 REG. No. 15534

Bioactivity-Guided Isolation of α-Glucosidase and α-Amylase Inhibitors from *Cassia mimosoides* L.

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Background: Kathaka kadhiradi kashayam, is an ayurvedic decoction used to manage diabetes mellitus. *Cassia mimosoides* L. (CM), a member of the family Caesalpiniaceae, is one of the key ingredients found in the formulation that might be responsible for their diabetic application. For scientific validation, the potentiality over diabetic complications was analyzed via in-vitro methods. In the case of diabetes, inhibition of dietary carbohydrate hydrolyzing enzymes such as alpha-glucosidase and alpha-amylase is one of the therapeutic strategies to decrease the postprandial glucose levels.

Methods: Shade-dried aerial parts of *Cassia mimosoides* were extracted with Ethanol-water and then partitioned into hexane, chloroform, ethyl acetate, and water fractions. Based on the α - glucosidase and α - amylase inhibitory activity the ethyl acetate fraction was found as an active fraction and then subjected to separation and purification using various chromatography techniques, including Sephadex LH-20, silica gel column chromatography, and Flash chromatography.

Results: Sephadex LH-20 chromatographic separation upon active ethyl acetate fraction yield a total of 14 fractions. The three fractions (XII, XIII

& XIV) exhibited significantly higher inhibition against α-glucosidase and α-amylase enzymes. The procyanidin polymers are the major constituents in these fractions and have reported activity against the same.

Conclusions: This study substantiates the potential use of *cassia mimosoides* as a chief ingredient in kathaka kadhiradi kashayam for its anti-diabetic effect through the α - glucosidase and α - amylase inhibitory action.

Keywords: α-glucosidase, α-amylase, *Cassia mimosoides* L., Kathaka kadhiradi kashayam

HEALTH SCIENCES-11 REG. No. 15551

Determining the Effects of High Glucose on Placental Glucose Transporters and Insulin Receptors Using HTR-8/SVneo Cells

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Background: Intrauterine events can shape fetal life and influence the future health of the offspring. Pregnancy is a period in which the fetus develops in an incubation milieu of maternal fuels. These fuels cross from the maternal compartment to the fetal environment via the placenta. The placenta regulates the intrauterine environment through fetal programming. Hyperglycemia is one of the major risk factor affecting the fetal environment. Any changes in the supply or function in the maternal fuels due to hyperglycemia influence the fetal life. In this work we are trying to study the effects of high glucose condition in first trimester placental cell line (HTR-8/SVneo) in terms of inflammatory markers, oxidative stress and its association with expression of glucose transporters and insulin receptors.

Methods: HTR8SV/neo, the first trimester placental cell lines was used for the study. MTT assay was performed to determine the cell viability of HTR-8/SVneo cells under different glucose concentrations (5 mM to 30 mM) at 24 hour, 48 hour, and 72 hour. Concentrations of inflammatory cytokines like TNF alpha, IL-6 was measured using ELISA kits. Oxidative stress was measured using catalase assay kit. q-RT PCR was performed to

determine the mRNA expression of glucose transporter genes like *SLC2A1, SLC2A3, SLC2A4* and insulin receptor genes like *IRS1, IRS2,INSR*.

Results: We observed a significant decrease in the percentage cell viability in HTR8SV/neo cells exposed to different glucose concentrations. There was an increase in the concentration of inflammatory cytokine markers TNF alpha, and IL-6 in high glucose conditions as compared to normal glucose conditions. Also, oxidative stress was increased in high glucose conditions. Genes encoding for glucose transporters and insulin receptors were also differentially expressed.

Conclusion: A decrease in the percentage cell viability, a significant difference in the expression of inflammatory markers, oxidative stress, glucose transporters and insulin receptors may indicate changes in the placenta due to high glucose conditions which may reflect on the growth of the fetus.

Keywords: Oxidative stress, Inflammation, Glucose transporters, Insulin receptors

HEALTH SCIENCES-12 REG. No. 15580

Alginate-PEG-Starch Inspired Templates for Guided Cardiac Tissue Engineering

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Tissue engineering has been emerged as a promising treatment modality for cardiac regeneration following myocardial infarction. As the native ECM exists as hydrogel, polymeric hydrogel-based templates promise tissue engineering applications owing to their biomimetic nature. Hence, the choice of co-polymers employed is crucial in determining the biocompatibility and biological performance of tissue engineering scaffolds. On this juncture, the present study aimed to engineer a biocompatible hybrid hydrogel scaffold by the interpenetration and crosslinking of the natural polymers alginate and starch reinforced with the synthetic polymer

PEG to function as the regenerative templates for cardiac regeneration. FT-IR revealed the functional groups suggesting the presence of alginate, starch and PEG segments on the surface, water dynamics revealed appreciable water holding capacity befitting native cardiac ECM, SEM analysis revealed surface porosity and dynamic contact angle unveiled the amphiphilic chemistry. The hydrogels were biodegradable as evaluated by aging in simulated biological fluids and the cytocompatibility was assessed with MTT cell viability assay, direct contact assay and live/dead assay using H9c2 cardiomyoblasts. The hydrogel supported the growth and survival of H9c2 cardiomyoblasts onto the interstices suggesting the possible biological performance. Overall, the findings demonstrated that the reinforced hydrogel system exhibits optimum physicochemical properties, excellent biocompatibility and appreciable biological performance to support cardiac cell growth suggesting the promising translational avenues in regenerative cardiology.

Keywords: Cardiac tissue engineering; Hydrogel template; Alginate; Starch; Polyethylene glycol; Regenerative cardiology.

HEALTH SCIENCES-13 REG. No. 15653

Salutary Attributes of Probiotic Human Gut *Lactobacilli*

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Background: Probiotics are live microbial feed supplements that beneficially affect the host animal by improving its intestinal microbial balance. Probiotics with human gut microbiome are used as novel therapy for treating gut associated diseases. *Lactobacillus* spp. of human origin as probiotics are widely accepted as they are generally recognized as safe (GRAS) organisms. *Lactobacillus* imparts specific and effective health benefits to the host and improves general performance.

Methods: Human gut *Lactobacilli* with *in vitro* probiotic properties were selected for the study. Seven *Limosilactobacillus fermentum* strains (L1,L3-L8), *Lactiplantibacillus plantarum* (L9) and *Ligilactobacillus salivarius* (L10) were used in this study.. Salutary properties studied for were β-galactosidase activity, anthelmintic property, anti-inflammatory property, anti-diabetic property, cholesterol-assimilation biofilm formation.

Result: All the nine probiotic strains showed good results for all the salutary properties studied. All the isolates showed the presence of β galactosidase. They also showed strong biofilm formation. The anthelminthic property differs among the isolates, with minimum paralysis time and death time for L8. The anti-inflammatory property increases with increasing concentration of cell-free supernatant. Percentage inhibition of α-amylase in anti-diabetic study was maximum for L8 (51%). L6 (76%) showed strong percentage of cholesterol assimilation.

Conclusion: Among the 9 probiotic human gut lactobacillus isolates studied L1, L5, L6, L8 and L9 have shown maximum activity for the salutary attributes assessed. Hence, these isolates can be further studied for their utility to combat various human gut health issues.

Keywords: Human gut, Probiotics, *Lactobacilli*, Salutary properties

HEALTH SCIENCES-14 REG. No. 15770

Genomic Screening of Hereditary Breast and Ovarian Cancer; its Interpretation and Counselling Challenges

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Background: Women who have inherited mutations in BRCA1 or BRCA2 are at greatly increased risk of developing breast cancer (BC) and ovarian cancer (OC). BRCA1 and BRCA2 are tumor suppressor genes, and tumors from the majority of mutation carriers have loss of heterozygosity (LOH), with loss of the normal allele, so there is no functioning protein.

Method: The next-generation sequencing-based test was used for identifying hereditary cancer susceptibility mutations. The test uses an advanced next-generation sequencing (SMSEQTM) platform to sequence 98 genes associated with hereditary cancers with a high degree of analytical sensitivity and specificity.

Results: The proband was clinically diagnosed for Breast and ovarian cancer and the treatment was initiated based on the molecular findings. The proband's genomic report indicated her carrier status for one copy (heterozygous) of a 'pathogenic' variant in the BRCA1 gene, which has been shown to be associated with hereditary breast

and ovarian cancer syndrome (HBOC) predisposition. While in her daughter no pathogenic variant was detected.

Conclusion: Genetic counseling: Germline pathogenic variants in BRCA1 and BRCA2 are inherited in an autosomal dominant manner. The vast majority of individuals with a BRCA1 or BRCA2 pathogenic variant have inherited it from a parent. However, because of incomplete penetrance, variable age of cancer development, cancer risk reduction resulting from prophylactic surgery, or early death, not all individuals with a BRCA1 or BRCA2 pathogenic variant have a parent affected with cancer.

Offspring of an individual with a BRCA1 or BRCA2 germline pathogenic variant have a 50% chance of inheriting the variant. Prenatal testing is possible for a pregnancy at increased risk if the cancer-predisposing variant in the family is known; however, requests for prenatal testing for adult-onset diseases are uncommon and require careful genetic counseling.

Keywords: NGS, tumour suppressor gene, autosomal dominant inheritance, heterozygosity, BRCA1-BRCA2, HBOC, pathogenic variant.

HEALTH SCIENCES-15 REG. No. 15868

In Silico Evaluation of Some Potentially Active Natural Phytochemicals as Effective Antiviral Agents on the SARS-CoV-2 M^{pro}

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Background: Controlling and defeating the deadly pandemic, COVID 19, is the most challenging issue the world is facing today. Currently, no drugs can be guaranteed of being 100 % effective and side effects are reported for most of the available drugs. Therefore, a best strategy is to take options from natural products and in this context, phytochemicals receive considerable attention. In this study, we explore the best phytochemical constituents from four medicinal herbs (Aegle Marmelos, Coleus Amboinicus, Aerva Lanta and Biophytum Sensitivum) for neutralizing SARS-COV-2 M^{pro}. We also highlight a few mechanistic aspects regarding the interaction between the selected phytochemicals and SARS-COV-2 protease.

Methodology: We carried out molecular docking trails for 87 chemical constituents obtained from Aegle Marmelos, Coleus Amboinicus, Aerva Lanta and Biophytum Sensitivum for neutralzing SARSCOV2-M^{pro}. Molecular docking analysis was performed using Discovery studio and binding energy was calculated from DOCKTHOR online server. Molecular dynamics was done using GROMACS software as implemented in WebGro server. Compounds were scrutinized for their pharmacokinetic properties and toxicity using in-silico method as implemented in Discovery studio.

Results: It is found that, Aegelinosides B, Ervoside, Epoxyaurapten, Epicatechin, Feruloyltyramine and Marmin show a significant binding affinity with LibDock score in the range of 120 kcal/mol to 129 kcal/mol. The best active compound is Aegelinosides B, as it shows a high LibDock score energy of 142 kcal/mol and binding energy of -8.54 kcal/mol. Further, LIPINSKI and ADMET values of well docked aforementioned ligands qualify druglikeness and pharmacokinetics properties. Moreover, molecular dynamics simulation for the best six systems shows good structural stability (RMSD and RMSF), consistent intermolecular hydrogen bonds, good solvent accessibility (SASA) and structural compactness of proteins (Rg).

Conclusions: The phytochemicals derived from four popular Indian herbal plants (Aegle Marmelos, Coleus Amboinicus, Aerva Lanta and Biophytum Sensitivum) in the current study are attractive candidates for fighting SARS-COV-2. Experimental studies in this direction will lead do breakthroughs in this area. To the best of our awareness, using these phytochemicals individually or in a mixture for steam or inhalation treatment is very attractive.

Keywords: COVID19, phytochemicals, Docking, Molecular dynamics, Discovery studio.

09
Life Sciences

Oral Presentation

LIFE SCIENCES-01 REG. No. 10641

Antimicrobial Peptides from Sin Croaker, *Johnius dussumieri*

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Background: Antimicrobial peptides (AMPs) are evolutional weapons, widely used by animals and plants in their innate immune system to fend off invading microbes. They are small molecular weight proteins with broad spectrum antimicrobial properties against pathogenic organisms. They are evolutionarily conserved molecules, which are usually positively charged. Investigating novel antimicrobial peptides from marine organisms can provide new insight into the immune response of these organisms and a possibility of discovering new and effective drugs in medicine/aquaculture. The present study is focused on isolation of AMP from Sin croaker, *Johnius dussumieri.*

Methods: The crude peptide was extracted by modified acetic acid-acetone precipitation method and its activity was tested against bacterial pathogens by disc diffusion assay. The peptide extracts were reconstituted in sterile milliQ .The peptide extracts were subjected to Sep-Pak purification using Sep-pak[R]c-18 cartridges (Waters, USA) and the 5%,40% and 80% Sep-Pak fractions were subjected to further purification by FPLC, *i.e.* cation exchange chromatography employing UNO™ QI (Q1 BioRad) column. FPLC active fractions were tested for antimicrobial activity by the liquid growth inhibition assay against Gram positive bacteria like *Bacillus cereus*, *Staphylococcus aureus* and Gram negative bacteria *Vibrio alginolyticus.*

Results: The crude peptide sample from *Johniusdussumieri* displayed potential activity against the tested microorganisms. Cation exchange chromatography of 5%, 40% and 80% Sep- pak® fraction yielded total 13 fractions. FPLC of 5% Sep-pak fraction yielded 3 fractions (Jd5-1, Jd5-2, Jd5-3), FPLC of 40% Sep-pak fraction yielded 6 fractions (Jd40-1,Jd40-2,Jd40-3, Jd40-4, Jd40-5, Jd40-6), FPLC of 80% Sep-pak fraction yielded 4 fractions(Jd80-1, Jd80-2, Jd80-3, Jd80-4). Broth microdilution assay performed using 5%, 40% and 80% FPLC fractions exhibited inhibition against one or the other pathogenic bacterial strains (*Staphylococcus aureus, Vibrio alginolyticus*, and

Bacillus cereus) tested. All the 5%, 40% and fractions exceptJd40-2 showed above 60% inhibition against *Bacillus cereus.* Fraction Jd40-1 showed 100% of growth inhibition against *Vibrio alginolyticus.*

Conclusion: The study suggest that the croaker *Johnius dussumieri*, an inhabitant of the marine environment is a potent source of antimicrobial peptides and offers great scope for further studies to explore their role as effective curatives in the near future

Keywords: Croaker, Host defense peptides, AMP, Innate immunity, Crude peptide

LIFE SCIENCES-02 REG. No. 14172

Sulfated Polyglucosaminopyranosyl Arabinopyranan from Seafood *Amphioctopus neglectus* Attenuates Angiotensin-II Prompted Cardiac Hypertrophy

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Background: Angiotensin converting enzyme (ACE) is a multifunctional enzyme involved in translation of angiotensin-I (AngI) to vasoconstrictor angiotensin-II (AngII). The bioactivity of polysaccharides was associated with their structural attributes, namely molecular mass, substitution pattern and branching, and composition of sugar residues. Cephalopods were recognized as the culinary delicacy in many cultures and the isolated polysaccharides from octopus possessed potential anti-hypertensive properties.

Method: A sulfated polyglucosaminopyranosyl arabinopyranan was purified from the crude polysaccharide of *Amphioctopus neglectus* sequentially partitioned by anion exchange chromatography (DEAE cellulose-52). The purified polysaccharide was characterized utilising extensive spectroscopic methods. Anti-oxidant and anti-hypertensive activities of the polysaccharide were performed using *in-vitro* assays. *In silico* molecular docking was performed against ACE-I. *Ex-vivo* study was conducted to inhibit cardiac hypertrophy in angiotensin induced cardiomyoblast (H9C2) cells.

Results: The polysaccharide exhibited potential ACE attenuation property (IC_{50} 0.11 mg mL^{-1}), whereas molecular docking simulations displayed its efficient binding at the ACE active site with lesser inhibitory constant (K_i) of 17.36 nM and binding energy (-10.59 kcal mol^{-1}). The *ex-vivo* analysis showed that studied polyglucosaminopyranosyl arabinopyranan attenuated Ang^{II} prompted cardiac hypertrophy at 50 µg mL^{-1} the cardiomyoblast cells, whereas 48 percent reduction in cellular surface area with extended viability could be correlated with anti-hypertrophic potencies of the studied polysaccharide. The polyglucosaminopyranosyl arabinopyranan purified from *A. neglectus* could function as a prospective functional lead against the pathophysiological conditions leading to hypertension.

Conclusion: The polyglucosaminopyranosyl arabinopyranan purified from *A. neglectus* could be utilized as a prospective functional lead against the pathophysiological conditions leading to hypertension.

Keywords: *Amphioctopus neglectus*; sulfated polyglucosaminopyranosyl arabinopyranan; angiotensin-II induced cardiac hypertrophy

LIFE SCIENCES-03 REG. No. 15191

Targeting NRF2 Mediated MDR Regulation in Cancer Stem Cells Using RXRA Agonist Bexarotene

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Nuclear factor erythroid 2-related factor 2 (NRF2) also known as nuclear factor erythroid-derived 2-like 2 (NFE2L2) is a basic leucine zipper (bZIP) protein transcription factor (TF) which regulates a wide range of genes involved in anti-oxidant responses, inflammation, aging as well as cancers. Here, we look at the role of NRF2 in regulating the expression of major MDR proteins responsible for chemoresistance in cancer stem cell (CSC) populations and used its inhibitor to elucidate the benefits of NRF2 down-regulation in cancer stem cells. Initial *in silico* TF binding analysis showed that NRF2 can bind to upper promoter regions of major MDR genes such as MDR1, MRP1, MRP2 and ABCG2. We found that NRF2 as well as these MDR proteins were differentially expressed in proliferating and differentiated

sub populations of NTERA2 cl.D1 (NT2) embryonic carcinoma stem cell line. The co-expression of NRF2 with MDRs was significantly down-regulated in differentiated population when compared to the proliferating NT2 (NT2P) cells. Next, we found that whether NRF2 directly interacts with MDR promoters using luciferase as well as chromatin immunoprecipitation (ChIP) analyses. Interestingly, the association of NRF2 with MDR promoters was decreased or absent in differentiated population. Bexarotene is an inhibitor of NRF2 transcription factor binding to retinoid X receptor alpha (RXRα) gene promoter region and thereby blocking NRF2 mediated transcriptional activity. Finally, the NRF2 targeted molecule was able to sensitize the resilient CSC population towards chemotherapy by increased cytotoxicity, decreased cancer cell migration, clonogenicity, tumor sphere formation and targeting key MDR genes.

LIFE SCIENCES-04 REG. No. 15322

In silico Investigation of Anti-Dengue Lead from *Annona reticulata* Linn.

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Background: Dengue fever, one of the most common viral infections transmitted by mosquitoes is caused by the dengue virus (DENV). Currently there is no clinically approved drugs or vaccines against dengue. Modern medicine seeks to identify the effective components contained in plants for the development of medicine. The identification of new chemical entities (NCEs) with the desired medicinal properties from synthetic or natural sources is crucial in the discovery of new drugs. The current study aims to identify bioactive metabolites from the library of chemical compounds derived from a traditionally important medicinal plant Annona reticulata Linn. through *in silico* techniques. This plant is known for its antipyretic, anthelmintic, anti-cancer, anti-proliferative, anti-microbial, antioxidant activity.

Methods: The 3D structure of Human IMPDH-II (pdb Id:1nf7) was retrieved from RCSB PDB. Chimera and Autodock Tools was used to prepare the structure for screening. The 3D struc-

ture of 60 phytochemicals obtained from the plant were retrieved from PubChem database. Virtual screening was performed using AutoDock Vina. The results were visualized using Discovery studio visualizer followed by the analysis of Druglikeness and Pharmacokinetic properties.

Results: Through molecular docking studies, top five hit molecules were selected based on the least free energy of binding and molecular interactions. Subsequent analysis of physiochemical and ADMET properties revealed Daucosterol a natural phytosterol as the lead compound.

Conclusion: The study emphasizes the importance of plants as the true source of new chemical compounds for drug leads. Although the lead molecule obtained is effective, it's i*n vitro* and *in vivo* analysis are essential for drug development.

Keywords: Dengue, Phytochemicals , Daucosterol, lead, IMPDH-II

LIFE SCIENCES-05 REG. No. 15443

Comparative Study of Antimicrobial Activity and Phytochemical Analysis of *Lagenandra toxicaria* Dalz. and its Endophytic Fungus

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Background: Endophytic fungus shows high diversification in terrestrial as well as aquatic plants. The endophytic fungus colonization varying in individual plants based on its environment and climatic conditions. Such fungus have various activities with antibiotic production, beneficiary relations to host plant and many antagonistic properties. Some of the endophytic fungus shows the peculiar characteristics of existing plant through the production of some specific compounds that found in its host. The studies reveals that the endophytes-plants relationship is mutual and both of them support each other's in their growth, existence and also in biochemical productions.

Methods: This work explores the isolation and characterization of endophytic fungus from the medicinal aquatic plant, *Lagenandra toxicaria* and analyze the antimicrobial activity and

phytochemical analysis of isolates and it's host plant.

Results: According to the data obtained, different types of fungi with different colony features and sporulation were isolated. Some of the fungal isolates and plant extracts of ethyl acetate showed antimicrobial activity against pathogenic microorganisms. The phytochemical analysis has proven that the endophytic fungal extract as well as plant extracts are rich in secondary metabolites like steroids, glycosides, terpenoids, phenols, etc.

Conclusions: This work reveals that the ethyl acetate extracts of fungi and plant showed mostly similar characterizations in antimicrobial and phytochemical analysis.

Keywords: *Lagenandra toxicaria*, endophytic fungus, morphological study, secondary metabolites, antimicrobial activities, phytochemical studies

LIFE SCIENCES-06 REG. No. 15502

Faunal Diversity of *Anopheles* (Diptera : Culicidae) in North Malabar and its Possible Role in Malaria Transmission in the Future.

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Genus *Anopheles* is a major group of mosquito in Kerala and it includes vectors of Malaria. There are six species of *Anopheles* which have been implicated as primary vectors of Malaria in India. Though Malaria cases are less in Kerala compared to other states, sporadic cases are being reported almost every day. With the presence of malaria vectors, localized outbreaks malaria is possible in future. This study was planned to investigate the species diversity, abundance and distribution of *Anopheles* mosquitoes of North Malabar region of Kerala, with special emphasis on malaria vectors. Larval surveys were carried out in different habitats of 5 districts viz., Kasaragod , Kannur , Kozhikode , Malappuram and Wayanad from 2019 to 2021. Besides, adults were collected from cattle sheds using hand collection method. A total of fifteen *Anopheles* species were recorded. Out of these *An. stephensi, An.culicifacies* and *An. subpictus* species B are primary vector species. Data on malaria cases from January to November 2021

were obtained from Directorate of Health services, Government of Kerala. A total of 111 cases were reported from these five districts. 3 cases were indigenous malaria (Kasaragod 1, Wayanad 1, Kozhikode 1). The results indicate the presence of both vectors and parasites, which warrants regular surveillance of both vectors and parasites to prevent future outbreaks of Malaria.

LIFE SCIENCES-07 REG. No. 15536

Screening of Marine Diatoms for Hydrocarbons of Biofuel Significance

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Background: Biofuels are becoming a viable renewable energy source, yet technological and biological advancements are necessary for sustainable and economic biofuel production. Micro algae-based biodiesel production has been intensively researched in recent years. However, hydrocarbons of biofuel significance in algae have been underrepresented in literature. Diatoms are key contributors to marine primary productivity and ecology and are projected to be critical contributors in the biofuel industry. Though, the biodiversity, chemo diversity and genetic diversity of marine diatoms are very high, the number of chemically studied diatoms are lower than any algae.

Method : Marine diatom samples collected from the west coast of India Cruise350 (For V Sagar Sampada), Cruise 357 (1000m depth) and coral reef associated diatoms from Lakshadweep was purified from mixed algal culture collections.12 diatom samples was selected for study for hydrocarbon production was mass cultured and harvested. The biomass of selected diatom species was extracted using n-hexane to get the crude extract. The crude extract was fractionated using 500 mg Bonna Agela silica column to get the hydrocarbons and the analysis was done using GC-MS.

Result: Both qualitative and quantitative analysis was performed on different samples of diatoms for hydrocarbons.

Conclusion: Screening of different marine diatom samples showed the presence of hydrocarbons in them.

Keywords: Hydrocarbons, Biofuel.

LIFE SCIENCES-08 REG. No. 15571

Cyclophilin A Impairs Efferocytosis and Advances Atherosclerotic Lesions

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Background: Cyclophilin A is as a key player in progression of atherosclerosis. Cyclophilin A promotes foam cell formation and its accumulation and thereby promotes lesion formation. However, it is unclear how this protein contributes to disease. Increased load of apoptotic cells and incomplete clearance of these cells together advances lesion progression. We speculate here that cyclophilin A increases apoptotic cell load and impairs normal efferocytotic mechanisms in macrophages thus promoting atherosclerosis.

Methods: Using monocytes and New Zealand White Rabbits (NZW), we analyzed the proapoptotic capability of cyclophilin A. Aortic lesion formation and apoptosis were studied in NZW which were fed with high fat diet (HFD)for 12 weeks. Efferocytosis efficiency of cyclophilin A primed macrophages grown in vitro was assessed using flow cytometry and confocal assays. Cholesterol content in cells was measured using cell-based cholesterol efflux assay. Proteomic analysis and bioinformatics tools were employed to decipher the link between cyclophilin A and the known ligand receptors involved in efferocytosis.

Results: En face staining revealed a significant increase in the lesion area in HFD fed rabbits accompanied with increased glucose, cholesterol and proinflammatory cytokine levels. An 8-fold increase was seen in the number of apoptotic cells in the lesion area of HFD fed NZW rabbits which was further associated with elevation in plasma levels of cyclophilin A. Cyclophilin A was found to induce macrophage apoptosis through mitochondrial membrane potential loss and mitochondrial pore transition protein (MPTP) opening through caspase 3 activation. We also demonstrated that cyclophilin A impairs efferocytosis in apoptotic macrophages and also reducing ABCA1-mediated cholesterol efflux in foam cells derived from macrophages. Cyclophilin A primed macrophages had increase in the expression of the *do not eat me* signal CD47 and decrease in the expression of *eat me signal*, calreticulin. Phago-

cytosis was restored on silencing of cyclophilin A in vitro.

Conclusion: Altogether our study indicate that Cyclophilin A, by its effects on the expression of CD 47 and calreticulin impair efferocytosis in apoptotic macrophages and leading to the progression of atherosclerosis lesions. Together with its impact on cholesterol efflux from macrophages, these effects can amplify other mechanisms of cyclophilin A in accelerating the progression of atherosclerosis.

Keywords: Cyclophilin A, Apoptosis, Efferocytosis, Macrophages, MPTP, Caspase 3, CD 47, Calreticulin, Atherosclerosis, New Zealand White Rabbits.

LIFE SCIENCES-09 REG. No. 15599

Rice Straw Ethanol: Evaluation of Pretreatment Method and the Performance of Low-Cost Commercial Acid Cellulases

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Background: Rice straw (RS) as a feed stock for bioethanol though sustainable, is challenging due to its relatively higher recalcitrance compared to similar agro-residues. Major technical challenges in rice straw conversion are its pretreatment and hydrolysis. Pretreatment strategies that remove lignin and allowing better access of enzymes to cellulose is essential for efficient hydrolysis. Similarly, hydrolysis efficiency is dependent on the type and composition of biomass hydrolyzing enzymes (BHE). Globally there are very few manufacturers of BHE, though there are several acid cellulases in market which are technically similar to BHEs but may be deficient in some component enzymes. Understanding their composition and hydrolysis performance on RS would enable creating of efficient cocktails with improved hydrolytic efficiencies.

Method: Dilute acid and alkali pretreatments were performed to evaluate their lignin removal efficiency and the compositional and structural changes they bring out in the biomass to choose the pretreatment strategy. Structural characterization of differ-

ently pretreated RS was performed using SEM, XPS, XRD, FTIR and porosity measurement. Thirteen different commercial acid cellulases were evaluated for their efficiency in hydrolysis of alkali pretreated RS, measured as sugar yields. Correlations were drawn on the component enzyme activity and hydrolysis efficiency.

Results: Alkali pretreatment removed more lignin, resulted in better exposure of cellulose fibres and created large pores in the biomass compared to acid treatment. Lignin redeposition was evident in acid pretreated biomass and this could reduce the efficiency of hydrolysis through non-specific enzyme adsorption, and acting as a barrier for enzymes to bind cellulose.

Conclusions: This work gives an idea to develop efficient biomass pretreatment strategy and to develop an enzyme cocktail that can specifically degrade alkali pretreated rice straw with increased efficiency. Evaluation of 13 commercial acid cellulase preparations from the market showed that they had different dosage of individual enzyme components, and hence large differences in their saccharification efficiencies. Higher beta glucosidase content of enzymes correlated to better hydrolysis, and higher xylanase content augmented the hydrolytic activity presumably through exposure of cellulose fibres due to removal of hemicellulose.

Keywords: bioethanol, rice straw, pretreatment, cellulase, enzyme blends

LIFE SCIENCES-10 REG. No. 15632

Antibiotic-Active Heterotropic Firmicutes Sheltered in Seaweeds: Can They Add New Dimensions to Future Antimicrobial Agents?

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Background: Emergence of drug-resistant bacteria and need for novel antimicrobial agents prompted researchers to look for new environments to develop promising anti-infective agents.

Methods: Heterotrophic bacteria associated with seaweeds were isolated and assessed for antimicrobial properties. Further, the selected bioactive isolate *Bacillus atrophaeus* SHB2097 was characterized by morphological, biochemical and molecular techniques. Characteristic *nrps* and *pks-I* genes were analyzed by PCR amplification other than antimicrobial and hemolytic profiling. Pathogenicity was assessed by *in vitro* hemolytic assay and presence of pore-forming non-hemolytic enterotoxin and hemolysin genes were analyzed. Organic extract *B. atrophaeus* SHB2097 was assessed for antibacterial properties coupled with siderophore production potential.

Results: *B. atrophaeus* MW82179 exhibiting a zone of inhibition of 30 mm on spot over lawn assay and antioxidant activity, was chosen for bioprospecting studies (GenBank accession number MW82179). Significant anti-infective activity was observed with bacterial organic extract against clinically important multidrug resistant pathogens with MIC 6.25 µg/mL and comparable to the antibiotic agents' chloramphenicol and ampicillin. Genes of type-1 *pks* (MZ222383, 700 bp) and hybrid *nrps/pks* (MZ222389, 1000-1400 bp) of *B. atrophaeus* MW821482 could be amplified. The bacterium possessed genes (1000-1400 bp) involved to biosynthesize siderophore-class molecules (MZ222387 and MZ222388). The bacterium displayed susceptibility to the commercially available antibiotic agents, and was negative for the pore-forming non-hemolytic hemolysin BL (*hbl*) and enterotoxin (*nhe*) toxins, therefore, was not pathogenic.

Conclusion: The heterotrophic *B.*

atrophaeus SHB2097 could be used to develop potential therapeutic and biomedical agents.

Keywords: Seaweed-associated heterotroph, *Bacillus atrophaeus* MW821482, antimicrobial, drug-resistant pathogens, polyketide synthetase

LIFE SCIENCES-11 REG. No. 15747

A Review of the Genus *Spilomena* Shuckard (Hymenoptera: Crabronidae) with the Description of Six New Species from India

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Background: *Spilomena* Shuckard is a cosmopolitan genus of digger wasps belonging to the family Crabronidae, consisting of 91 species worldwide. Most species are known from the Palearctic region followed by the Neotropical, Nearctic, Australian, Afrotropical and Oriental region. Only two species are presently known from India *viz*., *S. indostana* Turner (Maharashtra) and *S. keralaensis* Tessy, Sureshan & Girish Kumar (Kerala). Here we revise the Indian species, describing and illustrating six new species, namely, *S. attenboroughi*, *S. fulvopleuris*, *S. reticularis*, *S. sahyadriensis*, *S. tsunekii* and *S. tuberculata*, all from Southern India. A key to Indian species is provided. The differences between new species and their congeners are also examined.

Method: Specimens for the present study were collected from different parts of Southern India using yellow pan traps and Malaise traps. They were dried, card mounted and examined under LEICA M205 stereozoom microscope and imaged with an attached LEICA DFC 500 digital camera. Measurements were obtained using Leica LAS software (Leica Application Suite V3.80) and images taken at varying focal depths were stacked using Leica Auto montage Software. Final illustrations were improved for contrast and brightness using Adobe® Photoshop® CS5 (Version 12.0 x64) software. The type specimens of the new species are deposited in the 'National Zoological Collections' of the Zoological Survey of India, Western Ghat Regional Centre, Kozhikode, Kerala, India (ZSIK).

Results: The Indian species of *Spilomena* Shuckard are reviewed resulting in the description of six new species

viz., *S. attenboroughi* Tessy, Sureshan & Binoy, *S. fulvopleuris* Tessy, Sureshan & Binoy, *S. reticularis* Tessy, Sureshan & Binoy, *S. sahyadriensis* Tessy, Sureshan & Girish Kumar, *S. tsunekii* Tessy, Sureshan & Girish Kumar, and *S. tuberculata* Tessy, Sureshan & Girish Kumar, all from Southern India. A key to Indian species of *Spilomena* is provided.

Conclusion: The subfamily Pemphredoninae coming under the family Crabronidae has poorly been investigated taxonomically in India like many other families of Hymenoptera. Considering the richness of the Western Ghats fauna, many more crabronid species awaits discovery from the region. Hence extensive and intensive collection efforts are needed to get a clear picture of the species diversity.

Keywords. *Spilomena,* Pemphredoninae, India, new species, key, review, taxonomy.

LIFE SCIENCES-12 REG. No. 15753

Antioxidant Effect of A Glutathione Enriched Polyherbal Formulation on Experimental Diabetic Model

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Background: Diabetes mellitus is a complex and heterogeneous metabolic disorder which is characterised by hyperglycemia resulting from the deficiency or resistance of insulin. There are lots of commonly used anti-diabetic agents for the treatment of diabetes, but none of them has a profound effect without any side effects. Thus, the present study aims to evaluate the anti-diabetic effect of a novel glutathione enriched polyherbal formulation on streptozotocin induced diabetic model.

Method: Diabetes was induced by a single dose of Streptozotocin (60mg/kg b.wt) injection through the intra-peritoneum of male Wistar rats. For the study, animals were divided into four groups, such as normal control, diabetic control, standard drug and sample treated groups. The antidiabetic activity was determined by evaluating various parameters like blood glucose level, insulin level, glycated haemoglobin, antioxidants such as SOD, GPx and change in body weight was also noted.

Results: Treatment with glutathione enriched polyherbal formulation

significantly lowers blood glucose levels by stimulating insulin hormone production. As a result, it prevents the glycation of haemoglobin. Moreover, the severe oxidative stress was reduced by enhancing the antioxidant activity of SOD and GPx. Thus, there was no weight loss observed in the sample treated group as compared with diabetic control.

Conclusion: The results obtained from the present study show that the novel glutathione enriched polyherbal formulation has the ability to control the hyperglycemic condition by maintaining the blood glucose level and modulating the oxidative stress and glycation of biomolecules.

Keywords: Diabetes, Glutathione, Antioxidants, Oxidative stress

LIFE SCIENCES-13 REG. No. 15795

Growth Enhancement of Cardamom Upon Root Colonization by Endophytic Fungus *Piriformospora indica*

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Cardamom (*Elettaria cardamomum* Maton) is an economically valuable spice crop of Kerala. *In vitro* raised cardamom plantlets were co-cultivated with *Piriformospora indica*, an endophytic mycorrhiza-like fungus. Microscopic observation and PCR analysis confirmed the presence of *P. indica* inside the root of cardamom plantlets. Growth parameters of control and *P. indica* colonized plantlets were observed for three months at an interval of 15 days. Various morphological and molecular traits were assessed during this period. The growth enhancement was visible after 15 days of co-culture, which continued upto 90 days of co-cultivation. There was a significant increase ($p<0.05$) in the number and length of leaves and height of the plant in *P. indica* colonized plants compared to non-colonized control plant. In addition to this, the expression levels of auxin, nitrate reductase, vegetative storage protein and phosphate transporter genes were upregulated by 3.45, 3.26, 1.62 and 1.19 folds respectively. Keeping in view of the results obtained, it can be assumed that the co-cultivation with *P. indica* can improve overall growth of the cardamom plants. The findings obtained from this study can be used as

a foundation for future lines of research related to rational improvement of cardamom plants under different environmental conditions.

Keywords: Cardamom; *Piriformospora indica*; Gene expression; Real-time PCR

LIFE SCIENCES-14 REG. No. 15833

Effect of Nutritionally Rich Microalgal Species on Growth, Survival and Reproduction of Copepod *Oithona rigida*

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Background: Aquaculture plays a vital role by offering better nutrition and source of income to many countries. Marine microalgae are nutritionally rich source of proteins, carbohydrates, vitamins, antioxidants and polyunsaturated fatty acids are the natural food source of larval stages of many aquaculture organisms, considering only few species being used in aquaculture and therefore the development of new marine microalgal species is essential for fish seed production and the diversification of aquaculture. In this context, ten different marine microalgal species have been screened for the production of the copepod *Oithona rigida*.

Method: The work investigated the effects of ten different marine microalgal cultures isolated from east and west coast of India on the growth, survival and reproduction of the copepod *Oithona rigida*. Preliminary morphological screening was carried out to check the compatibility with zooplankton feeding size followed by molecular identification and biochemical composition analyses of the selected microalgae in terms of carbohydrates, proteins, minerals and amino acids. The feeding trials were carried out for 12 days and results were observed through a stereomicroscope.

Results: Based on nutritional segregation of selected microalgae in terms of carbohydrates, protein, amino acids, minerals and feeding trials with copepod *Oithona rigida*, new isolates of marine microalgal species *Nannochloropsis oceanica* MACC 24, MACC 26, *Nannochloropsis sp.* MACC 22, MACC 27 could be identified as potential candidates as live feeds in

aquaculture. The microalgal species tested were 2–3-micron size, and bio-encapsulation of *Oithona rigida* with selected microalgae was accomplished for feeding of fish and shellfish larvae.

Conclusions: Based on the feeding trials with the copepod *Oithona rigida*, five new isolates of marine microalgal species such as *Nannochloropsis oceanica* MACC 24 and MACC26 and green microalgal species MACC 20, *Nannochloropsis oceanica* MACC 22, and MACC 23 could be identified as potential candidates as live feeds for further nutritional analysis and feeding trails for fish and shellfish larvae.

Keywords: Marine microalgae, Nutritional composition, Feeding trial, *Nannochloropsis oceanica*

LIFE SCIENCES-15 REG. No. 15835

Antimalarial and Antimicrobial Potentials of a Marine Actinomycete *Nocardiopsis synnemataformans* MCCB 972 Isolated from an Arctic Fjord.

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Background: The role of natural products in health and medicine has always been indispensable. This work is aimed to explore the antimalarial and antibacterial potential of a marine actinomycete *Nocardiopsis synnemataformans* MCCB972 isolated from high Arctic fjord. The secondary metabolites produced by the organism is subjected to solvent extraction and fractionation and show significant antimalarial and antimicrobial activities.

Method: The objective of the work was to evaluate the antimalarial and antimicrobial activities of an actinomycetes *Nocardiopsis synnemataformans* MCCB972. The crude extract of *Nocardiopsis synnemataformans* was fractionated by silica gel column chromatography and reverse phase HPLC methods. The in vitro antiplasmodial activities were tested against erythrocytic stages of chloroquine (CQ) sensitive (*Pf*3D7), and CQ resistant (*Pf*Indo) strains of *P. falciparum through* SYBR green I fluorescence Assay. Fur-

thermore, the antimicrobial potential of pure fractions against selected pathogenic strains of bacteria was determined by Kirby-Bauer assay.

Results: The chromatographic fraction containing Hexane-Ethyl Acetate (1:1 ratio v/v) (**N2**) and Ethyl Acetate (100%) (**N3**) fractions showed highest anti-plasmodial activities with IC_{50}: 28.6 and 25.5 µg/mL respectively against CQ sensitive *Pf*3D7 strain along with good resistance indices (1.1 and 1.2 respectively) against CQ resistant *Pf*Indo. Further, cytotoxic studies were done against HEK293 and HUH-7 cell lines for all the fractions and showed that the fractions are less toxic to human cell lines. The selectivity indices revealed that the isolate *Nocardiopsis synnemataformans* MCCB972 is a potential candidate for finding interesting secondary metabolites having antimalarial activities. In addition to this Hexane-Ethyl Acetate fraction (1:1 ratio v/v) (**N2**) showed potent bioactivity against *Salmonella* species.

Conclusion: We have isolated and identified the actinomycete *Nocardiopsis synnemataformans* MCCB972 from an Arctic fjord that showed promising antimicrobial and antimalarial activities of good potency along with good selectivity indices against mammalian cell lines. Such promising finding warrants further study, including the purification and characterization of the active compounds and further in vivo assays.

Keywords: Antimicrobial, Antiplasmodial, Kirby-Bauer assay, *Nocardiopsis synnemataformans*, SYBR green I fluorescence Assay.

LIFE SCIENCES-16 REG. No. 15891

In vitro Anti-Inflammatory Activities and GC- MS Profiling of Essential Oil from *Thottea siliquosa* (Lam.) Ding Hou, An Ethnomedicinal Plant

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Background: The use of medicinal plants in the treatment of physical problems prevailed from much earlier times among the tribes. *Thottea siliqu-*

osa is a plant widely used by the tribal communities as an indigenous source of medicine. It has higher medicinal value since the roots extracts are claimed to have strong anti-inflammatory properties. These points towards a need for analysing the individual compounds present in the plant and also the anti-inflammatory properties that are responsible for its medicinal value.

Method: Essential oil was extracted from the rhizome of *T. siliquosa* using a Clevenger apparatus and *in vitro* anti-inflammatory studies were conducted by Cyclooxygenase (COX) and Lipoxygenase (LOX) method. Headspace GC-MS profiling of the rhizome was conducted inorder to identify the volatile constituents of *T. siliquosa*.

Results: Anti-inflammatory potentials of essential oil from the rhizome were confirmed by conducting the COX and LOX anti-inflammatory studies with IC50 values 108.09±1.66 µg/ml and 84.676±1.11 µg/ml respectively. Headspace GC-MS analysis of *T. siliquosa* rhizome revealed the presence of anti-inflammatory compounds like alloaromadendrene and thujopsene.

Conclusion: The essential oil extracted from the rhizome was found to have pronounced anti-inflammatory properties against RAW 264.7 cells. Headspace GC-MS profiling of the volatile fraction of *T. siliquosa* enabled the identification of some of the anti-inflammatory compounds.

Keywords: *Thottea siliquosa*, Cyclooxygenase, Lipoxygenase, Anti-inflammation, Headspace GC-MS

LIFE SCIENCES-17 REG. No. 15901

Screening and Isolation of Cold Active Lipase Producing Strain for Biodegradation of Lipid Rich Wastes

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Background: Lipases are subclass of esterases, which catalyze hydrolysis of fats. Microbial lipases are widely used in biotechnological applications as well as in the industries due to their broad substrate specificity, higher stability with less production costs compared to other sources

Method: This work mainly focused on screening and isolation of lipase

producing bacteria for degradation of lipid rich wastes mainly from oil mills and dairy effluents. Lipase producing strains were primarily screened on tributyrin agar plate based on clear zone of hydrolysis. Positive isolates were screened both qualitatively and quantitatively to get most potent isolates. The degradation efficiency of lipase producing strain was estimated in terms of reduction in biological oxygen demand and lipid content in oil mill waste and dairy effluents.

Results: Primary screening of bacteria results in 73 lipase producing strains. Out of these,12 isolates were considered to be pure lipase producers. The isolate I13, *Bacillus cereus* shows higher lipase activity and exhibited a clear zone of hydrolysis. The isolate I13 shows maximum efficiency for biodegradation of waste water. The I13 lowers biological oxygen demand by 40.85% from oil mill waste and 38.7% from dairy effluents respectively. The isolate *Bacillus cereus* I13 produces lipase with activity of 11.42 U/ml on 4th day of incubation at 20°C along with highest zone of clearance 27mm in agar well diffusion plate method. The optimum condition for higher production of lipase was at pH 7.0, temperature 20°C, incubation period 96 hr with glucose as carbon source, yeast as nitrogen source and olive oil as substrate.

Conclusion: The study helps to understand the cold active lipase enzyme production bacteria *Bacillus cereus* I13 from Arctic fjord sediments and can be used as a potential candidate in bioremediation.

Keywords: Cold active enzymes, psychrophiles, *Bacillus cereus*, biological oxygen demand, dairy effluents, bioremediation.

LIFE SCIENCES-18 REG. No. 15908

Contact Toxicity and Fumigation Effects of Methanolic Extracts of *Annona squamosa*, *Syzygium aromaticum* and *Citrus aurentifola* Against *Sitophilus oryzae*

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Background: Grains are a staple food of majority of people around the world. One of the major pests of grains in tropics is the Sitophilus species, which causes considerable economic loss to stored grains. Due to its longer residual action and its wide toxicity spectrum, synthetic chemical insecticides came to be more popular. Inadequate, improper, and indiscriminate use of synthetic insecticides in crop pest management programs throughout the world has led to tremendous damage to the environment as well as affected human health Consider the harmful, deleterious effect of synthetic insecticides, the biopesticides obtained from plant sources seems to be devoid of residue problems and safer In the present study contact toxicity and fumigation effects of three plant extracts *Annona squamosa, Syzygium aromaticum* and *Citrus aurantifolia* were tested for their efficacy in controlling rice weevil, *Sitophilus oryzae*

Method: the extraction was performed using Soxhlet apparatus. 25g of each plant powder and 125 ml methanol was taken for the extraction. Phytochemical screening of extracts were also performed. For contact toxicity studies the test organisms and filter paper treated with the extract was placed in a bottle with airflow. For fumigation studies the test organism and the filter paper treated with extract was placed in a small bottle which was inturn placed in a large airtight bottle containing the test organism. The mortality was noted after 24 hr

Results: All the three extracts were found to be effective in controlling rice weevil. In contact toxicity studies *Annona squamosa* was found to show highest effect on rice weevil with an LC 50 value - 0.6093% followed by *Syzygium aromaticum* with LC 50 - 5.7721% and *Citrus aurantifolia* with LC 50 - 1.2788%. In fumigation studies also *Annona squamosa* showed maximum effect with an LC 50 - 0.1343% followed by *Citrus aurantifolia* with LC 50 -0.5814% and *Syzygium aromaticum* with LC 50 - 0.9746%.

Conclusions: Considering the dam-

aging effects of synthetic pesticides, the recent trend is application of plant-based products for the control of pests worldwide. The main objective of the present study was to find novel methods of pest control utilizing three plant extracts namely, *Annona squamosa, Syzygium aromaticum* and *Citrus aurentifolia* against one of the world's most damaging pest *Sitophylus oryzae*. All these plants extracts were found to be effective in controlling rice weevil and capable of causing 100% mortality.

Keywords: *Sitophylus oryzae, Annona squamosa, Syzygium aromaticum, Citrus aurentifolia*

LIFE SCIENCES-19 REG. No. 15914

New Records of Pemphredonid Wasps (Hymenoptera: Crabronidae) from Kerala with an Updated Checklist

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Background: In India, taxonomic data is scanty even today on many insect groups, which are quite significant in preserving the ecological balance and in maintaining the overall biodiversity of our country. Pemphredonid wasps, also known as aphid wasps, comes under the family Crabronidae (Hymenoptera) with over 1000 species worldwide. They are ecologically important organisms as they are thought to play pivotal roles in ecosystems, as predators and biological control agents. The subfamily Pemphredoninae, being one of the most generalized taxa of the family Crabronidae, consists of 4 extant tribes, 42 genera, and 1173 species worldwide. So far only 14 species are reported from Kerala as it is an unexplored area of research.

Method: Different sites of Southern India were surveyed for specimen collection using yellow pan traps and Malaise traps. They were dried, card mounted and examined under LEICA M205 stereozoom microscope and imaged with an attached LEICA DFC 500 digital camera. Measurements were taken using Leica LAS software (Leica Application Suite V3.80) and Leica Auto montage Software was used for stacking images taken at varying focal depths. The final illustrations were post-processed for contrast and brightness using Adobe® Photoshop®. The type specimens of the new species are deposited in the 'National Zoological Collections' of

the Zoological Survey of India, Western Ghat Regional Centre, Kozhikode, Kerala, India (ZSIK).

Results: In this paper, three genera belonging to the subfamily Pemphredoninae *viz.*, *Psen*, *Psenulus* and *Polemistus* were studied from Kerala and a total of four species of pemphredonid wasps are represented as new records for the fauna of Kerala *viz.*, *Psen refractus* Nurse, 1903, *Psenulus pulcherrimus eburneus* van Lith, 1969, *Psenulus annamensis* van Lith, 1972 and *Polemistus fukuitor* Tsuneki, 1992. The specimens were collected using Malaise traps and yellow pan traps during 2017-2021. Diagnostic characters of the newly recorded species are provided. In addition, an updated checklist of the Pemphredonid wasps from Kerala is presented.

Conclusion: The subfamily Pemphredoninae coming under the family Crabronidae has poorly been investigated taxonomically in India like many other families of Hymenoptera. Considering the richness of the Western Ghats fauna, many more crabronid species awaits discovery from the region. Hence extensive and intensive collection efforts are needed for understanding its species diversity, species richness, endemism, its community level interactions and their role in sustaining our ecosystem.

Keywords. Pemphredoninae, India, new record, checklist, taxonomy

LIFE SCIENCES-20 REG. No. 15918

Nitela latreille, 1809 (Hymenoptera: Crabronidae: Crabroninae): First Record from India and a New Record from Kerala State

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Background: The genus *Nitela* coming under the family Crabronidae and subfamily Crabroninae is a predatory wasp, consisting of 66 species with two subspecies worldwide. Hitherto, only one species namely, *N. collaris* Turner have been reported from India (from pusa of Bihar).

Method: This study is based on the specimens collected from various localities of Kerala mainly by using 20-50 numbers of yellow pan traps. The specimens were studied and photographed with a Leica Stereo

microscope model LEICA M 205A with LEICA DFC 500 Camera. All the specimens are deposited in the 'National Zoological Collections' of the Western Ghat Regional Centre, Zoological Survey of India, Kozhikode.

Results: During our study, species namely *N. domestica* Williams was observed from India as a new record and *N. collaris* was observed from Kerala as a new state record.

Conclusions: Being the predators of aphids, these wasps are important in ecolgical pest control. Extensive study throughout India may reveal several new species from India.

Key words : Digger wasps, New record, Miscophini

LIFE SCIENCES-21 REG. No. 15936

First Record of *Methocha taprobane* Krombein (Hymenoptera: Tiphiidae: Methochinae) from India

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Background: The Sri Lankan species, *Methocha taprobane* Krombein, 1982 is newly reported for the fauna of India. Diagnostic characters and distribution are provided.

Method: The studied specimen is collected using yellow pan trap and then mounted on triangular cards and was examined under LEICA M205A stereozoom microscopes. In Biological point of view, *Methocha* females are wingless, hence the yellow pan traps and pitfall traps are the most efficient methods for collection of these insects.

Results: The species *Methocha taprobane* Krombein, 1982 earlier recorded from Sri Lanka. Till date, only eight species are reported from India. Here the species is newly recorded from the Peppara dam site area in the Peppara Wild Life Sanctuary of Kerala State.

Conclusion: The species *Methocha taprobane* Krombein, 1982, is newly reported from the Kerala state of India. The species in the genus *Methocha* are used in the biological control of Cicindelid beetles.

Keywords: Tiphiid wasp, Kerala, New record

09
Life Sciences

Poster Presentation

LIFE SCIENCES-22 REG. No. 10871

Marine Endophytic Actinomycetes as Potential Producers of Industrially Important Enzymes

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Background: Marine actinobacteria are one of the most efficient groups of secondary metabolite producers and are very important from an industrial point of view. Many representatives of the order Actinomycetales are prolific producers of thousands of biologically active secondary metabolites. Actinobacteria from terrestrial sources have been studied and screened since the 1950s, for many important antibiotics, anticancer, anti-tumour and immunosuppressive agents. They are efficient producers of new secondary metabolites that show a range of biological activities including antibacterial, antifungal, anticancer, antitumor, cytotoxic, cytostatic, anti-inflammatory, anti-parasitic, anti-malaria, antiviral, antioxidant, anti-angiogenesis, etc. Present study focuses on the isolation of endophytic actinomycetes from mangroves along Kerala coast and screening them for production of industrially important enzymes.

Methods: Endophytic actinomycetes were isolated from the various mangroves along the Kerala coast by a modified sandwich method, purified and stocked. The isolates were identified using ARDRA and PCR based sequencing. The isolates were screened for 14 microbial enzymes.

Results: A total of 63 isolates were obtained and identified. Out of 63 isolates all of them produced amylase, protease and lipase, 34% tyrosinase, 31% e Ligninase, 26% Asparaginase, 22% DNAase, 20% glutaminase, 17% cellulase, 8% Chitinase,11% were phosphatase and 2% Laccas .

Conclusion: This work reveals the potential actinomycetes associated with mangroves and shows that endophytic actinomycetes are a potential resource for commercially important enzymes.

Keywords: Mangrove endophytes, Endophytic actinomycetes, Microbial enzymes, ARDRA, PCR

LIFE SCIENCES-23 REG. No. 11285

Bioactive Potential of Endophytic Fungi from Marine Sea-grass *Thalassia hemprichii* of Lakshadweep Islands

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Background: Seagrass, the submerged marine angiosperm monocotyledon plants occupy the continents except the Antarctica. Being the primary producers, they also play a significant role in the physical, chemical and biologicals effects of the habitats near the shore coastal ecosystems. Endophytic fungi dwelling in different tissues of heathy seagrass often produce substances that not only protect the host plants but also enhance the growth rate. They have claimed medicinal properties and are capable of producing bioactive metabolites with anticancer, antibacterial, antifungal and enzyme activities. The present study reports on the isolation of the endophytic fungi from marine seagrass *Thalassia hemprichii,* its broad-spectrum antimicrobial activity and enzymatic activity.

Materials and Methods: Marine seagrass *Thalassia hemprichii* was collected from the Islands of Lakshadweep (Kalpeni)**.** Endophytic fungi were isolated from tissues of different parts of sample (2) (3). The frequency of fungal endophytes within the plant species was calculated by Fischer and Petrini (1998) method. The isolates were subjected for antimicrobial screening using Kirby–Bauer Disc Diffusion Test (1966) and hydrolytic enzyme production to identify the potent strains.

Results and Discussion: Out of 30 isolates 17 were found to show broad spectrum antibiotic activity against 13 pathogens and hydrolytic enzyme production was also high among the isolates.

Conclusion: The isolates revealed to possess antagonist activity which shows that endophytic fungi isolated from marine sea grass *Thalassia hemprichii* is a promising candidate and may provide scope for new drug discovery.

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LIFE SCIENCES-24 REG. No. 12814

Genetic Diversity Analysis of *Trichopus zeylanicus subsp. travancoricus* Accessions Using SCoT Markers

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Trichopus zeylanicus subsp. *travancoricus* Burkill ex K. Narayanan, is an ethnomedicinal plant used by Kani tribes of Kerala, India. In India, the plant is endemic to southern Western Ghats with a restricted distribution in Kerala and Tamil Nadu. In this study, the genetic diversity of 30 accessions collected from Kerala and Tamil Nadu states of India was assessed using SCoT markers. Among the 19 primers used for screening the accessions, 4 primers could generate unambiguous and reproducible bands. These four primers generated a total of 56 bands, with a mean of 13 bands per primer. The polymorphic ratio of 81% to 100 %, with an average polymorphism of 93.7% was revealed across all accessions. A total of 56 bands were detected among 30 accessions using 4 SCoT markers out of which 53 were polymorphic. Number of polymorphic bands ranged from 9 (SCoT35) to 17 (SCoT28) with average 13.2 per primers. Percentage of polymorphism ranged from 81 to 100 with an average polymorphism of 93.7% across all accessions. The genetic distance is calculated by used by NTSYS-pc version 2.02i software, highest value was found to be 1.00 and lowest value was 0.20. The average value was 0.61. By using clustering method (Sequential Agglomerative Hierarchical Nesting (SAHN) based Unweighted Pair-Group Method with Arithmetic Mean (UPGM) the dendrogram grouped 30 accessions into ten clusters, with similarity ranged from 0.73 to 0.95. This is first report of genetic diversity work in *Trichopus zeylanicus* subsp. *travancoricus*.

Keywords: Arogyapacha, Ethnomedicine, Traditional Knowledge, Kani tribe

LIFE SCIENCES-25 REG. No. 13598

Genome-Wide Analysis of Clinical *Staphylococcus aureus* Isolate Reveals the Presence of a Strain-Specific Integrated Resistance Plasmid with Antibiotic Resistance Genes

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Antibiotics are powerful medicines that fight against human morbidity and mortality. However, the extensive and inappropriate use of antibiotics is the main incentive for the selection of resistant bacterial populations. Bacterial adaptive evolution has been so effective that antibiotics are almost useless in treating such infectious diseases. As a result, antibiotic resistance is widely considered to be the next global silent pandemic as treatment of disease becomes more costly and burdensome. Methicillin-resistant *Staphylococcus aureus* (MRSA) epidemiology has undergone tremendous changes and the resistance and virulence properties are increasing at an alarming rate especially in India. But the main issue is the lack of sufficient research and paucity of data that not only hampers the estimation of the exact rise and extent of AMR in India but also prevents a nation-wide comparison. In this direction, this study aims towards a better understanding of the antibiotic resistance mechanisms that would form the scientific basis for designing strategies to combat AMR. To further unravel the genetic variability and resistance evolution of MRSA clones in India, in this study we are using whole genome sequencing and comparative genomics. Here, we obtained a complete genomic DNA of *S. aureus* isolate belonging to ST672 (designated as *S. aureus* S145), which carry some rare mobile pathogenicity islands with antibiotic resistance genes. The hybrid genome sequence analysis of multidrug resistant *S. aureus* S145 isolate with SCCmec-IV 2B was found to contain a circular genome of 27,79,733 bp with a GC content of 32.8% with 2,537 protein-coding genes. We identified 94 genes associated with antimicrobial resistance and 79 genes encoding putative virulence associated products. From gene distribution pattern and genomic linkage analysis of coding sequences revealed that, this isolate carries a strain-specific integrated

resistance plasmid (IRP) like element consists of antibiotic resistance genes include the aminoglycoside cluster *aphA3-sat4-aadE* as well as macrolide efflux genes *msrA* and *mphC* flanked by transposition and repeat elements. Antibiotic resistance genes flanked by transposition elements, suggest that the *S. aureus* isolates are more prone to accommodate more unique resistant genes in their genome, further making them a multi-drug resistant strain.

LIFE SCIENCES-26 REG. No. 15448

Phenology, Seed Development and Seed Storage in *Mesua ferrea* L., a Medicinal Tree of Indo-Malayan Region

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Background: In *M. ferrea* L. the seeds are desiccation sensitive and lose viability within a short period. In natural condition seeds lose moisture content at faster rate and they are become non-viable with in a period of 8 days. Though here, we have standardized a conventional technique whereby the viability of the seeds can be extended to 150-180 days by storing the seeds in polycarbonate bottles at 10°C. The flowering process, seed formation, maturation, seed germination and establishment are critical phases in the life cycle of any plant which are highly specific to the environmental factors. So, the present study deals about the phenology sequences, seed set, seed development in two populations of *Mesua ferrea* L. are evaluated.

Methods: This work reveals the phenological sequences, calculated the reproductive efficiency, analyzed the seed development stages, tested the seed storage and viability of the seeds in 5 different storage conditions.

Results: There was a slight variation in leaf and flower flushing among the two populations, further fruit/seed development did not show significant variation. Pollinating agents were also been identified. After pollination seed development was initiated with an increase in seed moisture content and fresh seed and dry weight. The moisture content started decreasing 60 days after anthesis and recorded 44.58% by 160 DAA. Seeds of *M. ferrea* are recalcitrant in nature and lose viability with a short span 8-15 days.

Of the different conventional methods tried using the polycarbonate bottle and bags, *M. ferrea* seeds retained viability for 150 days with a slow moisture loss from the seeds stored in closed polycarbonate bottles at 10 °C.

Conclusions: Leafing and flowering phenology of *M. ferrea* recorded difference in both the sites indicate that the rainfall, temperature and daylight had an influence in the leafing and flowering pattern and seed setting. Standardized a conventional technique whereby the viability of the seeds can be extended to 150-180 days without much expenses by storing the seeds in closed polycarbonate bottles at 10 °C.

Keywords: *Mesua ferrea,* Phenology, Seed development, Germination, Seed storage.

LIFE SCIENCES-27 REG. No. 15471

Hidden Mycobiont of Mangrove, *Avicennia officinalis* as a Source of Anticancer Enzyme L-Asparaginase

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Background: Search for novel bioactive molecules is being focussed on marine bioresources and mangroves are considered as potential candidates, having been an important source of traditional medicines for coastal populations. Major studies on endophytic fungi include screening for secondary metabolites, and commercially valuable enzymes have gained much attention. Not many have explored the endophytic fungi as a biotechnological source of industrially relevant enzymes; they remain as a relatively unexplored resource. Hence this study focused on mangrove-derived endophytic fungi as a source of therapeutic enzyme L-asparaginase, used as an anti-leukemic and anti-lymphocytic agent.

Material and methods: Indian mangrove *Avicennia officinalis* , one of the major mangrove species of the Kerala coast was selected for the current study for the isolation of endophytic fungi. A polyphasic approach based on colony characteristics, spore morphology and molecular methods were used to identify the endophytes. Isolation of DNA, amplification of ITS region, followed by restriction fragment analysis study (ARDRA) and sequencing of the representative

strains helped to identify the isolates up to species level. The ability of the fungi to produce glutaminase free, L-asparaginase were screened using MCD agar supplemented with phenol red and BTB.positive isolates were selected for quantitative estimation, followed by partial purification and dialysis. The molecular mass of the purified enzyme was estimated using SDS PAGE analysis.

Results: A total of 150 endophytic fungal isolates were isolated from *Avicennia officinalis* . These fungi included *Colletotrichum, Phyllosticta, Cladosporium,* and *Phaeophleospora* species. These endosymbionts were found to be an active source of L-asparaginase. Only few isolates showed glutaminase free L-asparaginase activity. All the isolates were screened for L-asparaginase production using Modified Czapex Dox's using phenol red and BTB as indicators. Isolates that showed prominent zone index, AO1 and AO3 (*Cladosporium sphaerospermum*), AO2 (*Cladosporium cladosporioides*), AO4 (*Phyllosticta capitalensis*), AO5 (*Colletotrichum gloeosporioides*), and AO6 (*Phaeophleospora eucalypticola*) were selected for further quantitative estimation. Crude extracts of AO2 (*Cladosporium cladosporioides*) that yielded 5 U/ml L-asparaginase were further purified and dialyzed for characterization. The homogeneity and molecular weight of purified asparaginase were analyzed by SDS PAGE and found to be approximately 65 kDa. This study showed that glutaminase-free asparaginase purified to apparent homogeneity may be used as an anticancer molecule with minimum side effects.

Conclusion: The present study is aimed to characterize, and purify pharmaceutically important anticancer enzyme L-asparaginase. The L-asparaginase from these halophilic organisms may be useful in the treatment of hypersensitive patients. Based on the current study, it was found that several species of this ecological group of fungi isolated from mangroves are an excellent source of L-asparaginase.

Keywords: Mangrove, Endophytic fungi, L-asparaginase, Anticancer

LIFE SCIENCES-28 REG. No. 15477

Global Climate Change Poses a Threat of Malaria Transmission in Coastal Kerala, India

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Kerala has a long history of Malaria. Till its official eradication using DDT in 1965, malaria was restricted to the eastern foothill areas of the state. The vector species incriminated was Anopheles fluviatilis. However, post eradication, occasional outbreaks were reported from the coastal areas with Anopheles stephensi as the vector. Major breeding habitats of Anopheles stephensi are wells, Over Head Tanks, containers and similar man-made habitats. In the present study Anopheles subpictus B, an efficient vector of Malaria, has been found breeding in saline water habitats in the coastal village Kadalundi of Kozhikode district. The salinity of water ranged from 20-32 ppt. Kerala is a coastal state with an extensive coast line of 590 km. Global warming is predicted to raise the sea level, leading to an increase in saline and brackish water bodies in coastal areas. This can increase the saline water habitats in the state and increase in the salinity tolerant vectors like Anopheles subpictus B. Similarly, there is also a possibility of the invasion of the notorious salinity tolerant vector species Anopheles sundaicus in these habitats. The ultimate result of these developments would be the emergence of a new paradigm of malaria in the state. Thus strategies to stall such a malaria paradigm has to be initiated right now involving regular vector surveys in the brackish water habitats in the state.

LIFE SCIENCES-29 REG. No. 15495

Green Synthesis of Silver Nanoparticles Using *Merremia vitifolia* (Burm F.) Hallier (Convolvulaceae) Leaf Extract; Comparing the Effectiveness of Larvicidal Activity on N-Hexane Extract Against *Aedes albopictus* L. (Diptera: Culicidae)

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Introduction: The present study has attempted to make the larvicidal activity of hexane solvent of the invasive weed *Merremia vitifolia* (Burmann.f) Hallier f. extract. It may be of great biocontrol value in the context of integrated vector control management

Method: Potential antioxidant molecules in *M. vitifolia* were analysed and antioxidant activity is determined by DPPH radical scavenging assay (Desmarchelier et al., 2008) after n-hexane plant extract is prepared. Synthesis of silver nanoparticle is done. Toxicity assay is done on third instar larvae of *A. albopictus*. LC50 value is estimated along with sub lethal toxicity and statistical analysis were done.

Results: The *M. vitifolia* leaf n-hexane extract was prepared from 20g of powdered sample and yielded1.7598g. The least percentage mortality is 26.67± 0.047 with in 40nm. Maximum larval death percentage is 96.33± 0.32 percentage mortality occurred at 280ppm. Silver coated nanoparticles of *M. vitifolia* were tested for larvicidal activity and the least mortality is observed in 0.01µg/mL having 33.3% mortality. Maximum mortality were observed in 0.05µg/mL concentration having 94.2% mortality.

Conclusion: The results indicated that the plant extract have a significant antioxidant activity and larvicidal effect on *A. albopictus*. The silver coated *M. vitifolia* nanoparticles shown greater potential in lower concentration than n-hexane extract of *M. Vitifolia.* Maximum mortality were observed in 0.05µg/mL concentration. 94.2% mortality. The least mortality is observed in 0.01µg/mL. 33.3% mortality is seen in 0.01µg/mL

LIFE SCIENCES-30 REG. No. 15564

Modulation of Microbial Virulence by Activated Furan Compounds

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Background: Opportunistic pathogens like *Pseudomonas aeruginosa, Chromobacterium violaceum* and *Candida albicans* are known to produce virulence factors and form intractable biofilms which are key confront for the management of infections. Recent research focuses on discovering novel targets to combat drug resistance. Compounds which reduce virulence without killing the microbes are a promising strategy as it does not impose high selective pressure for the development of resistance. Furan is an essential part of pharmacological building blocks, used in the synthesis of pharmaceuticals. Keeping in view of its pharmacological importance, the present study investigated the anti virulent properties of Meldrum acid and Barbituric acid activated Furans (MAF and BAF) against *C. violaceum*, *P. aeruginosa* and *C. albicans*.

Methods: This work explore to test the inhibitory effect of MAF and BAF on virulent traits of *C. violaceum*, *P. aeruginosa* and *C. albicans*. MAF and BAF were synthesised as previously described methods and checked its anti- virulent effect on violacein production in *C. violaceum*, biofilm formation, pigments, motility and elastase activity in *P. aeruginosa* and germ tube formation of *C. albicans*. Anti infective properties of the test compounds were confirmed by using an *in vivo* model *Caenorhabditis elegans.* To understand the mechanism of anti-virulent properties, gene expression studies and *in silico* docking analysis were used. To study the anti- virulent properties in *C. albicans* germ tube formation was assessed.

Result: In *C. violaceum*, MAF and BAF at sub-MIC concentrations exhibited significant inhibitory activity in violacein pigment production and biofilm formation. Further, in *P. aeruginosa* inhibition of virulence factors including motility, biofilm formation, pyocyanin production and elastase B activity were observed. *In vivo* studies demonstrated that MAF improved the survival of *C. elegans* infected with *P. aeruginosa*, established the anti-infective role in a whole animal model of pathogenesis. Gene expression studies of *lasI, rhlI and pqs*

A genes which are involved in quorum sensing regulatory circuit were down regulated in the presence of MAF. *In silico* studies further established that MAF competitively binding with the quorum sensing receptor molecules of *C. violaceum* and *P. aeruginosa*. MAF significantly reduces the germ tube formation of *C. albicans* – a potential pathogenicity feature of this fungus.

Conclusion: Results of the study suggest that furan activated compounds could serve as a promising strategy in the management of microbial infections.

Key words: Virulence, Activated furan, *C.violaceum, P. aeruginosa, C. albicans*

LIFE SCIENCES-31 REG. No. 15570

Microplastic as A "Macro" Concern – Problems and Solutions

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Background: Life without plastic has become impossible for us. Due to the small size of microplastic, it is easier to intake by aquatic organisms. These ingested particles can physically damage their internal organs. The accumulation of microplastic up the food chain is another major concern. This "man-made food chain" potentially impacts whole ecosystems. To avoid these serious problems we have to find various solutions to replace plastic material with something more eco-friendly. This study is trying to promote the extensive use of biodegradable plastics in our daily life.

Method: Starch is used as a base material; it is obtained from various cheap and easily available resources like porridge water, corn flour, potato, and tapioca. The base material is mixed and heated with glycerin and vinegar for converting the base into a product. The bioplastics thus produced are checked and compared for their biodegradability among themselves and also with synthetic plastic using a mixture of earthworm, soil, and cow dung.

Results: A bioplastic made of natural materials such as porridge water, corn flour, potato, tapioca, etc. is an innovative product. Earthworms were used to test the degradability of these bioplastics and synthetic plastics. It was found that bioplastics degrade at

a higher rate than synthetic plastics.

Conclusions: This work establishes the effects and solutions for micro-plastic pollution. However, bioplastics remain relatively unknown to many people despite their importance. Innovation is needed to get their interest in using products made from bioplastics and with easy access or find. As a result, environmental conditions can be improved, and the waste of plastics can be reduced.

Keywords: Micro-plastics, biodegradable plastics, environmental pollution

LIFE SCIENCES-32 REG. No. 15640

Silibinin's Inhibitory Activity on Bacterial Gelatinases

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Silibinin is a commonly used dietary supplement with well-known hepatoprotective roles originally extracted from the milk thistle plant. Silibinin has been proposed as a promising new treatment for cancer. Owing to the inevitable role of gelatinases in cell invasion and tissue remodeling they are promising drug targets in a plethora of disease conditions. This study aims to examine silibinin's inhibitory role towards bacterial gelatinases through a combination of molecular docking and *in vitro* assays. In the absence of a three-dimensional structure of Enterococcal gelatinase, we carried out homology modelling using the Swiss model server to predict its structure using Bacillolysin as the template. Further *In silico* docking studies conducted between Silibinin and the newly predicted model revealed a strong binding affinity of -10.2 kcal/mol. *In vitro* assays conducted also supported our hypothesis that silibinin even at very low concentration of 100 µg/ml could exert strong inhibition on Enterococcal gelatinase activity. Our results indicate for the first time that silibinin is a strong inhibitor of bacterial gelatinases and therefore, appropriate food supplementation of silibinin will help to reduce the virulence of gut microbial species.

Keywords:- Bacterial virulence, Docking, Gelatinase, Homology modelling, Silibinin

LIFE SCIENCES-33 REG. No. 15670

Lipofection-Mediated Gene Delivery and Transgenic Expression of *DSRED2* in The Primary Cell Culture from the Crustacean Model *Daphnia pulex*

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Background: Transfection is a highly efficient analytical tool for studying function and regulation of genes and gene products. Lipofectionis commonly accepted as the second most popular non-viral system for the safe delivery of exogenous nucleic acid into cells. Expression of foreign genes can be confirmed by using marker gene like *DsRed2*. Even though transfection-based studies are evolving rapidly, very few studies are reported in invertebrate cell culture, especially in crustaceans. In this context, we reported the first successful lipofection mediated transgenic expression ofvectorcontaining *DsRed2* gene as marker in the primary culture of a crustacean model organism, *Daphnia pulex.*

Method: Primary *D.pulex* cell culture was developed from *Daphnia* egg and maintained in Daphnia Cell Culture Medium (DCCM). 80% cell confluent flask was used for the standardization of lipofection.Transfection efficiency was standardized using different concentrations of Cellfectin and DNA having maximum cell efficiency and minimum cytotoxicity.

Results: The lipofection experiments of the cells using 7µL of cellfectin reagent and 3µg of plasmid resulted in good fluorescence, indicative of successful transfection and expression of *Daphnia* specific expression vector in the developed primary cell culture. More than 50% of primary *D. pulex* cells were transfected, and red fluorescence was observed under an inverted phase-contrast microscope (Leica, Switzerland) under the excitation wavelength of 470-490nm.

Conclusion: The concentrations of cellfectin reagent and plasmid required for successful lipofection could be standardized. Even though the *Daphnia* genome is fully sequenced, in-vitro studies are very limited in *Daphnia sp*. mostly due to the unavailability of cell line and proper transfection methods. So, this work is aimed to solve such barriers

and open an in-vitro platform for upcoming research to study transgene expression, knock-down procedures, development of cell lines and iPSC, functional analysis of different genes and gene products.

Keyword: Transfection , Lipofection, *Daphnia pulex*,Primary culture.

LIFE SCIENCES-34 REG. No. 15692

A Study on Climate Change Impact on Selected Three Endemic and Threatened Trees: Implications and Adaptive Strategies

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Background: The endemic and threatened trees are micro habitat specific and found prone to climate change or climate induced factors. This in turn affected the phenology calendar, reproductive biology, biotic interactions and overall rarity process of species. The present study on selected species of the Western Ghats, Kerala was enabled to understand the climate change implications on natural dynamics by temporal data analysis along with adaptive strategies evolved as part of resilience towards climate change by these species.

Method: Populations of target species such as *Gluta travancorica* Bedd. (Anacardiaceae), *Ochreinauclea missionis* (Wall. ex G. Don) Ridsd. (Rubiaceae) and *Persea macrantha* (Nees) Kosterm. (Luraceae) were identified at Western Ghats, Kerala. The vegetative and reproductive phenological events and biotic interactions studied were analyzed with temporal data availed for these species during the period 1995-2003.

Results: The populations of *Gluta travancorica* exhibited delay in phenophases, shift in anthesis from night to morning hours along with new insect interaction. *Ochreinauclea missionis* populations displayed erratic phenophases. Populations of *Persea macrantha* at semi evergreen to moist deciduous and riparian systems showed advanced phenophases along with extended phenophasing than populations at evergreen ecosystem.

Conclusion: The endemic and threatened species studied were found significantly affected by the climate change perturbations *in situ.* The delay

or advancement in phenophases, change in anthesis time, new biotic interactions were the implications on natural dynamics of these species. The adaptive strategies being evolved were treated as resilience of these towards climate change.

Key words: Phenology, reproductive biology, biotic interactions, climate change, adaptations

LIFE SCIENCES-35 REG. No. 15739

Copepods Infecting the Fishes of North Malabar Coast of Kerala: Diversity, Occurrence and Fecundity

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Background: Copepods represent the largest group of parasitic crustaceans that infect fishes. Considerable mortality of fishes occurs due to heavy infestations by copepod parasites. Very limited information is available on the parasitic copepods of Kerala coast. In this study, diversity, occurrence and host association of copepods in the North Malabar coast were investigated.

Methods: Fresh samples of commercial food fishes were examined for copepod parasite infestation at three major fish landing sites in North Malabar coast of Kerala over a period of eight months. Morphometric data and fecundity of four selected species of copepod parasites, namely, *Cybicola armatus*, *Lernanthropus corniger*, *Lernanthropus tylosuri* and *Caligus rotundigenitalis* were recorded and analysed for host-parasite association.

Results: Out of 720 fish specimens observed, 231 specimens were infected with different copepod parasites. A total of 32 species of copepod parasites were obtained from 24 species of fishes. *Priacanthus hamrur* (Moontail bullseye fish) suffered the highest prevalent infestation by its parasite *Norion priacanthi*. The most intense parasitisation was observed in *Strongylura leiura* (Banded needle fish) infected by *Lernanthropus tylosuri*. Fecundity of copepods was found to vary with their body lengths, which also corresponded to variation in host fish size.

Conclusion: North Malabar coast of Kerala is highly diverse in parasitic copepods that infect fishes. Size of

host fishes affect the growth and reproduction of the parasites. Understanding the parameters that cause parasite infestation could be helpful in commercial fish industry.

Keywords: Parasitic copepods, fish, North Malabar, diversity, fecundity, host-parasite association

LIFE SCIENCES-36 REG. No. 15780

Fruit Morphology and Nutritional Content of Frugivore Dispersed Trees: Identifying Drivers for the Foraging Preferences of Fruit-Eating Birds and Animals in Shola Forest of Western Ghats, India

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Introduction: Forest conservation is the main agenda of most of the conservation activities. Tropical Montane Forests (shola) are a complex ecosystem that represents some of the most threatened ecosystems globally. Seed dispersal by animals comprises one of the key ecosystem services shaping plant regeneration that may be disrupted by habitat loss and fragmentation. Yet, the impact of seed dispersal by frugivores and dispersers on the regeneration of a highly fragmented ecosystem like shola is poorly investigated. Special attention should be given to tropics where a significant proportion of the ecosystem is under the threat of extinction. In tropical forests a large proportion of tree species have fleshy fruit evolved for seed dispersal by fruit-eating animals (Howe & Smallwood 1982, Jordano 1992), so that plant–animal interactions underpin most dispersal processes. Many of the shola trees depend on birds and animals for the dispersal of their seeds away from the parent tree. Forest fragmentation and habitat loss are major factors affecting plant–frugivore interactions (Newbold et al., 2013). As an example of forest loss, between 1981 and 1990, a total of 2.5 million ha of TMF was destroyed at an estimated rate of 1.1% annually (FAO 1993). Furthermore, the presence of drupaceous trees that produce fewer seeds and the lack of different dispersal mechanisms also hinder the growth of shola trees. In this study, we examined the frugivore community assemblages and seed dispersal networks of ninety fleshy

fruiting shola trees. To determine if plant characteristics, fruit morphology, fruit colors, and/or fruit nutrients explained the relative importance of fruit consumption by the frugivores, we conducted nutrient analyses on fleshy fruits of ten shola trees, which are widely consumed by primates and birds, which are the two most important seed disperser groups. The bird body mass and fruit size removed from trees were also correlated to check for a relationship between the variables.

Materials and Methods: We analyzed frugivory in ninety tree species from different shola patches of the Western Ghats of Kerala, India over one-year period. The study sites were located in Tropical Montane Forests (TMF) -shola of Eravikulam National Park. The effects of frugivorous traits (e.g., gape size and some behaviors of birds) and plant characteristics (e.g., diaspore color, fruit type and size) on the number of fruits eaten were tested. The abundance of frugivores and seed dispersers were monitored by walking along a transect of 1km, recording animals (with eating or handling fruits) seen in the vicinity of the path. During each frugivore scan; species visited, visitation rate, individual numbers, time of first appearance, duration of visit, behavior of fruit or seed handling were recorded (including-visit lengths, time spending in searching, handling and feeding the fruit, total time spent on the plant, fruit consumed per foraging). Scats of different frugivores were collected for further identification of the fruits eaten and dispersed by the frugivore. Nutritional analysis of ten selected fruits was carried out to quantify the parameters such as moisture content, Vitamin -C, carbohydrate, fat, protein, fiber, flavonoids, ash and total energy.

Results and Discussion: During the inventory 90 tree species belonging to 37 families were examined. From these we closely monitored frugivore interaction with 10 species. The tree species are *Schefflera racemose*, *Mahonia leschenaultia*, *Garcinia cowa*, *Elaeocarpus munronii*, *Glochidion bourdillonii*, *Ternstromia gymnathera*, *Debregeasia longifolia*, *Nothapodytes nimmoniana*, *Chionanthus mala- elengi*, Buchanania *lanzan*, and *Neolitsea fischeri*. Major fruit type present in shola is drupe. Ornithochory is the dominant dispersal syndrome among these species followed by zoochory. Nilgiri langur (*Semnopithecus johnii*), Eurasian blackbird (*Turdus merula*), Red-whiskered bulbul (*Pycnonotus jocosus*), Palani laughing thrush (*Montecincla fairbanki*), Malabar whistling thrush (*Myophonus horsfieldii*), Jungle myna (*Acridotheres fuscus*), Malabar giant squirrel (*Ratufa indica*), Nilgiri Flycatcher (*Eumyias*

albicaudatus), Sloth Bear (*Ursus ursinus*), Barking Deer (*Muntiacus muntjack*), Indian Crested Porcupine (*Hystrix indica*) and Asiatic jackal (*Canis aureus*) are the major frugivores and dispersers of the shola. Though wind is a frequent event in shola, very few species seem to disperse by wind. Analyses of the nutritional content of the selected fruits show that they are rich in carbohydrates, protein, and energy. Our results indicate that fruit traits and nutritional contents of frugivore dispersed trees drive foraging preferences of fruit-eating birds, and animals whose interactions in different successional stages can help to reverse the negative effects of fragmentation in tropical montane forests of the study area.

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LIFE SCIENCES-37 REG. No. 15792

Hormone Receptor Heterogeneity in Breast Cancer Cells: Understanding The Receptor Dynamics in Hormone Resistance.

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Background: Breast cancer is the most common cancer in women accounting for 30% of all the cancers in females. The Estrogen receptor (ER) positive breast cancers are successfully managed with hormonal therapy. However, it is being reported that a significant percentage of patients will

later show non-responsiveness to hormone therapy and emerge as resistant phenotypes. Currently, the reasons for this resistance and recurrence mechanism are not clear. This could be due to complex cellular heterogeneity in the receptor status or attributed to post-transcriptional and translational regulation of receptor status. Proper understanding of cancer cells complex receptor status plasticity and its impact on hormone resistance is vital to find interventions to prevent clinical hormone resistance. To understand these mechanisms, we have developed hormonal therapy-resistant cells and analyzed the evolutional signaling involved in resistance generation.

Methodology: We have developed drug-resistant cells in hormone receptor-positive cell lines and studied the dynamics of resistance at distinct stages. Stable cell lines overexpressing receptors of Er-α, Her2 were developed in TNBC cell lines to understand the direct role of receptor status in determining the drug response and cell growth. The stably expressing cells and parental cells were exposed to anti-estrogen 4-OH tamoxifen, and the drug responses were analyzed using live-cell imaging and with western blotting.

Results: During the emergence of resistance for hormone therapy, cells downregulate their estrogen receptor to evade apoptosis and even if we exogenously express receptor proteins in TNBC cells, cells are not becoming sensitive to drug treatment. Also, the pro-apoptotic - anti-apoptotic protein's ratio is manipulated in such resistant cells.

Conclusions: The expression of receptor proteins seems to be regulated dynamically during physiological conditions and under diverse stress conditions. The generation of a stable hormone resistance mechanism involves complex modulation of pro and anti-apoptotic proteins.

Keywords: Heterogeneity, Apoptosis, Triple-negative breast cancer, Therapy resistance

LIFE SCIENCES-38 REG. No. 15825

Phytochemical Investigation of the Indian Pitcher Plant, *Nepenthes khasiana*

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Background: *Nepenthes* is a genus of insectivorous plants, having unique ways of attracting preys into their leaf-evolved biological traps, known as pitchers for surviving in low nutrient soils. *Nepenthes khasiana* Hook f. is native to the Khasi Hills of Meghalaya. Here we report the phytochemistry of the Indian pitcher plant, *N. khasiana*.

Methods: *N. khasiana* (whole plant) was collected from the JNTBGRI campus, shade dried and powdered. The plant powder (1.2 kg) was Soxhlet extracted sequentially with hexane, chloroform and methanol. Crude extracts were column chromatographed, and the fractions were subjected to different chromatographic techniques. The isolated components were characterized by spectroscopic techniques.

Results: *N. khasiana* whole plant powder on Soxhlet extraction resulted in Hexane (28 g), Chloroform (15 g) and Methanol (159 g) extracts. Hexane extract was column chromatographed and similar fractions on repeated column chromatography resulted in the isolation of 14 compounds. Spectral analysis resulted in the identification of 8 compounds *viz*. plumbagin, lupenone, triacontanol, lupenol, β-sitosterol, cis-isoshinanolone, 1-methoxynonacosanol and stearic acid. Chloroform extract on repeated column chromatography resulted in the isolation of 8 compounds. Five compounds (*viz*. 2,4-di-tert-butyl phenol, pentacosane, plumbagin, cis-isoshinanolone and lupenol) were characterised. Methanol extract (150 g) was suspended in 800 ml of water and partitioned successively with ethyl acetate and butanol to obtain ethyl acetate (13 g) and butanol (57 g) fractions. Five compounds were isolated from ethyl acetate fraction and dimethyl L-malate and plumbagin were identified.

Conclusions: Phytochemical investigation of *N. khasiana* resulted in the isolation of 27 compounds, of which 15 were identified by spectral analysis. This is the first report of phytochemical analysis of the Indian pitcher plant, *N. khasiana*.

Keywords: *Nepenthes khasiana*, prey capture, phytochemistry

LIFE SCIENCES-39 REG. No. 15834

Understanding Mangrove Salt Tolerant Strategies Using Anatomical Traits

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Background: With the help of salt tolerant mechanisms, mangrove species have adapted to exist in saline environment. Seven mangrove tree species from tropical mangrove forests of Kerala were studied for their leaf and stem anatomical traits, in order to understand the substantial variance of anatomical properties that contribute in salt tolerance.

Method: Six individuals of 7 true mangroves and 2 non mangrove species were selected for the study. Leaf area, cuticle thickness, epidermal layer thickness, mesophyll layer thickness, stomatal index, presence of salt glands, trichomes, and cork warts were analysed, including the density of xylem vessels in the stem. Using the Image J software, measurements were taken from the microscopic images. R Studio (version1.4.1717) was used for statistical analysis and creating plots.

Results: Statistical analysis shows significant variations in majority of traits studied across the groups. There are no statistically significant differences in epidermal layer thickness and xylem vascular density across the groups.The study reveals that prevailing variability of anatomical traits among mangrove is one of the reason which describes their plant functional types.

Conclusions: This study revealed a better understanding on the structural causes of salinity tolerance in mangrove tree species, as well as the variance with respect to salt tolerance mechanisms among species.

Keywords: Mangroves, salinity tolerance strategies, plant functional traits, plant functional types

LIFE SCIENCES-40 REG. No. 15841

Thismia (Thismiaceae): A Fungal-Like Flowering Plant Often Neglected by the Taxonomists

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The genus *Thismia* Griff. is a small mycoheterotrophic tiny herbs that lacking chlorophyll. They are commonly known as 'fairy lanterns' and believed to be the extremely rare narrowly endemic genus. It belonging to the family *Thismiaceae* comprising of approximately 80–90 species distributed in warm temperate and tropical Asia, eastern and south-eastern Australia, New Zealand and the neotropics. Mycoheterotrophy is a symbiotic relationship between certain plants with the fungi. Plants with the ability to obtain carbon from fungi during their lifecycle are known as Mycoheterotrophic plants. *Thismia* is one of the taxonomically complicated Mycoheterotrophic plant genera because of its fungus-like tiny habit, delicate nature and short lifespan makes it difficult to observe in the soil or amidst leaf litter. They grow in humus rich soil covered with dried leaves in the evergreen forest and completes the life cycle in two to four weeks. The study of the material from the herbarium specimens is also a difficult task because of its delicate floral structures that become folded or merged and lost the taxonomic details after pressing/mounting. Therefore, for obtaining the detailed floral structures, they must be dissected in the field itself or immediately stored in alcohol for further investigation. The members of the genus having distinctive vegetative and reproductive structure and colour and the major taxonomic characters used for species delimitation are the mitre, mitral appendages, perianth lobes and anther morphology. In India, the genus consists of two species *viz. Thismia aurantiaca* Hareesh & M.Sabu and *T. sahyadrica* Sujanapal *et al. Thismia aurantiaca* were recently published from Andaman and Nicobar Islands and *T. sahyadrica* from Kerala. Detailed morphology of the genus is discussed in detail.

LIFE SCIENCES-41 REG. No. 15842

Diversity of Endemic, Threat Category of Plant Species of Chemunji Hillock, Agasthyamala, Western Ghats

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Background: Agasthyamala is supporting unique assemblages of biological communities with an array of species and profound diversity. The Chemunji hillock is located in the Peppara Wildlife Sanctuay of Agasthyamala hill ranges of Kerala. It is an epitome of phytodiversity and forms the habitat of enormous rare and endemic plant species. Endemic elements are considered to live in ecological islands creating an ecological niche of their own and survive in very low population.

Method: Field survey had been conducted in the area, located the targeted species, collected and documented. They were identified referring the Floras and categorised for conservation status. Prepared herbarium as per standard procedure.

Results: The field study resulted in the documentation of 42 species representing 34 genera. Based on the life forms, there are 12 tree species, 21 shrubs and 8 herbs and 1 climber. Altogether 6 species are enlisted in IUCN category. There are 7 species enumerated in Indian Red Data Book. Again, Chemunji forms the 'Type Locality' of an array of species. All these throw light on the importance of this small hillock that beholds the unique assemblage of diversity. Relevant herbarium were also prepared and deposited inn JNTBGRI herbarium (TBGT).

Conclusion: Chemunji hillock is part of the Agasthyamala and a component of a major conservational complex in the Western Ghats. It is the abode of a number of endemic and threatened species and also forms the 'Type locality' of several plant species. This small hillock inhabits 42 rare, endemic species that include those with a viable population in this peak alone. It clearly reveals the floristic as well as potential conservational importance. .that enormous species are under rare category and demands immediate conservation measures to be undertaken to save these species from the brink of extinction.

LIFE SCIENCES-42 REG. No. 15850

Comparative Screening of Jacalin and Anticancer Activity In Wild and Cultivar Varieties of Jackfruit

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Background: Jacktree is a multi-purpose tree and it is known as second kalpavriksha. It yields edible summer fruits which has immense nutritional and pharmacological importance. . It was designated as the state fruit of Kerala by Government of India on March 2018. The raw jackfruit is good for health and it is used as vegetable, at the same time the ripened jackfruit is good to eat as fruit, because it has sugar content. The present study was aimed to evaluate the anti-cancerous effect of Jacalin present in the crude extract of wild and local landraces of jackfruit seeds.

Method: Cultivar and wild Jackfruit samples collected from Thiruvananthapuram district of Kerala and the herbarium specimens were deposited at TBGT, JNTBGRI, Palode under the collection numbers 95934 and 95935. Collected samples were processed for the extraction. Ammonium sulfate precipitation was also performed in all the three portions of Jackfruit to concentrate the proteins and estimated the protein from each of the samples, compared using standard. The crude protein extract was separated according to molecular weight by SDS-PAGE for checking whether Jacalin protein is present in seed, flakes and rind of Jackfruit. Human carcinoma cell lines were treated with PBS extract of jackfruit seeds to test the cytotoxicity in two different genotypes.

Results: Phytochemical analysis revealed that flakes and seeds possess abundance of proteins which have strong pharmacological properties and can be utilized for medicinal purposes. Also, this is the first report where we have unlocked the bioactivities of crude protein extracts obtained from the flakes and seeds from wild genotypes of *A. heterophyllus*.

Conclusions: The data suggested the potential application of the protein extracts isolated from different parts

of jackfruit for medicinal purposes. However, the field visits shown that wild population of jack trees are very limited. Considering the importance as a functional fruit, steps may be taken to increase the number of jack trees in the wild.

Keywords: Jacalin, SDS-PAGE, Mass spectrometry, Anti-cancer activity

LIFE SCIENCES-43 REG. No. 15905

Genotoxic Study of *Clerodendrum infortunatum* L. in Human Lymphocyte Culture Using CBMN Assay

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Background: *Clerodendrum infortunatum* Linn. (Family: Verbenaceae), is a well known medicinal plant, used in the treatment of bronchitis, asthma, fever, blood diseases, inflammation, burning sensation and epilepsy. Medicinal plants are known to contain numerous biologically active compounds, and although they have proven pharmacological properties, they can cause harm, including DNA damage. The investigation was planned to study the genotoxic activity of *C. infortunatum* in human lymphocyte cells by using Cytokinesis block micronucleus assay.

Methods: Methanolic extract of *C. infortunatum* root powder was prepared by Soxhlet extraction. The resulting methanolic extract filtered and used for the genotoxic study of *C. infortunatum* in human lymphocyte using CBMN assay. By using CBMN assay we can assess the DNA damage by observing micronuclei formation, chromosomal aberration like sister chromatid exchange and chromatid breaks.

Results: It was performed in five parallel cultures viz. A, B, C, D and E. The culture A Kept as a control revealed a CBMN frequency of 11.12, culture B with 100 µL of Methanolic extract of C. *infortunatum* revealed a CBMN frequency of 11.36 and culture C with 200µL of MECI revealed a CBMN frequency of 11.84. Culture D with, mutagen (Bleomycin) induced at a concentration of 0.3units/10ml revealed a CBMN frequency of 14.65. In culture E, the plant extract along with Bleomycin was added and

revealed a mean CBMN frequency of 14.52.

Conclusion: There was only a slight increase in mean CBMN frequency with increase in concentration of the plant extract. This indicates that the plant extract containing no significant genotoxic agent .Also the study showed that the CBMN frequency was decreased with the supplementation of plant extract. This reveals the genoprotective action of the plant.

Keywords:, *Clerodendrum infortunatum*, Genotoxicity, CBMN assay.

LIFE SCIENCES-44 REG. No. 15943

A Study on Indian Spalangiinae (Hymenoptera: Pteromalidae) with New Records to Kerala

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Background: The family Pteromalidae (Hymenoptera: Chalcidoidea) includes a large number of parasitoid species, many of which are important in the biological control of insect pests including synanthropic muscoids. The members of the subfamily Spalangiinae have been shown to be either primary parasitoids or rarely hyperparasitoids of Diptera puparia. Apart from the known species two new records form Kerala, India, is being described in this paper.

Method: The specimens for the present study were collected using yellow pan traps and sweep nets from various localities of India. The specimens preserved in 70% alcohol were later dried, card mounted and studied under LEICA M 205A stereoscopic binocular microscope and imaged using attached LEICA DFC 500 camera.

Results: The *Spalangia* species currently known from India are *Spalangia simplex* Perkins, 1910, *Spalangia cameroni* Perkins, 1910, *Spalangia endius* Walker, 1839, *Spalangia fuscipes* Nees, 1834, *Spalangia gemina* Bouček, 1963, *Spalangia nigra* Latreille, 1805, *Spalangia obscura* Bouček, 1963, *Spalangia parfuscipes* Ahmad, 1998, *Spalangia nigroaenea* Curtis, 1839 and *Spalangia impuncta* Howard, 1897. Studies on further specimens collected from various localities of India yielded a new record to the species *Spalangia cameroni* Perkins and *Spalangia obscura* Bouček to the state of Kerala.

Conclusions: Members belonging to Spalangiinae are important in the maintenance of environmental and physical hygiene as they parasitize the synanthropic dipteran pests. They regulate their host numbers by preventing breeding and reduces risks of epidemical outbreaks. Since the members of Spalangiinae are known to parasitize fruit flies and filth breeding flies they can be intensively utilized for effective pest control mechanisms. Despite our rich fauna, the Indian Spalangiinae has received very little attention both taxonomically and biologically.

Keywords: Hymenoptera, Pteromalidae, *Spalangia*, India, Kerala, new records, taxonomy.

10

Mathematical & Statistical Sciences

Oral Presentation

Microstructure of Kerala State Open Market Borrowings: A Statistical Study

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Background: The growing fiscal obligations of the Kerala state government are increasingly met from debt liabilities. COVID-19 is adding to spending needs as state seek to mitigate the health and economic effects of the crisis. The resulting rise in market borrowings will likely heighten the tension between meeting important development goals and containing debt vulnerabilities. To secure the government's funding at all times at low cost over the medium and long-term while avoiding excessive risk, an assessment of the market borrowing program is important.

Method: This paper examine the market borrowing program of Kerala state with a view to better understand the dynamics of cost and risk associated with Kerala state government securities. A regression analysis is carried out to assess the determinants of yield spreads of Kerala state government securities relative to the yields of central government securities of corresponding maturity.

Results: The finding suggests that market is not accounting the fiscal fundamentals of states into their pricing of state government securities.

Conclusions: A careful assessment might have to be undertaken by Kerala state for low cost borrowings from the open market, to avoid excessive risk and to maintain sustainable level of public debt.

Keywords: Kerala State, Market Borrowings, Multiple Regression, State Development Loans

MATHEMATICAL & STATISTICAL SCIENCES-02 REG. No. 15745

Differential Quadrature Method to Numerically Approximate the Solution of Two-Dimensional Telegraph Equation

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Background: In the field of numerical computations, the Differential Quadrature method is a novel technique to approximate the derivative of a given function as the linear combination of its sample values on a grid. An efficient way to maintain the balance between stability and accuracy of the approximation is by using the quadrature formula locally.

Method: This work focuses on computing the numerical solution of the two-dimensional hyperbolic Telegraph equation. The spatial derivatives are approximated on the spatial domain using the localized differential quadrature technique. This approximation will discretize the equation and is then converted to a system of first-order ordinary differential equations using a transformation. Using the SSPRK-43 scheme, the obtained system is then solved for the next time step.

Results: The proposed method has been performed for several test examples, and the stability of the numerical method has been ensured by computing eigenvalues of the coefficient matrix obtained from the discretized system. The computed solutions show significantly more minor errors when compared with the results obtained from several works in the literature. This shows the efficiency of the proposed scheme.

Conclusions: This work explains a numerically stable algorithm to solve the two-dimensional hyperbolic Telegraph equation with an accuracy order 3.

Keywords: Hyperbolic Telegraph equation, Differential Quadrature Method, SSPRK-43 Scheme

Identification of Differentially Expressed Gene in Covid-19 Gene Expression Data

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Introduction: Microarrays and Next Generation Sequencing (NGS) technology are very robust technique for identifying gene signatures in COVID-19 patients. A common purpose of microarray experiments is the detection of genes that are differentially expressed under two conditions such as treatment versus control. In present paper we propose empirical Bayes (Efron et al. (2002), Smyth (2004)) modified generalized p-value technique by for identifying differentially expressed genes. For ranking the differentially expressed genes we developed empirical Bayes approach using mixed Laplace distribution and illustrate the proposed methods with real SARS-CoV microarray datasets downloaded from Geo website.

Materials and Methods:

Modified generalized p-value

For general setup of the concepts of generalized confidence intervals and generalized p-values see Weerahandi (1993). Let $\widehat{\mu_{oi}}$ and $\widehat{\sigma^2_{0i}}$ be the observed values of $\hat{\mu}_i$ and $\hat{\sigma}_i$ respectively. Then the generalize pivotal variable for is given by

$$T_{\mu_{gi}} = \widehat{\mu_{oi}} - \frac{2n(\hat{\mu}_i - \mu_i)}{2n\sigma_i} \frac{\sigma}{\widehat{\sigma_i}} \widehat{\sigma_{gi}} \qquad (3)$$

Where

$$\widehat{\sigma_{gi}}^2 = \frac{n_{0i}{}^2 \sigma_{0i}{}^2 + d_{gi}{}^2 \sigma_{gi}{}^2}{n_{0i} + n_i}, \; i = 1, \; 2.$$

Then the generalized pivotal variable for the difference of means of two exponential distributions is

$$T_{\mu_g}{}^* = T_{\mu_{g1}} - T_{\mu_{g2.}}$$

Hence the empirical Bayes modified generalized p-value for the two sided test can be obtained as:

$$2 \, min\left\{p\left(T_{\mu_g}{}^* \le 0\right), \, p(T_{\mu_g}{}^* \ge 0)\right\}$$

Results and conclusions: In this study the concept of modified generalized p–value method has been applied for the selection of differentially expressed gene and Bayesian methods using the mixed Laplace, is helpful in finding and ranking the differentially expressed genes. This will help better drug discovery or disease diagnosis. We identified 100 differentially

expressed genes from SARS-CoV microarray data using generalized p- value approach.

Keywords: Empirical Bayes method, Generalized p value, modified generalized p value, microarray, COVID-19, SARS-CoV.

10

Mathematical & Statistical Sciences

Poster Presentations

MATHEMATICAL & STATISTICAL SCIENCES-04 REG. No. 15538

The Legacy of Kerala Mathematics

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The kerala school of mathematics can be specified as the first Indian school of mathematics where the mathematical relation between the heavenly bodies and earth was subjected for a deeper study and obtained very decisive results. Kerala sowed the seeds for many fabulous inventions and findings in Mathematics which the entire world observed with great astonishment later. This article is a survey on the major mathematicians from Kerala and their contributions.

MATHEMATICAL & STATISTICAL SCIENCES-05 REG. No. 15882

New Record Based Transmuted Exponentiated Inverse Weibull Distribution and its Applications to Covid-19 Data

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Background: The novel coronavirus (nCoV), more specifically referred to as the SARS-CoV-2 which was first detected in Wuhan, China in December 2019 has caused chaos and severe disaster across the world through the pandemic of a respiratory illness known as Coronavirus disease 2019 (Covid-19). Even though measures of prevention such as quarantine and social distancing were adopted, it disrupted the day to day routine of humankind. Since it's a highly contagious disease, the number of cases and death due to covid are also of importance. This becomes one of the main motivations behind the need for its study and analysis. In this study we're introducing a new type of distribution named Record Based transmuted Exponentiated Inverse Weibull distribution

(RTEIW) to analyse the mortality data due to the Covid-19 pandemic. We illustrated the application of RTEIW to daily COVID-19 deaths in Kerala and analysis is carried out using R package.

Methods

Record Based Transmuted Exponentiated Inverse Weibull Distribution

The probability density function (pdf) record based transmuted exponentiated inverse Weibull distribution with parameters θ, β, ρ denoted by RTEIW (θ, β, ρ) is given by

$$ff(x) = \theta\beta x^{-(\beta+1)}\left(e^{-x^{-\beta}}\right)^{\theta}\left[1 - p - p - \log\left(1 - \left(e^{-x^{-\beta}}\right)^{\theta}\right)\right]$$

Where θ, β >0, 0<ρ<1.

Results and conclusions: The record based transmuted exponentiated inverse Weibull (RTEIW) distribution introduced and studied various properties. RTEIW is useful in analyzing datasets that are having increasing and decreasing failure rate.

Keywords: Record based transmuted Exponentiated Inverse Weibull, Exponentiated inverse Weibull, Inverse Weibull, COVID-19, SARS-CoV-2.

MATHEMATICAL & STATISTICAL SCIENCES-06 REG. No. 15939

Radon Transformation and Its Applications

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In this poster we will present the Radon transform, its applications, present state of knowledge about the Radon transform, and some of its lesser-known applications. Although x-ray projections and tomographic reconstruction are used in the chapter as a starting point, no consideration is given to such things as fan-beam geometries, iterative reconstruction algorithms, polyenergetic X-rays, detector noise, or clinical applications. It is undoubtedly medical computed tomography (CT) that has attracted more attention than any other application of the Radon transform. The basic data obtained in a CT procedure are x-ray transmission measurements through a two-dimensional (2D) slice of the patient's body. Because of the overwhelming clinical and commercial success of CT, the 2D Radon transform is studied in exhaustive detail.

II

Physical Sciences

Oral Presentation

PHYSICAL SCIENCES-01 REG. No. 12750

Assessment of Natural Radioactivity Levels in Rocks of Kuthiran Tunnel and Hills, Kerala, India.

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Background: Radiometric methods were used to investigate the radioactive properties of rocks with a view of interpreting the geological structure and abundance of natural radioactive elements present. The knowledge of radionuclides distribution and radiation levels in the environment is important for assessing the effects of radiation exposure on the humans. Radiological hazards due natural radioactivity in rocks were assessed in the Kuthiran Tunnel and Hills of Thrissur district, Kerala, India.

Materials and Methods: About 18 samples of crustal rock were collected from locations in and around the Kuthiran twin tunnel and hills that are about 22 km away from the center of Thrissur city, Kerala. The activity concentrations of ^{226}Ra, ^{232}Th, and ^{40}K in the samples were determined using the gamma spectrometry, employing a 42% relative efficiency p-type low background high-purity germanium (HPGe) detector, having an energy resolution of 2.1 keV at 1.33 MeV. To trace the sources of radioactivity in rocks, the mineralogical studies were carried out using XRD and EDXRF technique.

Results: The mean activity concentrations of ^{226}Ra, ^{232}Th and ^{40}K obtained from rock samples were 69.26±1.32Bq/kg, 133.40±3.41Bq/kg and 948±20Bq/kg, respectively. These values are relatively higher than the global average values. The calculated average values of the radiological parameters of rock samples were slightly higher than the safe limit recommended by UNSCEAR. The XRD and EDXRF analysis of the rock indicates the presences of minerals such as Quartz, Monazite, Zeolites, Biotite, Zirconium, Albite, Kaolinite, sillimanites, and Calcite. The mineral analysis proved that rock samples with ^{232}Th rich phosphates and ^{40}K bearing feldspars are the main source of gamma radiation in the study area. The low mobility and even distribution of thorium, radium and potassium shows that their content in the rock is connected with mineral composition of the rock.

Conclusion: A health risk assessment was performed based on commercial rock samples taken from Kuthiran hills and Tunnel, Thrissur district. Average values of some of the radiological parameters measured, are slightly higher than the allowed safe limit. Therefore, the rocks in the study area may pose minor radiological hazard if used as construction materials.

Keywords: Natural radionuclides, Gamma-ray spectrometry, Activity concentrations, radiological hazards indices, Elemental analysis.

PHYSICAL SCIENCES-02 REG. No. 14133

Charge Radii of Thorium Nuclei Lying Between the Drip Lines

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Background: Nuclear charge radii helps to understand the nuclear structure of atomic nuclei, variation of nuclear shapes, nuclear deformation, and shape coexistence. Nucleon-nucleon interactions mainly depend on nuclear charge radii. We have calculated the nuclear charge radii of thorium nuclides spanned between the drip lines and thus identified the nuclear shape variations. Mean field theory is the most appropriate one for the study of the nuclear structure of nuclei far from the line of β stability. It gives better results for deformed and spherical nuclei.

Method: In the present study we have followed the nuclear structure studies based on self consistent mean field theory in order to estimate the nuclear charge radii of thorium isotopes between drip lines. Nuclear density functional theory based on relativistic mean field approach is extensively used for nuclear structure studies. The Hamiltonian of Hartree-Fock (HF) equation describes nuclear properties like quadrupole vibrations and rotations. The diagonalization of this equation gives energy and wave function. Skyrme Hartree-Fock method has been used for studying the ground state properties of nuclei. Hartree-Fock equation mainly depends on the effective force or nucleon-nucleon interactions used. Cartesian harmonic oscillator basis with different Skyrme

force interaction is used for the simplicity of the solutions. The method using Cartesian coordinate gives information about the nuclear shapes. Iterative diagonalization method with the help of a computational code is used for solving the Hartree-Fock equation.

Results: The nuclear charge radii of thorium isotopes in the mass range 204-280 were calculated by using the Skyrme force HF equation. The UDF2 parametrization of Skyrme interactive force is found to be the most suitable one for the study of the nuclear structure of thorium nuclei. Nuclear charge radii is found to be increased by adding neutrons. Dependence of neutron number on charge radii may influence the nuclear shape, deformation, pairing energy, moments, etc. To understand the nuclear shape, the spatial distribution of charge radii along x, y, and z directions were estimated. It shows an oscillating nature of nuclear shape with increase of neutron numbers.

Conclusions: The calculated charge radii of thorium isotopes with UDF2 parametrization is close to the experimental data than the other parametrizations. Charge radii along x and y directions are almost the same and that along z directions the radii are found to be more extended. Hence the nuclei are spherically deformed. The charge radii are different for different nuclei and shape varies from one nucleus to the other. The shape variation is of an oscillatory nature. The neutron number N=126, 140, 150, 170 and 184 are the suggested magic numbers.

Keywords: charge radii, thorium, deformation, mean field theory

PHYSICAL SCIENCES-03 REG. No. 15356

A Simulation Study on Enhanced Electromagnetic Interference Shielding in Multilayered Composites

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In this work, layered structures were simulated and the influence of electromagnetic parameters on the EMI shielding performance of the same was investigated. Simulation results revealed the superior shielding performance of layered structures over individual conductive and magnetic

systems. Further studies on the influence of electromagnetic properties, particularly electromagnetic losses, on the shielding of layered structures demonstrated the importance of incorporation of magnetic materials with high losses in the layered configuration. This study sheds light on the innovation of design strategy of stacked structures designated for suppressed electromagnetic reflections and enhanced microwave absorption.

PHYSICAL SCIENCES-04 REG. No. 15491

Luminescent Polymer Composite Film Made of Glucose Derived Carbon Dots Embedded into Polyvinyl Alcohol Matrix for The Detection of Pb^{2+} In Water.

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Background: Pollution of water bodies with heavy metals like Pb^{2+} poses a serious threat to aquatic life and humans and hence trace level detection of such heavy metals is of great significance Several existing methods for sensing heavy metals include atomic absorption spectroscopy, inductive coupled plasma atomic emission spectrometry (ICP-AES), X-ray absorption spectroscopy and surface-enhanced Raman scattering which provide exceptionally lower levels of selective detection but the drawback associated with them are complex sample preparation protocols, high cost for instrumentation and time consuming analyses. Here in we explore the photoluminescence property of polymer composite films made of glucose-derived carbon dots embedded into polyvinyl alcohol (PVA) matrix and the quenching of emission induced by the presence of Pb^{2+} in the matrix for the sensitive detection of Pb^{2+} in water.

Method: Carbon nanoparticles known as carbon dots/C-dots are synthesized from glucose by a facile heating and dehydration method involving 1M sulphuric acid. C-dots are then embedded in to PVA matrix by a solution casting method to obtain photoluminescent flexible freestanding composite film which is reacted with varying low concentrations of Pb^{2+} in water. The emission intensity is recorded to

quantify the limit of detection of Pb^{2+}.

Results: The obtained freestanding nanocomposite films of C-dot/PVA have broad emission in the visible region of electromagnetic spectrum. Considerable quenching in the PL intensity is observed upon the addition of trace levels of Pb^{2+} hence making the films excellent sensing probes for the detection of Pb^{2+}. The C-dot/PVA exhibited pH independent photoluminescence. The composite films are also found to be biocompatible as established from cell viability studies in N2a cells of mouse.

Conclusion: The C-dot/PVA composite films synthesized via a facile approach from cost effective, green resources such as glucose and PVA have interesting photoluminescent property which is utilized for the trace level detection of Pb^{2+} in water based on fluorescence quenching. The composite exhibits pH independent photoluminescence and excellent biocompatibility.

Keywords: C-dots, Polyvinyl alcohol, nanocomposites, photoluminescence quenching, Pb^{2+} detection.

PHYSICAL SCIENCES-05 REG. No. 15492

Solid Polymer Electrolyte (SPE) Films Based on PEO-PVdF-$LiNO_3$-Al_2O_3 for the Development of Next Generation all Solid-State Li-ion Cells

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All-solid- state lithium ion cells possess the advantages of higher safety, better electrochemical stability, higher energy density, and longer cycle life so they are identified as promising candidates for next-generation safe and stable high-energy-storage devices. Solid polymer electrolyte (SPE) films can be used to serve as both the solid electrolyte and the separator in all-solid- state Li- ion cells. Incorporation of inorganic nanofillers into the polymer matrix has been considered as an effective method to achieve high ionic conductivity for the developed SPE films. In the present study, mechanism of Li^+ ions transport variation caused by incorporating Al_2O_3 nanofiller into the blend matrix of poly ethylene oxide (PEO) and poly vinylidene fluoride (PVdF), complexed with lithium nitrate ($LiNO_3$) as Li source has been

investigated. Solid polymer electrolyte (SPE) films have been prepared by simple solution casting method.

Addition of nanostructured Al_2O_3, as the filler material is found to enhance Li ion conductivity and Li ion transference number (t_{Li+}). Ionic conductivity of the developed SPE film is 6.75 x10^{-4} S cm^{-1} for optimum concentrations of the lithium salt and filler material and the SPE film shows a high electrochemical stability window up to 4.75V. PEO-PVdF-$LiNO_3$-Al_2O_3 based SPE films have excellent thermal stability, ideal ion transport number and good electrochemical properties, suitable for applications in all solid-state lithium ion cells. Assembled $LiFePO_4$ - MWCNT/SPE film/Li cell in half cell configuration is found to deliver specific capacity of 140 mA h g^{-1} at 0.1 C and an initial columbic efficiency of 70% at 70 °C.

Keywords: Li-ion cells. All solid-state cells, Solid polymer electrolyte, Nano-filler

PHYSICAL SCIENCES-06 REG. No. 15521

On-Demand Assembly of Au NPs Over Solid Surfaces from Sessile Droplets by Thermoplasmonically-Controlled Liquid Flow

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Background: Optically controlled assembly of suspended particles from evaporating sessile droplets is an emerging method to realize on-demand patterning of particles over solid substrates. Though dynamic control over the assembly of microparticles is possible, limited success has been achieved in nanoparticle patterning, especially in the case of metallic nanoparticles. This work demonstrates a simple light-directed patterning of Gold nanoparticles (Au NPs) based on the thermoplasmonically-controlled liquid flow.

Method: The on-demand assembly of Au NPs was realized via thermoplasmonically- controlled liquid flow inside an evaporating sessile drop (3 µL, 0.8 nM Au NP droplet). A diode laser (532 nm, Power - 80 mW) focused into a circular spot radius of 75 µm

was utilized to induce the localized heating. We performed optical microscopy and 3D profilometry to characterize the final particle deposit.

Results: The plasmonic excitation led to a temperature difference of about 18 °C between the irradiated region and the three-phase contact line of the pinned droplet, resulting in the particle assembly at the irradiation zone in response to the thermocapillary flow created inside the droplet. Particle streak velocimetry experiments and analysis confirm the existence of a strong thermocapillary flow which counteracts the naturally occurring evaporative convection flows (up to t/t_f *~0.8*, where t_f denotes the total evaporation time). 3D profilometry analysis revealed a 10^2 times enhancement in the deposit height upon irradiation, in comparison to the size of individual NPs (~44 nm). To test the versatility of the developed method, we tried different illumination patterns using photomasks/sequential scanning, which led to various patterns, including off-center, two-spot, and line deposit.

Conclusions: We demonstrate an efficient optical strategy for realizing patterns of Au nanoparticles based on thermoplasmonically-controlled liquid flow. A variety of patterns such as central deposit, off-center deposit, multi-spot deposit, and lines could be inscribed by simply varying the illumination pattern.

Keywords: Directed assembly, Thermoplasmonics, Marangoni flow, Coffee ring effect.

PHYSICAL SCIENCES-07 REG. No. 15553

Electrochemical Detection of Imidacloprid Using MoS_2 Nanowire Cluster Modified Electrodes

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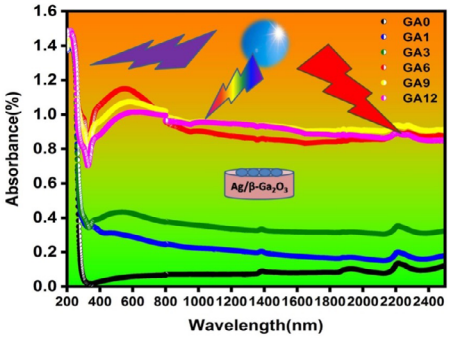
Background: Imidacloprid (IMI) is a commercially available agricultural insecticide for controlling pests in various crops (rice, cotton, peanuts etc.), fruits and vegetables. The extensive usage of IMI has increased its persistence in the environment and agricultural products. This is

adversely affecting human health and the biosphere. So, it is extremely necessary to develop effective analytical methods for the sensitive and rapid determination of IMI.

Method: IMI is an electroactive material; electrochemical detection is adopted. A conventional three-electrode system endowed with a MoS_2 modified Carbon Paste working electrode, Pt counter electrode and a saturated calomel reference electrode was used.

Results: The larger surface area, a greater number of electroactive sites and a faster electron transfer in the MoS_2 modified CP electrode favours the reduction of IMI. The fabricated sensor has shown a linear range of IMI detection from 1 to 100 µM. It also exhibited a lower detection limit of 12 nM with good sensitivity and selectivity.

Conclusion: MoS_2 modified CP electrodes have been constructed for the electrochemical detection of the



insecticide IMI with good sensitivity, selectivity and detection limit suitable for practical applications.

PHYSICAL SCIENCES-08 REG. No. 15651

Facile, Low-Cost Hydrothermal Synthesis of Plasmonic Ag/β-Ga_2O_3 Nanohybrids with Enhanced UV-VIS-NIR Absorption - A Promising Candidate for Solar-Powered Environmental Remediation and Fuel Production.

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Background: Solar energy is considered to be the best green energy source for addressing the worldwide energy and environmental concerns. Photocatalysis has been recognized as an ideal scheme for transforming "fossil fuel powered mode" to "sustainable photons mode". Semiconductor based

nanomaterials found an important place in the environmental monitoring and fuel production by utilizing solar energy. 95% of the total solar flux reaching the earth's surface is dominated by the Vis-NIR photons. Majority of the semiconductor based light harvesting studies were limited to the UV region due to the wide band gap of semiconductors. But UV region amounts to no more than 5% of the total solar spectrum. In that scenario the incorporation of plasmonic metals with these semiconductors significantly enhance the optical response of these materials. Plasmonic noble metals in combination with semiconductors offer a promising future for the next generation energy needs and environmental remediation to formulate a sustainable development strategy.

Method: Gallium oxide, (Ga_2O_3) a wide band gap semiconductor is one of the imminent material among the oxide based semiconductors. Here we adopted a novel low cost hydrothermal synthesis for the production of Ag/ β-Ga_2O_3 nanohybrids.

Results: XRD results confirm the incorporation of Ag nanoparticles into the β-Ga_2O_3 crystal lattice. The morphological studies using FESEM shows that cocoon shaped particles are formed. The diffuse reflectance spectra were utilized to examine the UV-Vis-NIR response of the synthesized nanohybrids. As the amount of Ag increases, there is an enhancement in the absorption properties of Ag/ β-Ga_2O_3 nanohybrids in the entire solar spectrum. UV absorption is due to the fundamental absorption of β-Ga_2O_3 and a broad band of absorption is obtained in the Vis-NIR region due to the plasmonic property of Ag nanoparticles. Photoluminescence spectra confirmed the low recombination rate of separated charge carriers, which found to be an inevitable characteristic of an efficient photocatalyst.

Conclusions: Ag/ β-Ga_2O_3 nanohybrid materials were successfully synthesized via a low cost and eco friendly hydrothermal method. Along with the fundamental absorption of β-Ga_2O_3, plasmonic resonance feature of the synthesized hybrid material results in the enhancement of absorption property in the entire solar spectrum. Owing to the wide possibilities of exploitation of Ag nanoparticles in combination with β-Ga_2O_3 semiconductor nanostructures, it is reasonable to hope that its exceptional plasmonic and light harvesting properties can be accomplished in a wide range of technological applications.

Keywords: UV-Vis-NIR absorption, gallium oxide, silver nanoparticles, plasmonics, photocatalysis

PHYSICAL SCIENCES-09 REG. No. 15704

Energy Efficient WO_{3-x} Thin Films by RF Magnetron Sputtering for NIR Shielding Application

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Background: Increased energy consumption by air conditioners in buildings and automobiles creates serious energy crisis and environmental pollution. WO_{3-x} based NIR shielding materials are potential candidates in blocking NIR radiation and transmitting visible light, thereby reducing the heat flow between indoor and outdoor environment.

Method: The present work focuses on the deposition of RF sputter deposited WO_{3-x} thin films on glass substrate by varying the substrate temperatures from room temperature (RT) to 600°C in steps of 100°C. The effects of substrate temperature on the structural, morphological, compositional and optical properties of WO_{3-x} thin films were studied. The NIR shielding performance of the deposited films with change in substrate temperature was evaluated.

Results: X-ray diffraction (XRD) pattern revealed that the films deposited below substrate temperature 500 °C were amorphous in nature while the films deposited at and above 500°C were crystalline monoclinic. The surface roughness of the deposited films, obtained from atomic force microscope (AFM), increases with an increase in substrate temperature. WO_{3-x} thin films deposited at 500 °C showed low optical transmittance of about 20% in the NIR region and above 70% transmittance in the visible region. As the substrate temperature increases to 500 °C, oxygen vacancies are created, as revealed from XPS. These oxygen vacancies give rise to free electrons that enhances NIR absorption of WO_{3-x} thin films by small polaron effect and surface plasmon resonance at ~900 nm and ~1700 nm respectively.

Conclusion: NIR shielding properties of WO_{3-x} thin films could be tuned by varying the substrate temperature by RF sputtering and is helpful for the fabrication of NIR shielding coatings in a simplest way. This work has great significance in adopting a facile method to develop WO_{3-x} thin films for NIR shielding applications without incorporating any dopants.

Keywords: WO_{3-x} thin films, RF sputtering, NIR Shielding

PHYSICAL SCIENCES-10 REG. No. 15741

Molybdenum Disulfide Nanosheets for Efficient Electrocatalytic Hydrogen Evolution Reaction

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Background: Generation of hydrogen through electrocatalytic water splitting has gained huge interest as it is a cheaper and environment friendly energy generation technique, which can meet the increasing energy demands of the globe. Molybdenum disulfie (MoS_2) assures to be a compromising HER candidate due to its multi-crystal structure, bandgap, abundant active surface sites, and high specific surface area. In this work, we report a facile synthesis of MoS_2 nanosheets for electrocatalytic hydrogen evolution.

Method: Herein, we synthesized MoS_2 nanosheets through a simple hydrothermal process. XRD, Raman and FT/IR studies were performed to determine the characteristics of the sample. The morphology of the material was analysed through FESEM. The electrocatalytic behaviour of the material was studied in acidic medium using a three electrode setup.

Results: XRD analysis revealed the formation of hexagonal phase of MoS_2. Raman and FT/IR studies confirmed the sample characteristics and the sheet like morphology of the sample was analysed through FESEM.

Conclusion: Electrocatalytic study using MoS_2 affirms the selection of the material as a viable HER electrocatalyst. The material exhibited favourable value of Tafel slope and overpotential at a defined current density.

Keywords: Electrocatalyst, hydrogen evolution.

PHYSICAL SCIENCES-11 REG. No. 15746

The Main Radioactive Decay Modes of Super Heavy Nuclei $^{290}120$

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Background: Super heavy nuclei with Z=120 is an element of great interest among researchers due to its proton magic number and the prediction of island of stability urge researchers to search for the existence of super heavy nuclei near Z=120.

Method: Modified Generalized Liquid drop model (MGLDM) with Q value dependent pre-formation factor [*Phys. Rev. C*, 99, 064604(2019)] is the theoretical model used to calculate alpha and cluster decay half-life of SHN $^{290}120$. MGLDM is a well proved theoretical model by our group[*Phys. Rev. C*, 98, 024625(2018)] where GLDM of Royer [*J. Phys. G: Nucl. Part. Phys*, **10**, 1057(1984)] is modified by adding nuclear proximity potential developed by Blocki et al.,[*Ann. Phys. (NY)*, **105**, 427(1977)].The spontaneous fission is estimated using the shell effect and mass inertia dependent formula by our group[*Phys. Rev. C*, 104, 024617(2021)].

Results: We studied the possibilities of SHN $^{290}120$ to emit alpha and heavier cluster emission using MGLDM and also estimated the probable heavy cluster emitted with half-life comparable to that of alpha decay half-life and the heavy cluster decay with least half-life. The role of magic number is evident as the predicted heavy cluster or daughter nuclei are found to be stable with magic number of protons or neutrons or near to it. We also predicts SHN $^{290}120$ decays by 6 alpha chains followed by spontaneous fission.

Conclusions: The predicted half-life in the case of alpha decay and heavy cluster emission from SHN $^{290}120$ are within experimental limits and we hope that our predictions will guide future experiments.

Keywords: alpha decay, heavy cluster decay, spontaneous fission, super heavy element.

REG. No. 15789

Dual Functional Exciplex with A Simple Device Design for Blue, Yellow and White Organic Light Emitting Diodes

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Smart gadgets like mobile phones, smart watches etc. have their ubiquitous presence in our daily life. In this context, cost-effectiveness of organic opto-electronic devices like organic light emitting diodes (OLEDs), which are integral part of many consumer-electronic products, have their own importance. Complicated fabrication procedure and high cost of emitter materials are the major causes for high cost in OLED industry. In this work, we are presenting a promising method for fabrication of OLEDs by utilizing the phenomenon of exciplex emission. Exciplex emission occurs at the interface of an electron accepting and an electron donating material. Hence it avoids the need for a separate emissive layer which helps to reduce the cost-effectiveness of the device.

Here we present novel blue emitting exciplex combinations. We have selected N,N′-Bis(naphthalen-1-yl)-N,N′-bis(phenyl)benzidine (NPB) and 3-(Biphenyl-4-yl)-5-(4-tert-butylphenyl)-4-phenyl-4H-1,2,4-triazole (TAZ); commonly used transporting materials for OLED. We could develop a promising blue exciplex OLED by using exciplex as an emitter and a yellow OLED by using exciplex as a host with a yellow phosphorescent dopant. A warm white emission has been achieved by utilizing the dual functionality of exciplex as an emitter as well as a host. The white emission is achieved via a device design strategy connecting these blue and yellow emitters using a spacer layer of tetracene, exploiting its ambipolar transport.

The selection as well as confirmation methods for a suitable conjugate pair for efficient exciplex emission are considered to be a crucial task. Analysis of photoluminescence spectra, UV-visible absorption spectra and the transient PL spectra of the exciplex mixed film along with the individual films have been done to give evidences for exciplex emission. Thus, by utilizing dual-functioning of exciplex emission as well a simple device design strat-

egy, we could achieve blue, yellow as well as white emission in OLEDs. These results address the challenges of complicated device fabrication and the lack of a stable and efficient blue emitter, providing guidelines for a cost-effective white OLED.

Keywords : Organic Light Emitting Diodes, Exciplex emission, Spacer , Deep blue exciplex, Yellow OLEDs, White light emission

PHYSICAL SCIENCES-13 REG. No. 15797

Effect of Co and Ni Dopant on Boosting the Thermoelectric Properties of CuO for Heat Energy Harvesting

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Background: Energy crisis and environmental degradation facing from overwhelming dependence of conventional energy resources demands remarkable development in renewable energy resources. In this regard economically feasible thermoelectric materials are much interest as they can generate electrical energy from diverse heat resources. Investigations of adequate strategies are needed to improve thermoelectric conversion efficiency.

Method: This work highlights modification in various transport properties such as Seebeck coefficient, electrical conductivity and thermal conductivity of CuO through the novel strategy of doping. Co and Ni doped CuO samples were fabricated through simple solid state reaction method in a stoichiometric ratio and the thermoelectric studies were performed in the temperature range of 300-873K.

Results: As the dopants are entered into the lattice, there occurred simultaneous increase in electrical conductivity and Seebeck coefficient of pristine CuO. Additional charge carriers generated and band structure modification leads to decoupling of these electric transport parameters. Accordingly about 6 fold improvements in powerfactor were attained for both Co and Ni doped CuO. Formation of point defects with doping aided the scattering of phonons and thereby reduced the contribution of lattice thermal conductivity. These results collectively enhanced figure of merit (ZT) of Co and Ni doped CuO greatly from that of pristine CuO.

Conclusions: This work demonstrate that doping with transition metal ions Co and Ni are very helpful on improving the thermoelectric properties of CuO by modifying various transport properties and bring out the possibility for mid to high temperature heat energy harvesting applications.

Keywords: Thermoelectricity, powerfactor, doping, phonons, figure of merit

PHYSICAL SCIENCES-14 REG. No. 15798

Room Temperature Ammonia Sensors Using Morphology-Controlled Organic Field-Effect Transistors

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Organic field-effect transistors (OFETs) have received much attention for flexible, light weight and cheap cost sensor applications, mainly in industrial and medical diagnostics field. The susceptibility to degradation in both ambient and aqueous environments has prevented OFETs from gaining rapid traction for sensing applications. On the other hand, the versatility of molecules and device designs have kept OFET as an interesting candidate for sensors for environmental monitoring, particularly for toxic gases like ammonia (NH_3)

Here, we fabricated a highly sensitive, organic field-effect transistor (OFET) based room temperature sensor for NH_3 using a p-type fused thiophene based organic molecule, dinaphtho[2,3-b:2′,3′-f]thieno[3,2-b] thiophene (DNTT), in a bottom-gate top-contact structure, which showed a fast response to low concentration of the analyte down to 100 ppb. The devices showed good air stability and performed well at room temperature. A smooth thin film of polymethyl methacrylate (PMMA) has been used as the dielectric material and its hydrophobic surface led to structured growth of organic semiconductor, DNTT.

We optimized the sensor performance by controlling the growth dynamics of the semiconductor film, and the sensi-

tivity of the device towards 1 ppm of ammonia was almost doubled with a porous film of DNTT as compared to that with a thick film. Morphological studies of the sensing layers, using atomic force microscopy (AFM), have been done to establish this structure-property relation. The variations in different transistor parameters like, saturation current, field-effect mobility, threshold voltage, subthreshold swing and interface states density have been studied with respect to different analyte concentrations. The devices exhibited a fast response and good recovery to the initial state within two minutes. The proposed OFET based ammonia sensor can have potential applications in health and environmental monitoring particularly due to its room-temperature performance, easy integration, good air stability, and enhanced ammonia sensing properties.

Keywords: DNTT, Porous monolayer, Organic field-effect Transistor, Ammonia Sensor

PHYSICAL SCIENCES-15 REG. No. 15812

Modelling the Knot Emissions of Active Galactic Nuclei(AGN) Jets

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The nucleus of a galaxy with luminosity greater than 1044 erg/s and exceeding the overall luminosity of the entire host galaxy is known as active Galactic Nucleus(AGN). High emission regions along the jets of active galaxies are called Knots. Radio, Optical emission from such knots were already observed. And after the advent of Chandra X-ray observatory, X-ray counterpart was also detected. The radio and optical emissions were explained by synchrotron emission processes but the radiative process responsible for X-ray is not very well understood. The synchrotron emission and an associated Inverse compton process of cosmic microwave background radiation of a single electron population, could satisfactorily explain the radio-optical-x-ray emissions from the knots, but this emission model predicts significant gamma ray emission from these knots which are not consistent with the upperlimits attained through fermi gamma-ray observations.

In this work, we develop a two population model which has two physically separated regions responsible for the emission processes. The inner spherical region from where particles are accelerated and an extended outer region where particles from inner region diffuse out. The extension of the outer region is decided by the time taken by the particles to cool. Particles accelerated and cooled by the magnetic field in the inner region form a broken power law distribution of particles. Using this model, X-ray knots of 3C 273 was explained by the synchrotron radiation from these regions.

PHYSICAL SCIENCES-16 REG. No. 15880

Design and Performance Analysis of Flexible Organic Thermoelectric Generator

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AcSIR- Academy of Scientific and Innovative Research, Ghaziabad, India

Background: The capability of converting heat into electricity (and vice versa) of a thermoelectric (TE) devices are expected to play an important role in addressing today's global energy issues. Electronic TE materials based on organic conjugated polymers have attracted considerable interest due to their advantages of easy processing, lower weight, cost-effectiveness, high flexibility along with their inherently low thermal conductivity. Conjugated polymers based on thienothiophene units have been intensively studied as photovoltaic materials, due to their good planarity of the conjugated backbone and high carrier mobility. However, TE properties have rarely been explored.

Method: This work explores simulating an organic TE generator using COMSOL Multiphysics software and compares its power output with the experimental results. A composite of conjugated thienothiophene polymer mixed with single-walled carbon nanotube via probe sonication was used for device fabrication and silver as the electrode. A flexible 21-leg TE generator was fabricated and measured the open circuit voltage, short circuit current and calculated the power output.

Result: The performance of the 21-leg flexible TE generator was demonstrated, exhibiting the power delivery of ~ 50 nW when subjected to a 65 K temperature gradient. The simulation of the same device using COMSOL Multiphysics software predicted a power output of 370 nW.

Conclusion: It is possible to expand these studies to identify and mitigate the performance loss pathways in a device. The flexible devices based on these organic hybrid materials, which have low thermal conductivity, lightweight, material abundance, and low-cost manufacturing, show significant advances in realizing prototypes for next-generation electronic gadgets and wearable TE energy harvesters.

Keyword: Thermoelectrics, Conjugated polymer, Carbon nanotube, Flexible device

II

Physical Sciences

Poster Presentation

PHYSICAL SCIENCES-17 REG. No. 13216

Unravelling Phonon Assisted Thermographic Response in Eu^{3+} Activated $Sr_2NaMg_2V_3O_{12}$ for Dualmode Temperature Sensing

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Background: The optical thermometry based on thermographic phosphors is a key method which offers high accuracy and consistency in which fluorescence intensity ratio method offers several advantages. Moreover, optical thermometry studies based on self-activated vanadate complexes are still limited. Hence to understand the potentiality of vanadate based garnets in the field of thermometry and safety sign applications, we opted dual emitting $Sr_2NaMg_2V_3O_{12}$ as the host and Eu^{3+} as the activator for designing thermographic phosphor.

Method: The material, $Sr_2NaMg_2V_3O_{12}$: xEu^{3+} were synthesized via conventional solid- state reaction route. $SrCO_3$, MgO, Na_2CO_3, NH_4VO_3 and Eu_2O_3 were the starting materials used. The stoichiometric amounts of precursors were accurately weighed and mixed together in acetone medium for 18 h and calcined at 900°C for 4 h.

Results: The single phase nature of synthesized phosphors is observed by XRD and the substitution of Eu^{3+} in the dodecahedral site is confirmed by Rietveld refinment. The dual emission from VO_4^{3-} and Eu^{3+} along with the energy transfer VO_4^{3-} to Eu^{3+} is observed. The phenomenon of diverse thermal quenching in which VO_4^{3-}undergo rapid falls in intensity and Eu^{3+} a slow reduction in intensity is identified. The maximum relative sensitivity, S_r is 1.61% at 420 K and also material shows high repeatability and a temperature resolution of < 0.2 K making it suitable for optical thermometry applications. Moreover, the thermochromic response is evaluated in which a rapid colorific shift from white to deep red (0.353, 0.335) to (0.611, 0.360) in 300-500 K is observed. The rapid colorific shift finds application in safety sign in high temperature environment. On comparing with already reported materials, the present $Sr_2NaMg_2V_3O_{12}$: 8% Eu^{3+} exhibits superior colorific shift. The phenomena of rapid and slow thermal quenching is due to the increased non radiative transition via

crossover in VO_4^{3-} and the existence of large energy gap between the excited and ground states of Eu^{3+} respectively.

Conclusions: In summary, based on the thermographic response of $Sr_2NaMg_2V_3O_{12}$: Eu^{3+}, maximum relative sensitivity of 1.61%/K as well as rapid colorific shift from white to deep red was observed and thus confirmed its potentiality as a superior candidate for dual mode temperature sensing.

Keywords: Garnet, Thermographic response, Safety sign

PHYSICAL SCIENCES-18 REG. No. 13678

High-frequency EMI Shielding and Microwave Absorption in Mayenite Electride (C12A7:e^-) with the Smallest Anions, Induced Porosity and Graphene Interfaces

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Background: Highly efficient EMI shielding and high-frequency microwave absorbing materials (MAMs) are indispensable in the present scenario where we are witnessing the 5G technology and the internet of things (IoT). Mayenite electride (C12A7:e^-) is the first room-temperature stable inorganic electride in which the cage-trapped electrons serves the function of the smallest possible anions. Desirable electromagnetic responses for microwave attenuation are possible from this material owing to its unique structural and morphological properties.

Methods: This study explores the high-frequency EMI shielding and microwave absorption properties of porosity induced C12A7:e^- with graphene interfaces. The EMI shielding properties were analyzed in the Ku and K bands and the microwave absorptions were analyzed from 5 to 40 GHz.

Results: The studied material exhibits EMI shielding effectiveness of 34.8 dB at 26.5 GHz for a thickness of 2.5 mm and an average specific shielding effectiveness of 107 $dBcm^2g^{-1}$, thereby having comparatively better result among ceramic composites. Moreover, the material has a dominating microwave absorption with minimum reflection. The microwave absorption studies from 5 to 40 GHz exhibits a minimum reflection loss of -22.9 dB at 30.9 GHz for a thickness of 2.54 mm

with an ultra-high bandwidth of 10.1 GHz.

Conclusions: The peculiar structure-derived electromagnetic response and various dissipation mechanisms like high electrical conductivity, polarizations from the cavity-trapped electron anions, interfacial polarizations at macropores and graphene/C12A7:e^- interfaces, and dipolar polarization at defects sites in graphene makes C12A7:e^- a potential candidate for microwave attenuation in 5G bands.

Keywords: EMI shielding, Microwave absorption, Electron anions, Graphene interfaces

PHYSICAL SCIENCES-19 REG. No. 13966

Study of Central Light Distribution in Nearby Early Type Galaxies Hosting Nuclear Star Clusters

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Background: In some galaxies, the central supermassive black hole is surrounded by a massive, very compact, star cluster composed of up to 10^8 stars, commonly referred as nuclear star cluster (NSC). Central intensity ratio (CIR; Aswathy & Ravikumar 2018, 2020, Sruthi & Ravikumar 2021) is a photometric parameter that measures the variation of light intensity at the very centre of the galaxy image. The simple photometric definition of CIR makes it sensitive to any addition (or subtraction) to the light near the centre of a galaxy.

Method: A representative sample of 63 nearby (< 44 Mpc) early-type galaxies hosting nuclear star clusters including 35 ellipticals and 28 lenticulars is adopted from Scott & Graham (2013). *Hubble Space Telescope* observations in optical band taken using cameras *ACS* and *WFPC2* (F850, F814 and F702 filters) are used for the analysis. The central intensity ratio (CIR) in the two concentric apertures of sizes 1.5 and 3 arcsec at the centre of the galaxy image is calculated using SExtractor (Bertin & Arnouts 1996).

Results: We report a significantly good correlation between CIR and magnitude of the nuclear star cluster residing at the centre of the galaxy (linear correlation coefficient r = -0.76 with a significance, S greater than 99.99 per cent).

Conclusions: Luminous NSCs contribute more light in the inner

aperture which reflects in the value of CIR. Thus, the result suggests a possible connection of NSC with its host galaxy. Magnitude, one of the directly measurable property of NSC, is usually derived from galaxy fitting. Our result propose the quick estimation of NSC magnitude with the aid of CIR. Also the result suggests a possible co-evolution of NSC with its host galaxy reported in literature.

Keywords: Galaxies , photometry, Nuclear star clusters.

PHYSICAL SCIENCES-20 REG. No. 14125

Novel Ways to Access Lower Energy Levels in GaAsBi Quantum Well Pin Diode

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Background: Devices with GaAsBi have been widely studied in the past decade due to its potential application in long-wavelength optoelectronics, spintronics, photovoltaics applications, and quantum well diode laser whose wavelength is getting closer to telecom wavelength range. A Small amount of Bi incorporation in GasAs leads to emission and absorption of lower energy photons than that of GaAs due strong bandgap reduction (~80meV per Bi %). An increase in the spin-orbit splitting energy is also observed where the magnitude of splitting exceeds the bandgap offering the suppression of non-radiative auger recombination.

Method: Temperature-dependent photoluminescence (PL) measurement and Electroluminescence (EL) of GaAsBi pin diode were recorded. The device was excited using a continuous wave, solid-state laser of 532 nm focused to a spot size of 2μm using a long working distance objective. The average power of the laser was varied from 0.5 to 4 mW. The device was biased in the range of 23 to 37 mA. The measurements were done in the temperature range of 22 – 300 K.

Results: PL and EL spectra shows two peaks. Lower energy peak is attributed to GaAsBi and higher energy peak is attributed to GaAs. For low biases, the GaAsBi shows an S-shaped temperature dependence. For higher bias the temperature dependent peak follows Varshini law. By introducing low fluence optical pumping with 523nm

continuous wave laser, it is observed that lower energy states become accessible.

Conclusion: This work shows the possibility to access energy levels of GaAsBi pin diode quantum well, which are otherwise inaccessible using a combination of optical and electrical pumping.

Keywords: Quantum well pindiode, photoluminescence, Electroluminescence, GaAsBi

PHYSICAL SCIENCES-21 REG. No. 15154

Hydrothermally Synthesized Van Der Waal Layered Structure of 2D WS_2 for TFT Application

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Background: Beyond graphene, 2D transition metal dichalcogenides are widely investigated because of their layer-dependent tunable properties. Tungsten disulphide (WS_2) being a promising material from this group, having potential application for next generation thin film transistors. The hydrothermal synthesis and subsequent post annealing to form van der waal layered structure has not been reported elsewhere.

Method: Typical hydrothermal method was employed to synthesize WS_2. Sodium tungstate, thiourea and oxalic acid were used as the precursors. The reaction carried out at a temperature of 150^0C followed by the annealing in the atmosphere of sulphur and argon.

Results: Post annealing treatment induces better crystallinity and facilitated van der waal layered structure.

Conclusions: Hydrothermal process and subsequent annealing identified a simple route to achieve 2D vander waal structure with enhanced crystallinity for the fabrication of thin film transistors.

Keywords: Transition metal dichalcogenides, Hydrothermal synthesis, post annealing

PHYSICAL SCIENCES-22 REG. No. 15422

Synthesis and Characterization of Mn-doped MoS_2 for Electrochemical Sensing of Folic Acid

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Background: Nowadays there is triggering interest in 2D materials like Transition Metal Dichalcogenides (TMD's). Among TMD's MoS_2 has the most robust nature and its biosensing properties are still been explored. Folic Acid (FA) is an essential vitamin that is necessary for the proper growth and development of humans in every stage of growth. Also, manganese (Mn) is a catalyst with distinguishing properties. The FA sensing properties of Mn-doped MoS_2 are not yet reported.

Method: Facile hydrothermal synthesis method was used for the synthesis of Mn-doped MoS2. For that sodium molybdate dihydrate, thiourea, manganese acetate tetrahydrate were used as precursors. The reaction was carried out at 2000C for 24 hours.

Results: The Mn-doped MoS_2 has shown a 42% increase in oxidation current than pure MoS_2 in the presence of 1mM FA.

Conclusions: The synergetic effect of both Mn and MoS_2 can effectively increase the sensing of FA.

Keywords: Transition Metal Dichalcogenides, manganese, Folic Acid, biosensing.

PHYSICAL SCIENCES-23 REG. No. 15493

Copper Oxide Doped Polyaniline as A Bifunctional Interlayer for Performance Enrichment of Li-S Cells

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Ever increasing demand for storing energy harvested from sustainable resources has intensified research for developing new, low-cost materials for efficient energy-storage applications. Research attention is more focused on developing storage devices with high energy density and operational stability with less environmental pollution. High theoretical capacity and easy availability of sulphur make lithium-sulphur cell chemistry one of the most promising viable technologies for developing next generation energy storage devices.

In lithium - sulphur cell, sulphur cathode offers quite high theoretical specific capacity of 1675mAh/g against lithium. However, low electrical conductivity of sulphur, volume expansion of sulphur cathode to significant extent during Li intake and the formation of polysulphides during cycling, which dissolve in the electrolyte, giving rise to polysulphide shuttling effect limit practical applications and commercialization prospects of lithium-sulphur cells presently. To overcome these limitations, several effective approaches have been adopted. Inserting a suitable interlayer between the cathode and separator is being widely pursued as a promising approach. The chosen interlayer should be able to enhance electrical conductivity of sulphur cathode and inhibit polysulphide shuttling phenomenon.

In the present work, suitability of copper oxide doped polyaniline (CP) interlayer to inhibit polysulfide shuttling effect and thus improve cell performance is investigated. Composite of sulphur with polyaniline coated activated carbon (PACS) is used as modified sulphur cathode with increased electrical conductivity.

Structural and morphological characterizations of the synthesized PACS cathode and the CP interlayer are carried out using X-ray diffraction (XRD) and Field Emission Scanning Electron Microscopy (FE-SEM) techniques. Electrochemical characterizations are carried out by assembling stainless steel Swagelok cells inside argon filled glove box.

Li-S cells assembled with CP interlayer

offer much higher initial discharge capacity of 699 $mAhg^{-1}$, compared to that of the ones without interlayer, which is only 289 mA h g^{-1} and good cycling stability. Pores in the polymer network of the CP interlayer act as "traps" for the polysulfides by holding back the migrating polysulfides. Interlayer also acts as an upper current collector. Our study suggests that surface modification of sulphur cathode as PACS and the use of CP interlayer offer promising scope for designing the next generation Li-S cells with high capacity, energy density, and excellent cycling stability.

Keywords: Li-S cell, Polysulfides, Copper oxide, PANI, Interlayer.

PHYSICAL SCIENCES-24 REG. No. 15503

Improved Optical Limiting Property of Carbon Wrapped Zinc Sulfide Core-Shell Nanostructures

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Background: The optical limiting property of nonlinear optical materials can be made use in protecting sensitive optical devices from the damage caused by high-power laser systems. This can be realized by maintaining the output fluence below a certain damage threshold even at high input intensities. However, most of the nonlinear optical materials found in nature exhibit weak nonlinearities. Thus, it is high time to find new materials that can withstand high intensities without getting damaged.

Method: Herein, we report the enhanced nonlinear absorption (NLA) of Zinc sulfide (ZnS) nanoparticles as a consequence of core-shell structure formation with graphite. The synthesis ZnS@C core-shell structure was carried out in chlorobenzene by Pulsed Laser Ablation in Liquid (PLAL). The formation of the synthesized structure was confirmed using a UV-Vis spectrophotometer. The optical limiting studies were conducted by standard Z-scan technique using the second harmonic of a Q-switched Nd: YAG laser with 10 Hz repetition rate and 7 ns pulse width.

Results: The characteristic Surface Plasmon Resonance (SPR) peak of ZnS

nanoparticles at 270 nm was absent in the UV-Vis spectrum. Instead, a peak was formed at 288 nm due to the presence of graphitic layer around the ZnS core which quenched the SPR peak of ZnS. The open aperture Z-scan studies revealed a fall in transmittance at the focus, hence confirming the contribution of Reverse Saturable Absorption (RSA) towards NLA. A three-fold enlargement in the effective nonlinear absorption coefficient was obtained for the core-shell nanostructure compared to pristine ZnS nanoparticles. This phenomenal enhancement of the NLA behavior of the core-shell structure can be attributed to the interaction between the intermediate energy levels of ZnS core and graphite shell. The Optical Limiting (OL) threshold value of the synthesized ZnS@C core-shell structure was 0.369 J/cm^2, which is one of the best values of optical limiters reported so far.

Conclusion: The effective integration of ZnS with graphite significantly improves its optical properties, allowing our structure for applications in optical limiting and laser safety

Key Words: Pulsed Laser Ablation, Nanoparticle core-shell nanostructure, Z-Scan, Optical Limiting

PHYSICAL SCIENCES-25 REG. No. 15627

Nd: YAG Laser Ablated Non-Hazardous Platinum-Gold Alloy Nanoparticles for Catalytic Degradation of Methylene Blue Dye

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Background: When the plasmonically efficient Au NPs and traditionally catalytic Pt NPs are combined in bimetallic NPs, plasmonic excitation can occur along with significant molecule adsorption characteristics which result in amazing enhancement in catalytic activities Laser assisted techniques can produce ligand-free, non hazardous Pt-Au NPs on a cost effective basis without any chemical surfactants and pre cursors.

Method: To synthesize Pt-Au alloy NPs, laser irradiation method of heating and diffusion of laser ablated monometallic colloidal mix using Nd:

YAG laser was adopted. The catalytic activity of Pt, Au and Pt-Au alloy NPs in the catalytic degradation of Methylene blue dye was investigated.

Results: Regression analysis shows that measuring anions using impedance spectroscopy and simple stainless steel cylinders that detection limits at the parts per trillion (ppt) level are possible. There was no statistical difference when comparing impedance values of the same concentration of acetate and chloride in solution, showing real impedance is not dependent on ion size. However, ions with higher charge do result in lower impedance measurements.

Conclusions: Surfactant-free non-hazardous Au-Pt alloy NPs were synthesized via a novel laser irradiation method. Catalytic application of Pt, Au and Pt-Au alloy NPs were analyzed in catalytic degradation of MB dye. The Pt-Au alloy NPs were found to have enhanced catalytic activity than monometallic NPs due to the simultaneous occurrence of plasmonic as well as adsorption effects.

Keywords: laser assisted synthesis, Pt-Au alloy nanoparticles, catalytic degradation, Methylene Blue

PHYSICAL SCIENCES-26 REG. No. 15667

All-Optical Diode Action from Nonlinear Photonic Crystal/ Metal Hybrid Structure

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Background: The past few decades witnessed remarkable technological advancement in replacing conventional electronic devices with integrated photonic systems with superior performances. The photonic integrated chips (PIC) require all-optical elements to control the light propagation. The optical diode is one of the fundamental elements in optical communication systems. Similar to its electronic counterpart, optical diode can block the propagation of light in one direction, while letting in the other direction.We demonstrate the working of an all-optical, passive nonlinear photonic diode by juxtaposing a reverse saturable absorber (RSA) and saturable absorber (SA) in tandem. The asymmetric nonlinear

absorption causes non-reciprocity in light transmission, and work as an all-optical diode.

Method: A one-dimensional polymeric photonic crystal microcavity structure is fabricated via spin-coating 20 bilayers of polyvinyl carbazole and cellulose acetate with quarter-wave optical thickness with a photonic bandgap around 532 nm. A defect layer containing a metal-free phthalocyanine creates a resonant cavity for light. The localized mode of the photonic cavity is designed at 532 nm, which is the excitation wavelength of the laser used in the study.

Results: Due to high optical density of states in photonic crystal cavity and resultant enhanced light-matter interaction leads to giant enhancement in the RSA property of phthalocyanine. A thin layer of gold is vacuum deposited on the top act as SA material. The forward and reverse diode actions were studied using nanosecond pulsed laser by varying the input fluencies.

Conclusion: Our structure offers high non-reciprocity factor with low input threshold, with good chemical and mechanical stability, making it a potential candidate towards realizing all-optical analogous of electronic devices.

Keywords: Optical diode, Photonic crystal, Bragg mirror, Nonlinear optics, Nonreciprocity

PHYSICAL SCIENCES-27 REG. No. 15713

Monte Carlo Simulation and Validation of Beam Characteristics of 10MV Flattening-Filter-Free Photon Beam of Truebeam® Medical Linear Accelerator.

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Background: A Monte Carlo (MC) based calculation was used for the simulation of radiation dose delivery in order to increase accuracy during radiotherapy treatment planning.

Materials and Methods: This study aims to validate the accuracy of the Monte Carlo (MC) model of 10 MV flattening filter-free (FFF) photon beam against experimental measurements for a TrueBeam® Linear accelerator (Linac).MC simulation of the

10MV FFF beam of TrueBeam® Linac was performed using the PRIMO MC simulation software (Version 0.3.64). The simulated beam parameters were compared against the measured beam data of the TrueBeam machine. The measurements were carried out in water sizes at different depths using a radiation field analyzer (RFA). A virtual water phantom defined in PRIMO was used to determine the dose. The gamma analysis method was used to compare the dose distributions with 2%, 2 mm acceptance criteria.

Results: Statistical uncertainty in the dose calculation reported by PRIMO at two standard deviations was around 1% (a range of 0.95% to 1.5%). Gamma analysis indicates a minimum pass percentage of 98% for depth dose curves and 95% for beam profiles. The beam quality indexes, output factors, and absolute point dose agree with measurements.

Conclusions: MC simulation results of 10 MV FFF of photon beams from TrueBeam LINAC using the PRIMO code show good agreement with experimental data. This study shows that PRIMO can be used to verify beam characteristics independently.

Keywords: Monte Carlo simulation, PRIMO Code, FFF beam, Linac.

PHYSICAL SCIENCES-28 REG. No. 15723

Modification of Optical and Structural Properties of PCD Deposited ZnSe Nanostructured Thin Films

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Background: The semiconductor industry has greatly benefitted by the advancements in thin film technology through very large scale integration. ZnSe is a wide band gap II-VI semiconductor with direct transition.

Method: ZnSe thin films were synthesised through Photo-assisted Chemical bath Deposition technique with a UV lamp (125) W emitting radiations of wavelength 355 nm.

Results: The polycrystalline thin films have hexagonal wurtzite crystal structure. Various structural properties like grain size, micro strain and dislocation density are evaluated. The morphol-

ogy shows variation with duration of deposition and the films were nearly stoichiometric. All the samples possessed very high optical transmission in the visible and IR region and optical band gap widened with increase in deposition time. Room temperature PL emission spectra shows a blue shift in NBE peak which is in agreement with the optical band gap value. The electrical conductivity is evaluated from I-V plot.

Conclusion: the peculiar morphology, structural, optical and electrical properties make the thin films good candidate for luminescent and photovoltaic window layer applications.

Keywords: Photo-assisted chemical deposition, photoluminescence, SEM

PHYSICAL SCIENCES-29 REG. No. 15740

Pairing Correlations in The Isotopes of Cobalt in the Light of Hartree-Fock-Bogoliubov Theory

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Background: The existence of nucleon pairing could be traced out from the Bethe-Weizäcker semi-empirical formula, which helps us understand the behavior of nuclear properties, viz. the binding energy, stability, shape etc. Even though the correlation energy due to pairing appears to be a small correction to the binding energy, it has been proved to play a vital role in determining the structure of both finite and infinite nuclear systems. The additional binding that pairing offers provides increased stability and in turn affects the position of the dripline. Pairing correlations also influence reaction cross sections, neutrinoless double β decays, odd-even staggering, incompressibility, symmetry energy, moments of inertia, alignments, deformation etc.

Method: We use Hartree-Fock-Bogoliubov (HFB) theory for the study. The general wave functions for the HFB approach, incorporating the quasi-particles which move independently and the possible correlations are determined by variational principle. We define eigen functions for the Hamiltonian as the ground state quasi-particle vacuum by using the Rayleigh-Ritz variational principle and are connected to the original particle operators through Bogoliubov trans-

formation. The Hartree-Fock energy is obtained through the minimization of the variational parameter. The HFB equation is solved by iterative diagonalization in the quasi-particle basis defined for protons and neutrons. In each iteration the particle number symmetry is restored by Lipkin-Nogami method, which plays the role of a Lagrange multiplier, by including an additional term in the HFB Hamiltonian. We use a standard computer code HFBTHO to accomplish these procedures.

Results: The HFBTHO analysis proves that there is considerable effect of pairing correlation in the binding energies, neutron and proton pairing energies, neutron and proton pairing gaps and one- and two-neutron separation energies of the Cobalt isotopes with mass numbers ranging from 44 to 76. It could be seen that the binding energies matches with the experimental values and the contribution due to the pairing is evident. Similarly, for pairing energies and pairing gaps, we could identify regions where pairing is significant and the effects of shell closure at the vicinity of magic configuration of neutrons. The one- and two-neutron separation energies also agree well with experimental values and could prove the effect of pairing.

Conclusion: The Hartree-Fock-Bogoliubov calculations of the effects of pairing could be used as an efficient tool to study the nuclear structure effectively. It can be ascertained that the pairing plays an important role in determining the ground state properties of atomic nuclei.

Keywords: Pairing correlation, Hartree-Fock-Bogoliubov theory, nuclear structure, binding energy, pairing gap, neutron separation energy.

PHYSICAL SCIENCES-30 REG. No. 15773

Two Proton Decay of ^{19}Mg, ^{22}Si, ^{26}S, ^{30}Ar Isotopes

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Background: The present work aims to study the two-proton radioactivity of light nuclei with atomic number in between 10 to 20. It is found that the isotopes ^{19}Mg, ^{22}Si, ^{26}S, ^{30}Ar nuclei have minimum separation energy for two proton decays S(2p). We have also computed the driving potential for

these isotopes with different angular momentum (l=0,1,2,3,4). These nuclei have the minimum driving potential for two proton. These two results show the high probability of showing two proton radioactivity from these nuclei. The half-lives computations are done by using the simplified form of effective liquid drop model (ELDM).

Method: Effective liquid drop model (ELDM) is a complicated model; hence we reduce the complexity of the model into a simplified form. The interacting potential is modified by considering the nuclei as point charges. That is Gaudin's expression is replaced and the Coulomb potential energy is calculated by considering the daughter nucleus and fragment as point charges. The separation energy of one proton (S(p)) and two proton (S(2p)) is computed and analyzed the possibility of one proton and two proton decay from the nucleus.

Results: in the present work we have computed the one and two proton separation energy for ^{19}Mg, ^{22}Si, ^{26}S, ^{30}Ar isotopes. If the separation energy is minimum that decay is more possible. In the present case the isotopes ^{19}Mg, ^{22}Si, ^{26}S, ^{30}Ar nuclei have lower S(2p) than S(p). We have also computed the driving potential for these isotopes with different angular momentum (l=0,1,2,3,4). Increasing the angular momentum the variation in driving potential is showing a similar pattern shown in the ground state. Analysing the driving potential and separation energy ^{19}Mg, ^{22}Si, ^{26}S, ^{30}Ar nuclei have a high probability of showing two proton decay comparing other decay possibilities. In addition, we have computed the half-lives of nuclei with different angular momentum (l=0,1,2,3). The computed logarithmic half-lives of two proton decay using the present model and are in good agreement with experimental values and with the predictions of GLDM, ELDM, and the empirical formula.

Conclusions: we would like to point out that the two-proton decay is probable decay for emission of ^{19}Mg, ^{22}Si, ^{26}S, ^{30}Ar nuclei. The computed logarithmic half-lives of two proton decay using the present model and are in good agreement with the predictions of GLDM, ELDM, and the empirical formula.

Key words: Two proton decay, Separation energy, Driving potential

PHYSICAL SCIENCES-31 REG. No. 15827

Liquid-Liquid Interface Decorated with Self-Assembled Au NPs Array As An Optofluidic Modulator

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Background: Metallic nanoparticles (NPs) assembled at the liquid-liquid interface (LLI) are shown to have widespread applications ranging from sensors to tunable optical devices. Optical actuation of LLI is a promising way to realize simple, cost-effective and reconfigurable optical components. Herein, we report a thermoplasmonically actuated all-optical modulator based on a heptane/water interface incorporated with assembled Au NPs.

Method: The working principle relies on the temperature rise at the LLI due to plasmonic heating and controllable dewetting of the top liquid layer triggered by the thermocapillary flow. The system comprises of heptane layer as the top layer, water as the bottom layer and 2D array of Au NPs (size 51 ± 5 nm) at the interface. The temperature gradient to drive flow arises from the plasmonic heating using a focused 532 nm laser beam at the NP array.

Results: The excitation of assembled Au NP layer at the plasmonic wavelength causes a localized temperature rise of 3.2 ± 0.7 °C, at the irradiated zone and creates a thermocapillary flow across the interface. The flow thus generated results in the deformation and subsequent rupturing of the heptane layer, when the thickness of the layer is below the capillary length (0.5 ± 0.05 mm). To operate the platform as an optical modulator, a signal beam (655 nm) was aligned to pass through the heptane layer, parallel to the interface. When the trigger beam is off, the layer is intact and the signal beam gives a maximum output (ON state). Upon switching on the trigger beam, the heptane layer ruptures and blocks the incoming signal, resulting in a minimum output (OFF state).

Conclusions: We developed a thermoplasmonically-actuated optical modulator based on a liquid-liquid interface decorated with self-assembled Au nanoparticles. The working principle relies on thermoplasmonically controlled reversible rupturing of the top layer, which modulates the transmittance of the signal beam pass-

ing through this layer. A temperature rise of only 3.2±0.7 °C at the interface is sufficient to realize modulation in optical transmission.

Keywords: Plasmonics, Nanoparticle array, Fluid-fluid interface, All-optical switch.

PHYSICAL SCIENCES-32 REG. No. 15896

Elucidating the Multifunctionality of $NaGdMgTeO_6:Eu^{3+}$ Double Perovskite in Ratiometric Thermometry and Solid-State Lighting

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Background: Multifunctional materials are under the limelight since it proves to be a cost-effective route to maximize the features of a single material. The choice of the host plays a significant role in determining the multifunctionality of the material [1]. A potential candidate for multifunctional material is perovskite structure with general formula ABX_3. In order to tailor the properties of perovskite compounds, partial cation substitution at A- or B- site or both and in varying degrees can be carried out. This led to double perovskite with general formula $A_2B_2O_6$, $A_2BB'O_6$, $AA'BB''O_6$. As there is a charge difference between the two cations in double perovskite, a particular ordering on B- site and A-site can reduce the strain energy of the double perovskite. Due to electrostatic considerations and bond strains, A-site cations have preference for layered ordering and B-site cations for the rock salt ordering. Among various multifunctional materials, lanthanide doped double perovskites are popularly used in wide range of applications ranging from solid state lighting, bio imaging, bio labelling, optical thermometry, photovoltaics, etc. Owing to their narrow emission lines and prolonged lifetime and dependence on temperature, it finds application in optical thermometry. [2-4, 11]

Method : $NaGdMgTeO_6:Eu^{3+}$ was synthesized via solid-state route. The raw materials used for the synthesis are Na_2CO_3 (Sigma Aldrich, 99 %), Gd_2O_3 (Sigma Aldrich, 99 %), Eu_2O_3 (Alfa Aesar, 99.9%), MgO (Sigma Aldrich, 99 %), TeO_2 (Sigma Aldrich,

99 %). Stoichiometrically weighed chemicals was mixed and calcined at 1050C for 4h. The sample $NaGd_{1-x}Eu_xMgTeO_6$ were prepared in this way for seven different concentrations of Eu^{3+} (x=0.02, 0.04, 0.06, 0.08, 0.10, 0.12 and 0.14).

Results and Discussions: The crystal structure and photoluminescent properties under different Eu^{3+} concentrations is investigated by XRD, Raman spectroscopy, DRS and photoluminescence spectroscopy. X ray diffraction profile in combination with Rietveld refinement reveals the phase purity and crystallinity of the samples and successful introduction of Eu^{3+} into the matrix. The compounds have monoclinic structure with space group P121/m1 (11). A slight increase in the cell volume is observed which may be due to the difference in the ionic radii of Eu^{3+} and Gd^{3+}. Further structural characterisation is studied using Raman spectroscopy and FTIR spectroscopy which shows the structure is stable when trivalent europium ion is incorporated into the host. Diffuse Reflectance Spectroscopy (DRS) is used to investigate the optical properties and a direct bandgap of 3.5 eV was obtained for $NaMgGdTeO_6$: 8% Eu^{3+} which suggests that these phosphors can be efficiently excited using ultraviolet radiations. The excitation spectrum monitored at 615 nm has a broad charge transfer state excitation band centred at 265 nm and some narrow peaks corresponding to characteristic transitions of Eu^{3+} ions. When excited at 265 nm, the photoluminescence emission spectra show an intense red emission at 615 nm which corresponds to $^5D_0$- $^7F_2$ electric dipole transition of Eu $^{3+}$ ions. The optimum doping concentration of Eu^{3+} is obtained as 8 mol % with a quantum yield of 35.12 upon 265 nm excitation. Concentration quenching took place with further Eu^{3+} concentration, where the energy transfer mechanism was analysed to be an electric dipole-dipole interaction. The luminescent decay time monitored at 265 nm = 615 showed a decrease in lifetime with increase in Eu^{3+} concentration. The critical distance is determined to be 13.17 Å which indicate that electric multipolar interaction occur among Eu^{3+} ions. Correlated colour temperature and color purity are estimated to be 2227 K and 94 % respectively. Thermal activation energy of the phosphor is evaluated as 0.2 eV. Thermal stability and other phosphor parameters show its potential application in solid state lighting. The relative temperature sensitivity and absolute sensitivity obtained by measuring fluorescence intensity ratio of $^5D_0$ $^7F_1$ to $^5D_0$ $^7F_2$ is 0.34 $\%K^{-1}$ and 0.0014 K^{-1} respectively. All the results suggested that $NaGdMgTeO_6$: Eu^{3+} phosphors have potential applications in solid state lighting and optical thermometry.

Keywords: Double layered perovskite, Crystal structure, red phosphor, Optical thermometry, FIR

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Scientific Social Responsibility

Oral Presentation

SCIENTIFIC SOCIAL RESPONSIBILITY-01 REG. No. 15237

Development of an Equipment for Sustainable Bark Harvesting of NTFP Yielding Trees with Special Emphasize on *Machilus macrantha* (Nees) Kosterm.

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Background: Traditionally, the tribal communities are the harvesters of NTFP resources and it is their main source of livelihood and income needs. Unscientific and unsustainable harvesting has been caused fast depletion of NTFPs, particularly bark yielding species. A bark stripping equipment was developed first of its kind for stakeholders purpose. *Machilus macrantha* was targeted for the present study.

Method: Two types of harvesting methods viz. longitudinal stripping and longitudinal inter-space bark stripping was standardized for the pre-reproductive and reproductive individuals of *Machilus macrantha.* The bark stripping equipment developed could for the sustainable harvesting practice of the species.

Results: Prereproductive individual's showed faster regeneration ability within a period of 10 months by inter-space bark stripping method. Reproductive individuals showed slower regeneration in both type of harvesting methods. Summer months (February to April) is found to be ideal season for harvesting. The inner bark should be left while harvesting the bark that maintain humidity and promote bark regeneration. Bark stripping equipment developed along with an adjustable blade which will be fixed manually as per bark thickness of respective age class of the tree so as to limit the extraction at secondary phloem. The rechargeable battery could help the stakeholders for continuous working and a single battery can lasts upto 1.30 hours. The handy equipment weighs around 3 kgs.

Conclusion: The bark stripping equipment developed could be utilized for the sustainable harvesting of NTFPs for livelihood of depending communities.

Key words: NTFPs, sustainable harvest, bark stripping equipment, conservation.

SCIENTIFIC SOCIAL RESPONSIBILITY-02 REG. No. 15546

Effective Counterfeit Currency Blocking System by AI and Statistics.

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Background: In present scenario counterfeit currency detection is based on comparison with original one, by an expert, with the help of security details printed on currency. This expert is not available in everywhere, he is available only in certain points of currency circulation path.

In this new method the possibility of a currency became fake is continuously monitored throughout its circulation by the help of Artificial Intelligent (AI). This method is fast, more reliable, cheap and socially connected.

Method: In this new method all notes are continuously monitored using its serial number along with its circulation area. When an abnormal behaviour of circulation is noticed it is detected by AI based application and inform the authority for detailed verification.

AI based application will take the decision according to the following condition.

1. The serial numbers of currency which have already in circulation.
2. The present circulation area of a currency.
3. The probability of change in circulation area.
4. The diffusion constant of a counterfeit currency.

Modification/Equipment required

1. A web server.
2. A small modification in note counting machine.
3. An AI based application.

Benefits

1. More efficient & fast.
2. It can reduce the cost of security printing.
3. Assistance of expert can be reduced to < 10%.
4. Source and quantity can also be estimated before arrest the people.

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Journal of Financial Crime, ISSN: 1359-0790, Article publication date: 4 July 2016, By Balasubramaniyan_Viswanathan_*(Department of Defence and Strategic Studies, Gurunanak College of Arts and Science, Chennai, India)*

SCIENTIFIC SOCIAL RESPONSIBILITY-03 REG. No. 15576

Smart Learning Environment in a Knowledge Economy Through Multiple Intelligences Based Multimedia

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Background: Technology has a profound impact on the knowledge economy and society and is changing the way we work, communicate, engage in social activities and enjoy ourselves. From a constructivist learning approach, integration of Multiple Intelligences and Multimedia is an excellent way to actively involve students in quality learning.

Method: The present investigation is traversed through a mixed paradigm with a Qual-Quant approach sandwiched with a developmental process. The mixed-method research design employed in the investigation is Sequential Exploratory Instrument Development Design with a post- positivistic worldview calls for a quantitative priority. . Experimental method namely pre-test, post-test equivalent group design was employed on a selected sample of Higher Secondary School Students

Results: The investigator designed, developed, and validated a Multiple Intelligences Based Multimedia Learning Package (MIBMLP) in Physics for Higher Secondary School Students following the ADDIE model of instructional material design (Analysis, Design, and Development steps) with academic and technical supports. The investigator projected the findings of the study as an action plan model with a synthetic design entitled 'Silpa & Benedict Instructional Approach-Theory Integration Model' as a pattern with futuristic use. The findings of the study showed that MIBMLP employed learning of Physics at Higher Secondary School level is more effective than the Expository Approach in fostering the components of Multiple Intelligences, achievement, and Retention of knowledge.

Conclusion: The research experience and the analysis of the findings clearly point towards a broad spectrum of implications spread over multiple levels of functional platforms and may naturally trigger out a series of functional research initiatives in the years to come.

Keywords: Smart Learning Environment, Knowledge Economy, Multiple Intelligences, Multimedia

SCIENTIFIC SOCIAL RESPONSIBILITY-04 REG. No. 15784

"MOZHI" – An Audio-Visual Malayalam Speech Database

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Background: In Malayalam, speech processing is still in its infancy stage, with only a few works focusing only on audio speech. Thus, there is a significant gap between the computational and linguistic aspects of the Malayalam language, making it an under-resourced language. One of the in-depth reasons cited by the research community is the scarcity of application-oriented speech database.

Method: A phonetically rich audio-visual speech database in Malayalam suitable for various research in audio and visual speech processing is presented, making it the first of its kind in the language. This database consists of 3 categories of recording, which can be used for various research works. There is one category of audio-only speech database and two categories of audio-visual speech database.

Results: The recorded database is segmented and labelled properly. The database has been available through the servers of Kannur University, Kerala, India. This database is used for research purpose only and will be provided only through request.

Conclusions: This is the first standard audio-visual speech database in Malayalam. This database is designed to aid research into the effects of age on speech, noisy speech processing, visual speech processing, viseme-based speech synthesis, and lip synchronisation utilising audio-visual speech asynchrony, among other topics.

Keywords: Audio-Visual Speech Database, Phonemes, Allophones.

SCIENTIFIC SOCIAL RESPONSIBILITY-05 REG. No. 15873

A Study on the Various Preschool Systems in Kerala

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Introduction: The preschool period is the most notable and important period in the life of a person.Though these pre-school systems are known by various names such as Pre-primary, Anganwadi, Nursery school, Kindergarten and Montessori, the ultimate aim of all these systems is the complete development and care of children.

Objectives: To analyse the preschool systems in Kerala on the basis of the factors: Infrastructure, Learning aids, Human resources,Admission, Medium of instruction, Safety, cleanliness and nutrition, Support system. To provide suggestions for the improvement of preschool systems.

Method of study: The study was completed in four months using survey method. The survey was focused mainly on Thiruvananthapuram. **Sample**:Total 20 schools, 5 each from different system.

Findings: All schools under government sector have their own buildings. But the preschools under the Kindergarten, Montessori and Anganwadi streams occupy rented buildings. All schools except Anganwadis had facilities such as attractive classrooms, electricity and fan/light. However, facilities for the children for safekeeping their materials, proper ventilation, child friendly furniture, cleanliness and space for keeping footwear were found rare in many schools.The availability of facilities for children with special needs were very limited in majority of preschools (Government, Montessori, Anganwadi, Kindergarten).Most of the schools possessed learning aids but there were many preschools (Montessori) which did not have learning aids like sand trays and BaLA.While considering the number of children, the government and anganwadi systems strictly stick to the preschool criteria and do not admit any children under the age of three. But the private institutions do not follow the regulations and admit children under three. All helpers except the ones in Anganwadi have completed 10th standard.Majority of teachers in the preschools except Anganwadis have passed PPTTC teacher training course. Only teachers of government schools possessed the

two year professional qualification. Contrary to the prescribed criteria, the rest of the schools appointed employees who had passed courses of one year or six months duration only.The government and Anganwadi streams have completed the registration process as per the criteria. But private institutions are not registered as they have not implemented any legal regulations. However, these private schools are allocating ID cards and uniforms. Some government schools and most of the private institutions provide transport facilities and have implemented CCTV systems. Anganwadis , however, do not have these facilities. Most of the schools did not have fire and safety equipment.All government schools and Anganwadi's distribute nutritious food to children. All Anganwadis measure and record the height and weight of the children every month. They also conduct health check ups twice a year and distribute nutritious food. But none of these facilities are available in the private institutions. They confessed that they resort to mild punishments such as scolding and staring. The teachers of government schools and Anganwadis unanimously pointed out that they needed training to understand the instructional methods for children with special needs.All teachers under the Montessori and Kindergarten stream teach other languages along with the mother tongue. They also give directions in English.

Conclusion: The study reveals that lot of preschool systems in Kerala do not achieve the desired goal. In spite of the government's emphasis on child centered learning, the society is unable to make effective use of this policy. It is essential that these institutions which strive to mould the children into promising citizens of the future should function effectively. The government, non government organizations, social workers and research scholars should take the measures to achieve this.

SCIENTIFIC SOCIAL RESPONSIBILITY-06 REG. No. 15876

Nudge and Vulnerability to Climate Change: A Case Study on Forest Dependent Tribal Community

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Background: Positive enforcement and indirect suggestions are emphasised in Nudge theory as techniques to affect individual or group behaviour. Other alternative legislative measures, such as fines or incentives, disagree with this behavioural economics idea. Nudge theory's applications include using helpful norms as positive influences, modifying people's available alternatives, and using reminders and reinforcements. It works well as a tool for public policy or as part of government efforts to execute adaptive capacity building methods.

Method: The Community Based Vulnerability Assessment of the marginalised forest dependent tribal community of Western Ghats in Kerala, India was done by considering vulnerability as a function of exposure, sensitivity and adaptive capacity. Adaptive capacity was evaluated based on human, natural, financial, social and physical parameters.

Results: Variation in adaptive capacity values had a significant impact on the aggregate vulnerability level of each settlement in this comparative research of two tribal villages with identical exposure and sensitivity indices. The Panchayat (local self-government) in Settlement-2 had various capacity-building projects that used nudge theory to influence people's choices in employment, marketing, education, and self-awareness. The settlements immensely adapted to the social variables, while their ability to adapt to financial and physical constraints was the lowest. Settlement-2 had a higher social and human adaptive capacity, lowering its vulnerability score significantly.

Conclusion: Based on the obtained vulnerability levels of the forest dependent tribal communities to the climate change induced drought in forest, the study recommends the application of nudge theory in the implementation of well-planned capacity building strategies for empowerment and infrastructural development based on a settlement specific community-based approach.

Keywords: Vulnerability Assessment, Nudge, Climate Change, Tribal Empowerment, Adaptive Capacity.

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Scientific Social Responsibility

Poster Presentation

SCIENTIFIC SOCIAL RESPONSIBILITY-07 REG. No. 10484

Data: Of The People, By The People, For The People. Ownership, Privacy and Consumption of Data in A Knowledge Economy

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Sir Fransis Bacon in his *Meditationes Sacrae* (1597) says "*Ipsa scientia potestas est*" - 'knowledge itself is power'. Knowledge be it explicit (documented information), implicit (applied information), or tacit (understood information), its ownership, valuation and application is a potent tool of power, governance, and commerce.

A knowledge society generates, shares, and makes available to all members of the society knowledge that may be used to improve the human condition. Innovation, Intellectual property creation, and education are essential for a knowledge society. The idea of the present-day knowledge society is based on the vast increase in data creation and information dissemination that results from the innovation of information technologies.

Data is the core of Information technology, subsequently Knowledge economy. The existing governing law in India, the two-decade-old Information Technology Act, 2000 (IT Act), hasn't been able to keep up with the rapid advancements in technology. For an effective knowledge economy more legal support is needed in all the steps of data creation and management. Moreover, education related to data is a requirement for an effective sensitization of the concept of knowledge economy.

The government has proposed Personal Data Protection Bill (PDPB) seeks to bring about a comprehensive overhaul of India's current data protection policies. If we consider data as commodity, the constitution provides an equal opportunity to access them to all the citizens. But do we have sufficient infrastructure to let the public access those data. Can the government provide physical access points for its citizen to access all the services provided by the government?

This paper will deal with a critical analysis of above said question for a better implementation of the policies for the knowledge society the government has envisioned for its public.

Keywords: Data, IPR, PDPB

SCIENTIFIC SOCIAL RESPONSIBILITY-08 REG. No. 15592

Identification of Plant Extracts with Cytotoxicity Against HT-29 Colorectal Cancer Cell Line

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Background: In spite of the advances in drug development, cancer is still a leading cause of mortality worldwide. Global statistics showed that Colorectal cancer is in third position in terms of newly diagnosed diseases and in second position in the case of causing death. The present study aimed to identify the cytotoxicity of various plant extracts on Human colorectal adenocarcinoma cell line (HT 29) and determining the IC 50 values of plant extracts with higher activity.

Method: Sequential extraction using 5 solvents of increasing polarity was carried out to prepare different extracts from plants. Cytotoxicity of 61 extracts from the leaves of 13 locally available plants collected from Pulpally, Wayanad were tested on HT 29 cell line using MTT assay. Cell viability was determined by the differences in absorbance values between control and test samples. Various concentrations of the highly active extracts were tested by using MTT assay and their IC 50 values were determined.

Results: The results showed that a total of 7 plants have shown cytotoxicity of greater than 50% for at least one of their different solvent extracts. The highly active *Alangium salvifolium* chloroform extract and *Syzygium caryophyllatum* methanol extract has showed IC 50 values of 93.75±2.50 µg/ml and 282.92±1.09µg/ml respectively.

Conclusions: From this study, it can be concluded that the chloroform extract of *Alangium salvifolium* and methanol extract of *Syzygium caryophyllatum* has relatively good cytotoxic activity to HT 29 cells. The results suggest that *Alangium salvifolium* (IC 50: 93.75±2.50 µg/ml) and *Syzygium caryophyllatum* (IC 50:282.92±1.09µg/ml) can be used as promising sources for isolatng new anticancer drugs.Studies in this direction are ongoing.

Keywords: Anticancer, plants, *Alangium salvifolium*, *Syzygium caryophyllatum*, cytotoxicity, colorectal cancer cell line.

SCIENTIFIC SOCIAL RESPONSIBILITY-09 REG. No. 15729

An Integrated Citizens' Observatory: A Practical Approach from a Fast Growing City in India

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The rapid urbanization has led to severe impact on the aquatic environment of fast growing cities of India. Lack of reliable data is the major barrier for the effective intervention and conservation of water resources in the cities. Systemic hydrological monitoring is critical for generating data which guide to the evidence-based decision making in the management and governance of water resources. The ability of citizen science to produce data over wider spatial and temporal scales than conventional approaches is well recognized. The introduction of smart phones and internet access has paved the way for new opportunities for data collection, mainly through widespread public participation in science. In the present study reports the introduction of a citizen based monitoring system introduced in the city of Kozhikode, Kerala involving multiple community groups for generating the drinking water quality data of different sources. The said groups were provided with the testing tool and adequate training for water quality analysis. The data is then uploaded into a mobile application named WATERCAT, developed by us. The data is then validated by the experts and necessary suggestion are made for the immediate intervention if required. The study revealed that the co-created way of generating knowledge involving citizens enhances data quality as well strengthen the water resource management.

Keywords: Citizen observatory, Water quality monitoring, Public participation

SCIENTIFIC SOCIAL RESPONSIBILITY-10 REG. No. 15819

Virtual Water Foot Print of Major Imported Agricultural Commodities of Kerala—A Case Study

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Kerala has long been a consumer state, depending on their neighbours to meet their food requirement.Kerala imports 'virtual water' from other states through agricultural products that it imports.The water footprints of a product can be used to provide information to consumers about the water-related impacts of products they use or to give policy makers an idea of how much water is being "traded" through imports and exports of the product.This study investigates the virtual Water Footprint (WF) resulting from the agricultural imports of Kerala. Within the study, the virtual water imports of agricultural commodities for the year 2018 were assessed.Virtual water import (mcm) was calculated by multiplying the water footprint (m^3/ton) of the agricultural commodity by the amount of the imported agricultural commodity(ton). Mainly cereals, pulses, fruits and vegetables, which Kerala is importing is considered for the study. Cereals and pulses accounted for the majority of the Virtual water import among the agricultural commodities that were imported in Kerala. This study indicated that the state of Kerala saves around 5.7 billion cubic meters of water per year by the importing virtual water through agricultural products from other states. Further study in this field is required to account for the net virtual water footprint by considering the import and export of products in Kerala.

Keywords: Water foot print, Cereals, pulses, vegetables

SCIENTIFIC SOCIAL RESPONSIBILITY-11 REG. No. 15849

Illuminating Fuel Oil from *Garcinia gummi-gutta* Seeds: An R&D Innovation of Social Relevance

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Background: Though our country is endowed with a diversity of oil bearing plants, the traditional oil sources were neglected by the emergence of more commercialized products. Further, lack of proper validation through modern science and technology tools also decreased the acceptability of traditional oils in domestic sector, and now we are importing around 65% of our domestic oil demand. The increasing dependence of imported oils prompted us to think of alternate sources of oils and value added products from our indigenous plant resources.

Methods: The seeds of ripened fruits of *G. gummi-gutta* were collected from Thiruvalla. The oil was analyzed by GC-MS and NMR, which yield more precise and accurate results compared to the conventional wet lab methods. The thermal stability study of oils was done using TG/DTG, while the calorific value was determined using Bomb calorimeter.

Results: The oil yield was 35.0 %, and continuous solvent extraction using hexane was found as the optimum extraction method for seed oil. The major constituents were the saturated fatty acid stearic acid (55.4%) and the unsaturated fatty acid oleic acid (40.2%) as determined by GC-MS analysis of FAME. The physico-chemical parameters were determined through NMR values. TG/DTG studies showed mass loss of 93.16% for *G. gummi-gutta* seed oil compared with coconut oil at 78.35% in the temperature range 231-402°C.

Conclusions: The seeds of *G. gummi-gutta* are considered as a waste material, difficult to dispose, and the present study suggest the seeds as rich source of oils that can be used as illuminating fuel, along with its previously reported edible utility. The socio economic relevance of the findings are; self sustenance in oil sector, sustainable utilization of local resources, and additional income for the rural

agricultural sector. The findings also highlight the importance of our biodiversity and make an awareness on how to use the resource sustainably.

Keywords: *Garcinia gummi-gutta;* Seed oil; Illuminating fuel

SCIENTIFIC SOCIAL RESPONSIBILITY-12 REG. No. 15890

A Bioinformatics Approach for the Development of Plant Based Molecules for Use in the Treatment of Rheumatoid Arthritis, a Chronic Inflammatory Disorder

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Background: Rheumatoid Arthritis, also abbreviated as RA, is a grave auto-immune and inflammatory disease that affects majority of the adult population. People affected by this disease experience immense pain especially at the joints of hands and legs. When RA is less uncontrolled, the patient may experience joint deterioration, severe disability, decreased quality of life, dependence on others, the onset of comorbidities and premature mortality. Because of the disease severity, it is of utmost importance to design drugs that are effective for treatment of Rheumatoid Arthritis. Currently available drugs are non-steroidal anti-inflammatory drugs, glucocorticoids, and DMARDs (disease-modifying anti-rheumatic drugs) of synthetic origin or of biological origin. Some of the conventional DMARDs are methotrexate or targeted DMARDs, such as Janus kinase [JAK]-inhibitors and those of biological origin are tumor necrosis factor [TNF]-inhibitors, B-cell depleting drugs etc. This work is aimed to find the suitability of potential lead molecules from *Ficus religiosa* and *Sida cordifolia* for use in the treatment of Rheumatoid Arthritis.

Method: Molecular docking simulation was carried out in the present study using the software tool Molegro Virtual Docker. The drug properties of two selected compounds, one each from *Ficus religiosa* and *Sida cordifolia* were assessed and the features of the selected compounds were compared with popular chemical drugs used in the treatment of Rheumatoid Arthritis.

Results: Docking results demonstrated that Quercetin, a prominent phytoconstituent present in *Ficus religiosa*, can be used as a potential

lead compound for the treatment of Rheumatoid Arthritis. It is also known that the long term usage of synthetic drugs produce undesirable side effects and has to be replaced with natural (plant derived) drugs with minimal or no side effects.

Conclusion: The results revealed that Quercetin can be used as a potential drug candidate for the treatment of Rheumatoid Arthritis. However, Quercetin molecule need to be further screened extensively through dry lab and wet lab experimentation and more receptors have to be tested to understand its efficiency.

Key words: Rheumatoid Arthritis, Molecular Docking, Molegro Virtual Docker, Quercetin

This volume contains the abstracts of papers that the researchers present during the 34th Kerala Science Congress- an annual event of Kerala State Council for Science, Technology and Environment. Focal theme of the Science Congress is 'Science, Technology and Innovation for Transition to a Knowledge Economy'. Presentations are grouped in 12 different subject areas viz. Agriculture & Food Sciences; Biotechnology; Chemical Sciences; Earth & Planetary Sciences; Engineering & Technology; Environmental Sciences, Forestry & Wildlife; Fisheries & Veterinary Sciences; Health Sciences; Life Sciences; Mathematical Sciences; Physical Sciences & Scientific Social Responsibility.

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